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Interim Service ISDN Satellite (ISIS) Simulator Development

for
Advanced ISDN Satellite Design
and Experiments

30 August 1992

Task Completion Report
NASA SCAR Contract NASW-4520, 13 Sep 1990

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SECTION 1

INTRODUCTION

1.1 Background

The objectives of this element of the NASA Satellite Communications Applications Research (SCAR) Program are to develop new advanced on-board satellite capabilities that will enable the provision of new services, namely interim and full Integrated Services Digital Network (ISDN) services via satellite and to provide a system analysis of futuristic satellite communications concepts, namely broadband services via satellite.

This aspect of the NASA SCAR Program provides a research and development effort to:

1) develop basic technologies and concepts to use the on-board processing and switching capabilities of advanced satellites that will enable the provision of interim and full ISDN services and

2) provide a systems and requirements analysis of future satellite communications concepts based on a new generation of broadband switching and processing satellites.

These objectives will be achieved in part via modeling and simulation of ISDN satellites as part of the ISDN terrestrial network. Models of the Interim Service ISDN Satellite (ISIS) and the Full Service ISDN Satellite (FSIS) described in their Task Completion Report dated 15 Sep 1991 and 1 Mar 92, respectively, will be developed and exercised using discrete event simulation techniques. To provide meaningful results these network models represent the subsystems of the advanced satellite system at a proper level of abstraction to include real world ISDN communications satellite design parameters.

An end-to-end network view was developed using the framework of the CCITT and ANSI standards to ensure that ISDN procedures and protocols are properly implemented to permit meaningful simulation, evaluation and analyses of ISDN communications satellite designs. Performance measures and scenarios published in a report, dated 28 Feb 1992, addressed simulation results in terms of throughput, response time, blocking probability, and robustness. Simulation measurements must provide insight into the engineering viability of the ISDN communications satellite systems by associating them with parameters such as propagation delay, signal degradation, message queue lengths, network node switching delays and protocol timers.

1.2 Scope

This task completion report documents the simulation development associated with the network model of both the ISIS and FSIS architectures. These approaches are described in Figure 1.1-1, "NASA/SCAR Approaches for Advanced ISDN Satellites". The ISIS Network Model development represents satellite systems like the Advanced Communications Technology Satellite (ACTS) orbiting switch.

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ISIS Interim Service ISDN Satellite	FSIS Full Service ISDN Satellite	BSIS Broadband Service ISDN Satellite
• ACTS-like Satellite Design and Transponder	• New ISDN Satellite Design with onboard Class 5 Switch and SS7 Network Interface	• Advanced ISDN Satellite Design with onboard Class 5 Switch and SS7 Network Interface and layered protocol
• Provide Narrowband ISDN Services (Basic Rate Access)	• Provide Narrowband ISDN Services (Basic/Primary Rate Access)	• Provide Broadband ISDN Services (Primary Rate Access)
• Provide remote access ISDN Satellite Terminals using ISDN Satellite Terminal Adapter	• Provide nationwide single hop single CONUS earth coverage antenna satellite link connectivity to an interexchange node for ISDN Satellite Terminals (up to 10,000 ISAT)	• Provide nationwide single hop, multiple high gain hopping beams, forward error control, optical processing, and "zero delay" satellite link interexchange node connectivity
• Will use D channel signaling but NOT SS7	• Will use D channel signaling with SS7	• Will use D channel signaling with SS7
• Will use ACTS call control and Baseband Switching Architecture	• Will use SS7 call control with minimum call set-up time and efficient satellite BW utilization	• Will center design around ATM fast packet switching techniques

Figure 1.1-1 NASA/SCAR Approaches for Advanced ISDN Satellites

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Approach Adv ISDN Satel
August 17, 1992

ACTS will be controlled by a Master Ground Station (MGS) shown in Figure 1.2-1, "Closed User-Oriented Scenario". A user of the ACTS satellite orbiting switch request services from the MGS, a combination of the NASA Ground Station (NGS) and the Master Control Station (MCS). The MGS, in turn, commands the satellite to switch the appropriate communication channel.

The ultimate aim of this element of the SCAR Program is to move these MGS functions on-board the next generation ISDN communications satellite as shown in Figure 1.2-2, "Advanced ISDN Satellite" as part of the FSIS architecture. The technical and operational parameters for the advanced ISDN communications satellite design will be obtained from the simulation of ISIS and FSIS engineering software models of the major subsystems of the ISDN communications satellite architecture. Discrete event simulation experiments will be performed with these models using various traffic scenarios, design parameters, and operational procedures. The data from these simulations will be analyzed using the NASA SCAR performance measures discussed in previous reports.

1.3 Document Overview

This task completion report begins by citing the SCAR Simulation Objectives in Section 2, and explain the logic for the simulation phases. A description of each phase is provided. Section 3 discusses the SCAR simulation development and methodology used to determine the design parameters for the SCAR advanced ISDN communications satellite design. Particular attention is given to the comparison between the ISIS and FSIS simulations since over 80% of the software modules are reused between them. The two main sections of this task completion report are Section 4.3, Simulation Structures, which include a descriptions of both ISIS and FSIS architectures down to the process level and Section 4.4, Simulation Processes, provides a detail description of each process used for both the ISIS and FSIS development.

Several appendices are included to provide more details on the Scenario Traffic File (STF), Process Array Structure, the Traffic Model Database, the Q.931 Protocol Simulation, the Measurement Save (MSave) file, and the products of: ISDN Satellite Call Data, ISDN Satellite Response Time, ISDN Satellite Throughput, and Z-Chart Trace..

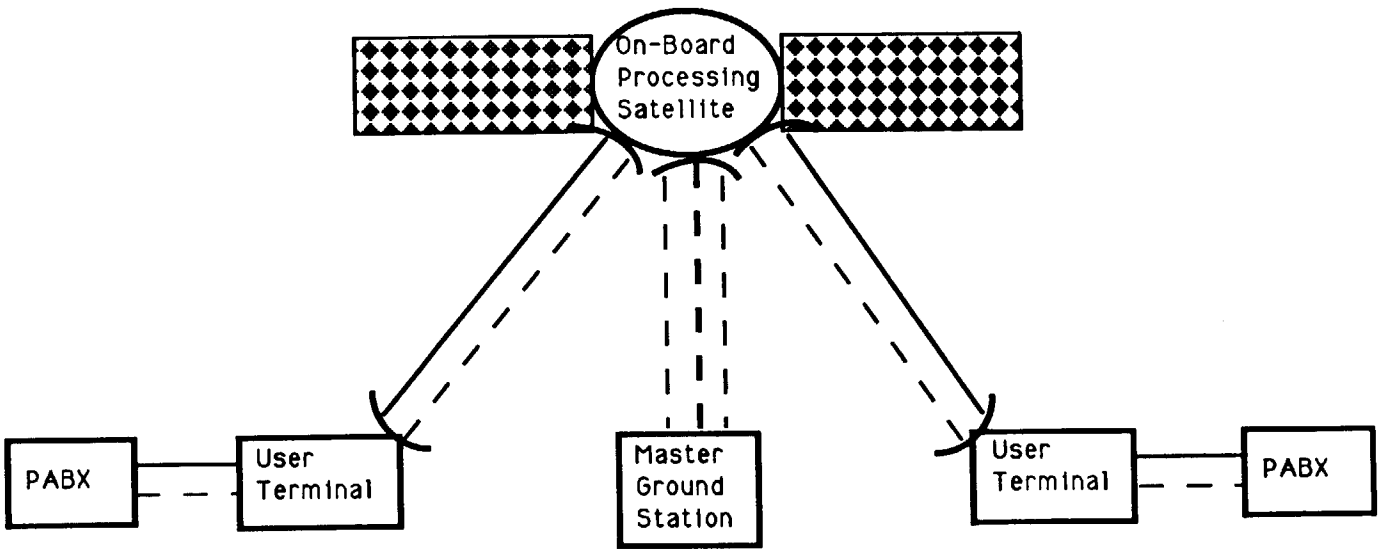

Figure 1.2 -1 Closed User-Oriented Scenario

Ref: Fournon 131SS

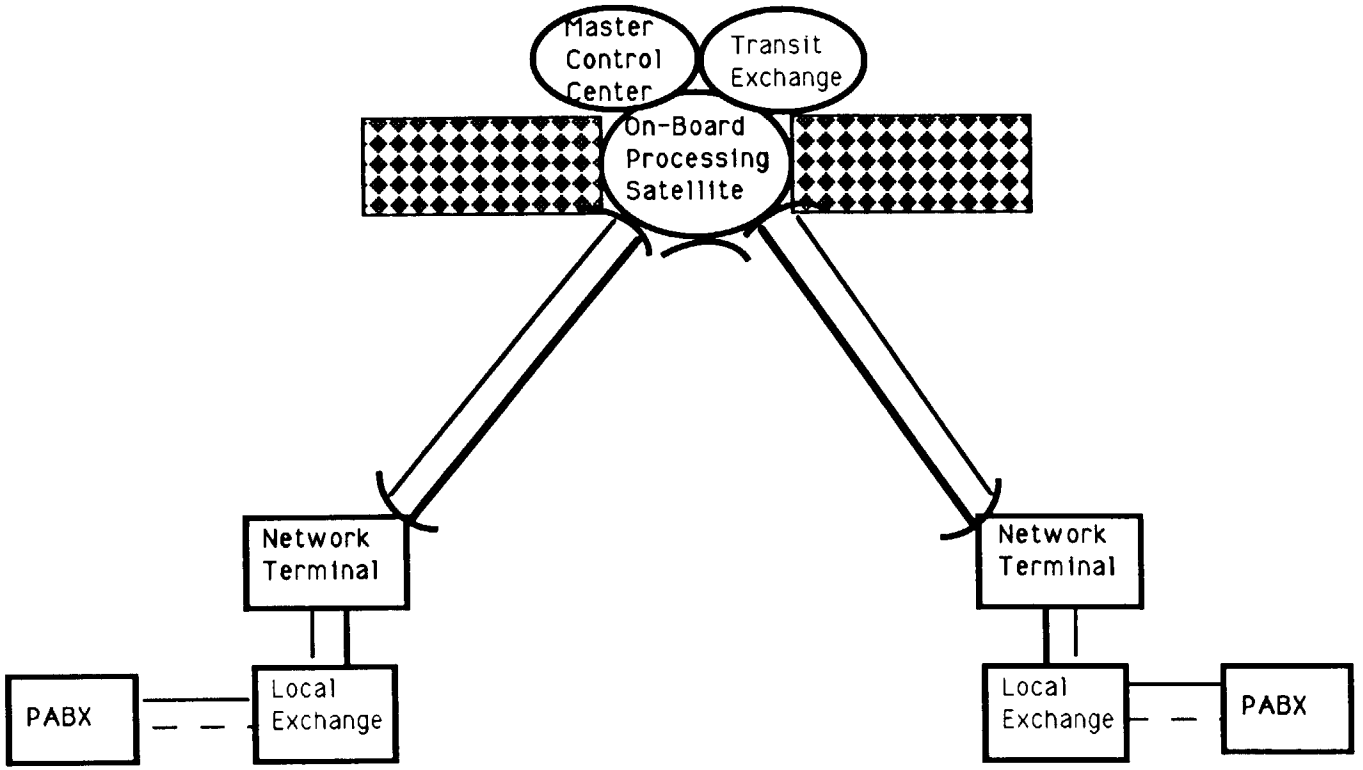

Figure 1.2-2 Advanced ISDN Satellite

SECTION 2

SCAR SIMULATION

2.1 SCAR Simulation Objective

The objective of this SCAR simulation project is to design and develop software models that can be used to simulate an ISDN communications satellite with sufficient fidelity to assist in determining its design parameters. This simulation effort will assist in the development new advanced on-board satellite capabilities that will enable the provision of new services of an interim and full ISDN communication satellite. Figure 2.1-1., "ISDN Communications Satellite Simulation Top View", indicates the inputs and outputs expected of the SCAR simulation as well as the characteristics of the simulation, itself.

ISDN protocols, procedures, standards and user traffic are the input bases for the simulation. The on-board processing technology, the OSI methodology, and the satellite environment challenge the ISDN aspects of the communications satellite design. Both the ISIS and FSIS communications satellite simulations use discrete event based simulation of communication protocol flows through an engineering model to generated results traceable to the technical design parameters. The ISDN communications satellite simulation outputs will be capable of demonstrating the viability of an ISDN satellite design and provide the rationale for recommending specific engineering parameters and changes to published ISDN standards.

2.2 Simulation Programs

This end-to-end simulation is divided into distinct simulation phases: database generation, scenario generation, engineering data generation, simulation run, and product generation as shown in Figure 2.2-1., "SCAR Simulation Phases". The ISDN communications satellite end-to-end simulation is shown in Figure 2.2-2, "ISDN Communications Satellite Simulation Software". Each program is physically and functionally separated by input/output data files. This separation ensures that each simulator program is independent. The only link between these programs is the data file they share. Each program is briefly described in the following sections in order to provide an overview of the simulation process.

2.2.1 Database Generation Program

The Database Generation (DbGen) program assembles the major ISDN user characteristics into a machine readable database. For this NASA SCAR effort the traffic model consists of a number of databases: the City Reference DB, ISDN User vs Industry DB, Application vs Industry DB, Application vs Time DB, and Application vs Bearer Services DB. Figure 2.2.1-1, "CONUS City Locations for NASA SCAR Traffic Model Database", shows the cities that are part of the traffic model. Those cities outlined with an ellipse identify the ACTS-east cities. Those cities outline with a rectangle identify the "ACTS-west" cities and the blackened squares depict the fixed antenna cities. The east/west city clusters are separated by a dashed line. The figure shows that the NASA SCAR traffic model is well aligned with the cities of interest for ACTS. The traffic model database represents the ISDN traffic for these cities and is the principal input to the scenario generation process. The traffic model databases data are presented in Appendix C. "SCAR Traffic Model Database Data".

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ISDN
- Protocols
- Procedures
- Standards
- User Traffic

SS7
- Protocols
- Message Parts

OSI
- Layers
- Protocols
- Services

Satellite
- Architectures
- Constellation
- Environment
- Parameters

ISDN Satellite Operational Demonstration
ISDN Communication Satellite Design
Specific Engineering Parameters
Recommend Changes to ISDN Standards

Engineering Model
Protocol Level
Discrete-Event Based
High Resolution
Deterministic
Traceable Results
Satellite Oriented
Emphasis on ISIS/FSIS
Tightly ISDN Coupled
Oriented to Advanced Satellite Design

Figure 2.1-1 ISDN Communications Satellite Simulation Top View

5 T050 SCA DAT
ISDN Comm Satel Top View
March 18, 1992

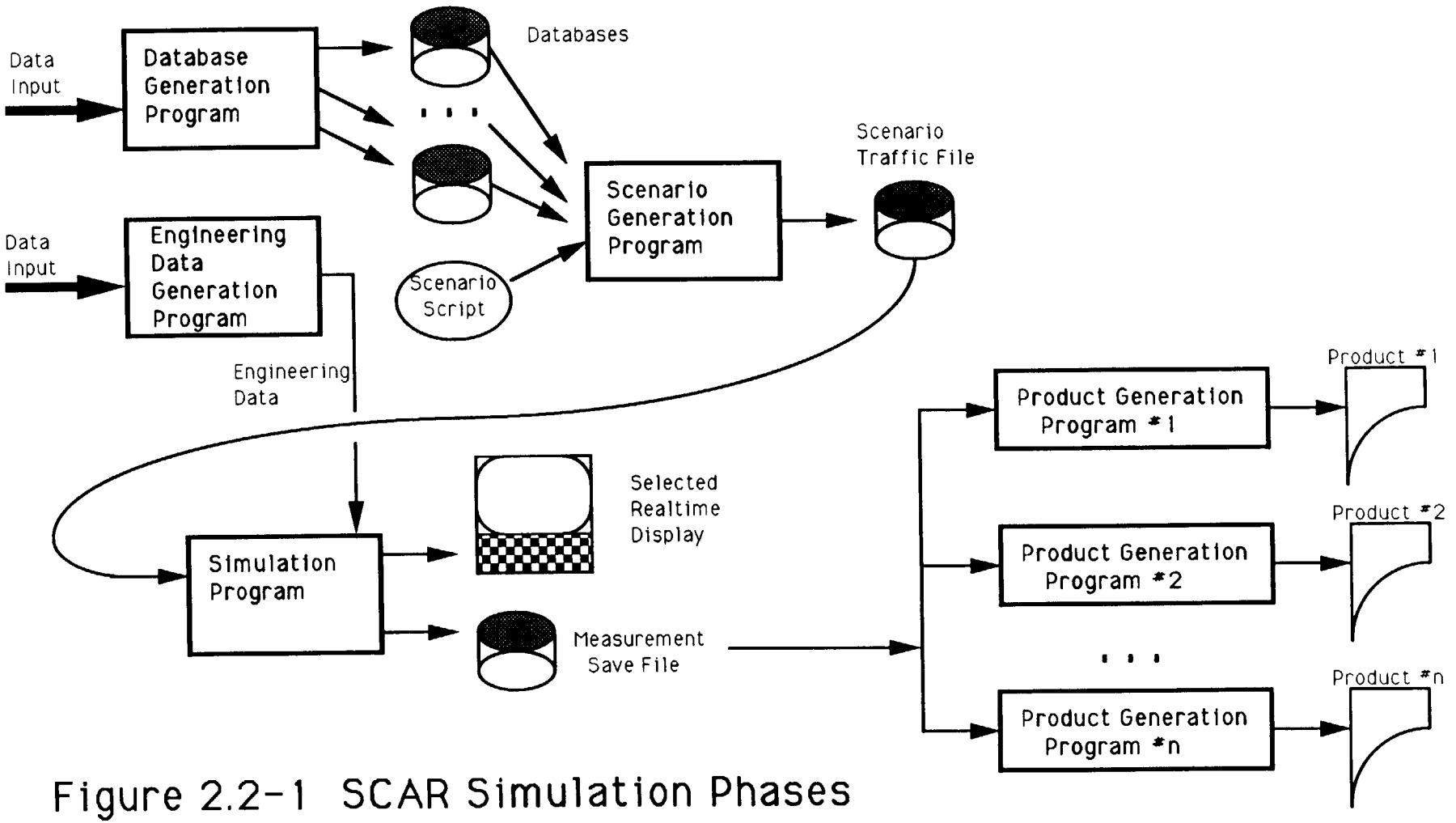

Figure 2.2-1 SCAR Simulation Phases

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SCAR Simulation Phases Brf
August 17, 1992

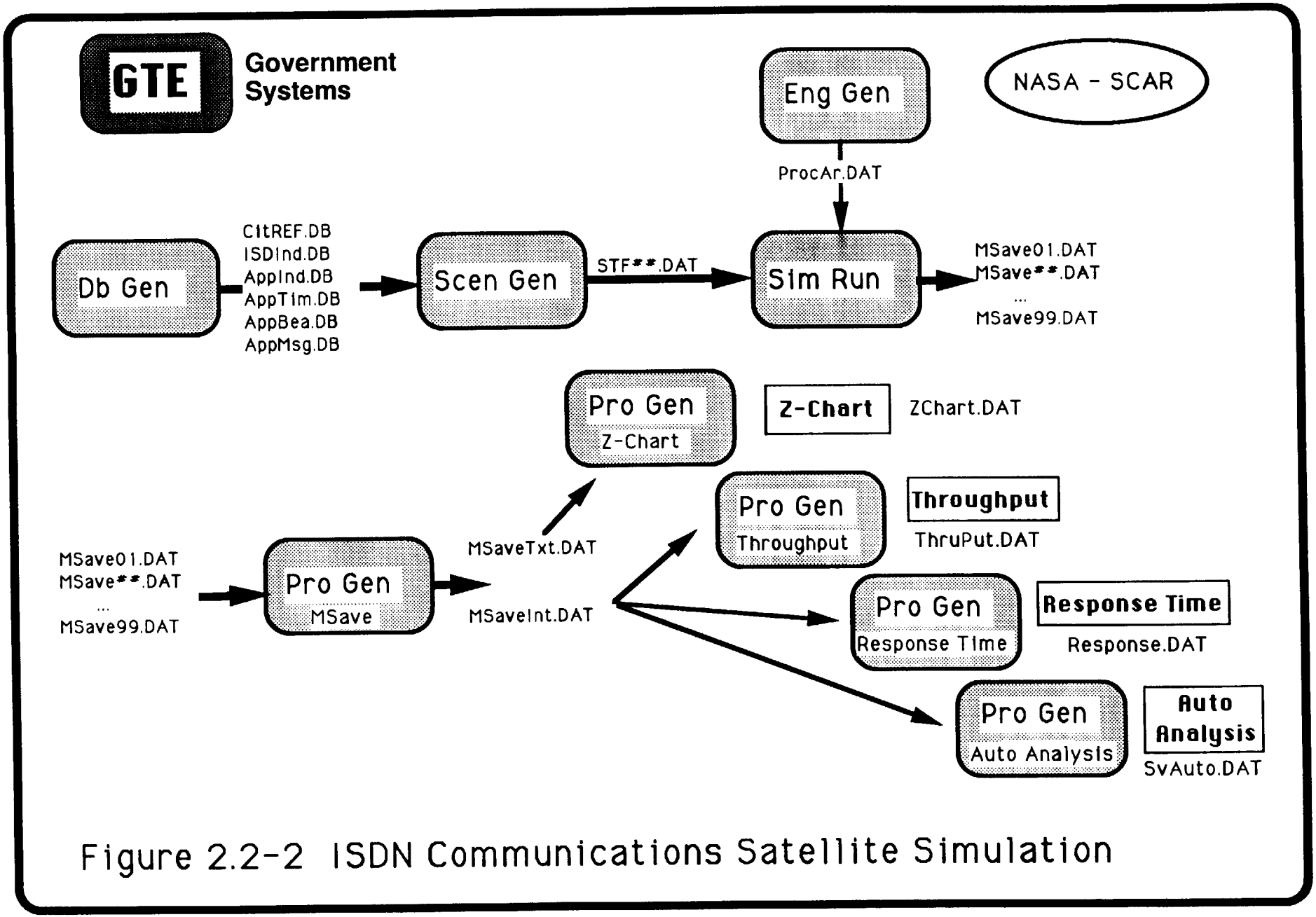

Figure 2.2-2 ISDN Communications Satellite Simulation

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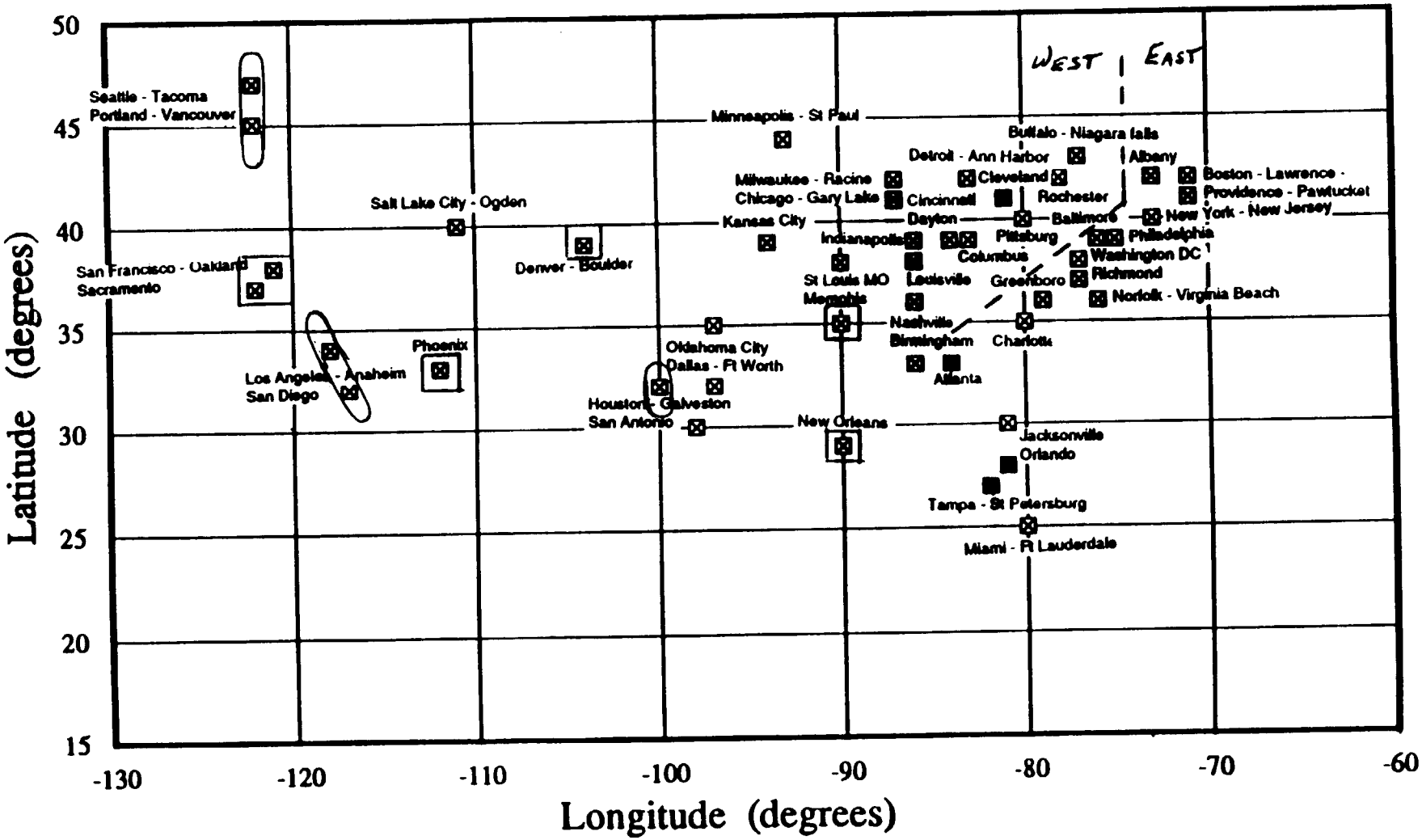

Figure 2.2.1-1 CONUS City Locations for NASA SCAR Traffic Model Database

5 T036 SCA DAT
TrafModel City Loc Map
September 26, 1991

2.2.2 Engineering Data Generation Program

The Engineering Data Generation (EngGen) program allows the selection of the engineering parameters for describing the advanced ISDN communications satellite. Each software module of the ISIS and FSIS simulation represents a communication subsystem. Each of these communication subsystem module is constrained in its operation by specific engineering parameters. The EngGen program allows the selection of these engineering parameter on a subsystem-by-subsystem basis. The output of EngGen is a matrix of engineering parameters organized on a communication subsystem basis. These EngGen parameters are read by the ISIS and FSIS simulation software before the simulation begins and describe the ISDN communications satellite architecture being simulated. The output of EngGen is a data matrix for the process array, ProcAr, of the simulation run phase. The process array is described in Appendix B, "Process Array (ProcAr) Structure".

2.2.3 Scenario Generation Program

The Scenario Generation (ScenGen) program selects the traffic model database entries that describes a scenario of ISDN users together with the statistical information of the ISDN services requested. The ScenGen program uses entries from the user traffic model database to generate a list of time ordered, initiating discrete events. The discrete event list is call a Scenario Traffic File (STF). The STF is used to exercise that satellite design using the requests for ISDN services dictated by the ISDN user traffic. The STF is described in Appendix A, "Scenario Traffic File (STF) Structure"

2.2.4 Simulation Run Program

The Simulation Run (SimRun) program consists of a model of the major ISDN communications satellite components. Each of these ISDN communication components is represented by a block diagram within the overall architecture. As shown in Figure 2.2.4-1, "Simulation Run Program", the SimRun program essentially reads the engineering data and each discrete event from the (STF) in turn, takes the appropriate action, and logs that action and the corresponding results in a measurement save (MSave) file. The appropriate action taken by the simulation includes allocating and releasing communication resources, denying specific services, and calling other processes in-turn. These actions conform to communication standards for the CCITT Q931 protocols as depicted in the "Blue Book" and described in Appendix D, "Q931 Protocol Simulation". The major output of SimRun is the MSave data file. The description of the MSave is presented in Appendix E, "Measurement Save (MSave) Structure".

2.2.5 Product Generation Program

The Product Generation (ProGen) program reads the data in the MSave file and analyzes these data in accordance with specific algorithms. It is envisioned that there will be as many product generation programs as there are ISDN communications satellite issues to be studied: throughput, response time, trace, delay, call blocking, busy-minute, busy-hour, etc. Each ProGen program is tailored to a particular area of ISDN communications satellite design. Performance measures will be used as criteria to evaluate the design parameters, operational procedures and degree of ISDN communications standard compliance of the particular ISDN communications satellite design. Several products have been demonstrated in FSIS Build 3. The "Basic ISDN Satellite Call Data Product", the "ISDN Satellite

Response Time Product", and the "ISDN Satellite Throughput Product" are presented in Appendices F, G, and H,. respectively.

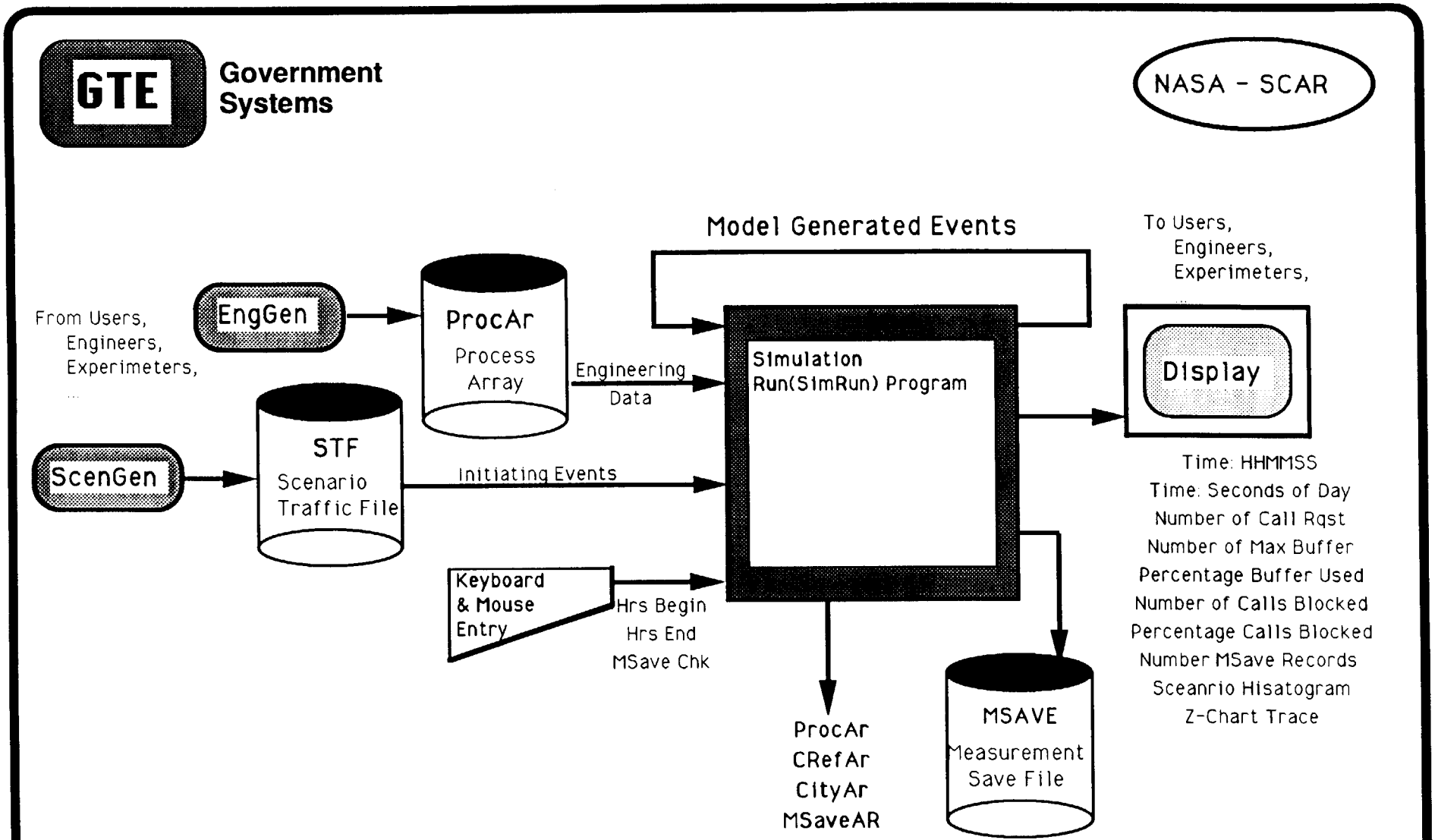

Figure 2.2.4-1 Simulation Run Program

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Simul Run Program
August 17, 1992

SECTION 3

SIMULATION DEVELOPMENT

3.1 Technical Concept

This NASA SCAR effort uses network modeling and simulation as the principal vehicle for determining the parameters of an ISDN communications satellite design. This network modeling and simulation must clearly delineate the network architecture (as defined by the network methodology, the number and kinds of communications elements and how those elements are configured), the network operations (including link and network layer protocols and how network functions are distributed among communications elements), and the system constraints (imposed by the engineering parameters, by the network and by the operational requirements).

3.2 Network Model and Simulator Design

Discrete event simulator designs for both ISIS and FSIS were initially defined based on the Phase I network model of the these communications architectures. The traffic model database and the scenarios, also developed in Phase I, were used to define ISIS and FSIS the designs using these simulator inputs. The simulator design outputs were based on the performance measures established in Phase I and will be used to evaluate overall ISDN communications satellite design.

3.3 Simulator Development

ISDN is based on the Open System Interconnection (OSI) Reference Model. Though the simulator development focuses on the second (data link) and third (network) layers to evaluate the performance of routing, acknowledgement, congestion control, and other protocol driven functions, this simulation development also addresses the time-out and retry issues relate to the first (physical) layer. Although physical characteristics of the system are not directly simulated, the effects of the physical conditions are parametrically simulated. For example, instead of calculating a link budget where all signal losses and gains are summed and converting the signal-to-noise ratio and to a bit-error rate, the simulator takes the transmitted power in dBs as its basis and adjusts the power gain for antennas and power losses for propagation. The resultant received power is compared to a threshold before signal acceptance. Such simulation techniques reduce the complexity of the simulator development, while providing adequate information about layer protocols and their timers.

3.4 Generic Network Model for Simulation

Figure 3.4-1, "Generic Network Model Block Diagram", shows the major subsystems of a communications architecture for a generic ISDN communications satellite simulating two satellite terminals each supporting three users. For this simulation, these subsystem models associated with the satellite terminals consist of an uplink transmitter and transmitting antenna, a downlink receiver and receive antenna, three users generating traffic, and a multiplexer/demultiplexer that combines and separates this traffic. The satellite is modeled by corresponding receivers, transmitters, antennas, an on-board switch, and an on-board processor that decodes received commands, controls the switch, and generates response traffic.

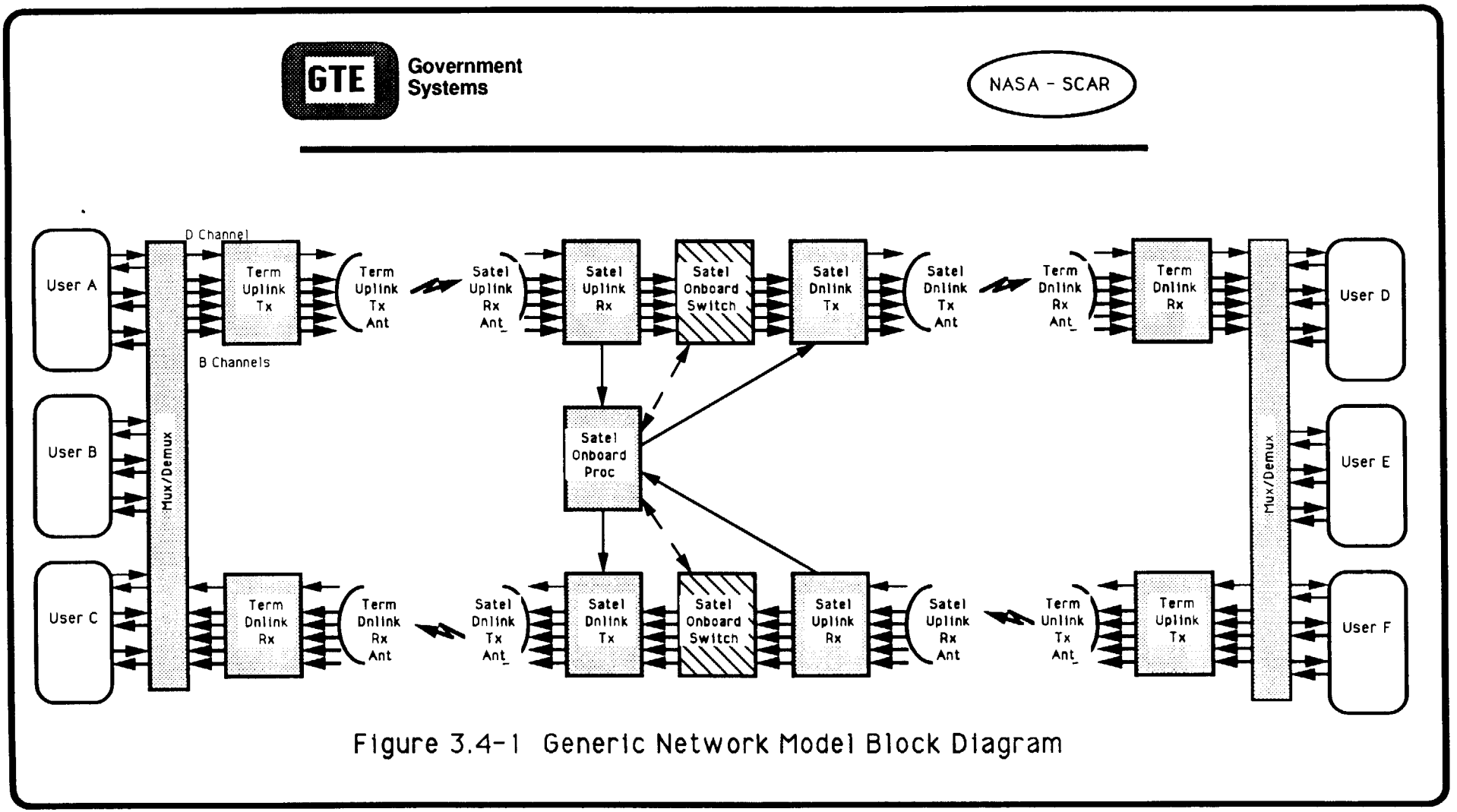

Figure 3.4-1 Generic Network Model Block Diagram

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Generic Netwo Model Block Diagram
August 17, 1992

3.5 Generic Network Model Subsystems

Each of the communications subsystem in the network model design is represented by a software module that performs the functions of that communication component. Figure 3.5-1, "SCAR Network Model Systems", shows the generic network model presented in Figure 3.4-1 as interconnected software modules. Each module has parameters (p) inputs that determines that module's characteristics. For an antenna: p includes such things as the gain, beamwidth, scan rate, dwell time, etc. For a receiver: p includes frequency, burst rates, receiver threshold, receiver delay, etc. For a processor: protocol repertoire, processing time, clock frequency, number of ISDN resources, etc. In general each model module has a p-set that determines the design characteristics. These p's are input via an engineering data matrix that is loaded before the simulation run begins. These engineering data determine the design of the ISDN communication satellite subsystems being evaluated.

The initial discrete events (E) are part of the STF and are executed as a function of time depending on the scenario that generated them. Each of event (E) serves as the initial event for a sequence of internal protocols generated by a particular module in the simulation. Each module processes each discrete event (E) and takes actions accordingly. Many of these actions include generating response events (e) for another modules. The response events (e) are integrated in time order with the initial events (E) via the (stf) to be executed at their respective times. For ISDN protocols, a single initial discrete event (E) will generate many sequential response events (e). The simulation process continues the execution of the time ordered event list of Es and es until the simulation ends. The technical data generated by the simulation is obtained from a Measurement Save (MSave) file. Every time an discrete event is presented to a module its identity and its time of arrival is time-tagged and saved on the MSave file (M). Also, all resource allocations, resource releases, resource denials, event generations, and the status of every module are saved on the MSave file (M) together with their time of occurrence, The MSave file has a complete time ordered history of every event, action, and status of every module for the entire simulation. That MSave file can be analyzed on post run basis to generate any number of technical and operational report products.

3.6 Generic Network Model Simulation Software

The simulation software inside each module determines its communication characteristics and responses. Figure 3.6-1, "SCAR Network Model Simulation Software", depicts the software flow chart for a single module - Proc. In that example, when the processor function (Proc) receives the event (Sig#27). It first reports the event and time to MSave (M). The software then determines if the requested resources are available. At the beginning of the simulation parameter (P1) allocated a number of these resources to Proc. If none of those resources are now available, Proc sends a "No Resources Available" message to the MSave. Proc then clears all Sig#27 items and returns control to the simulation timing routine. On the other hand if resources were available, Proc would allocate and adjust those resources; report the allocation to MSave; and activate the next process in the sequence. The activation time for the next process will be calculated using the processing delay value of P2 milliseconds. Both P1 and P2 values were assigned via the engineering data matrix before the start of the simulation.

The same software modules are re-used with different parametric values for similar functions such as antenna, receiver, processor, etc. for both the ISIS and FSIS architectures. This results in the generation of less simulation code for a given software development.

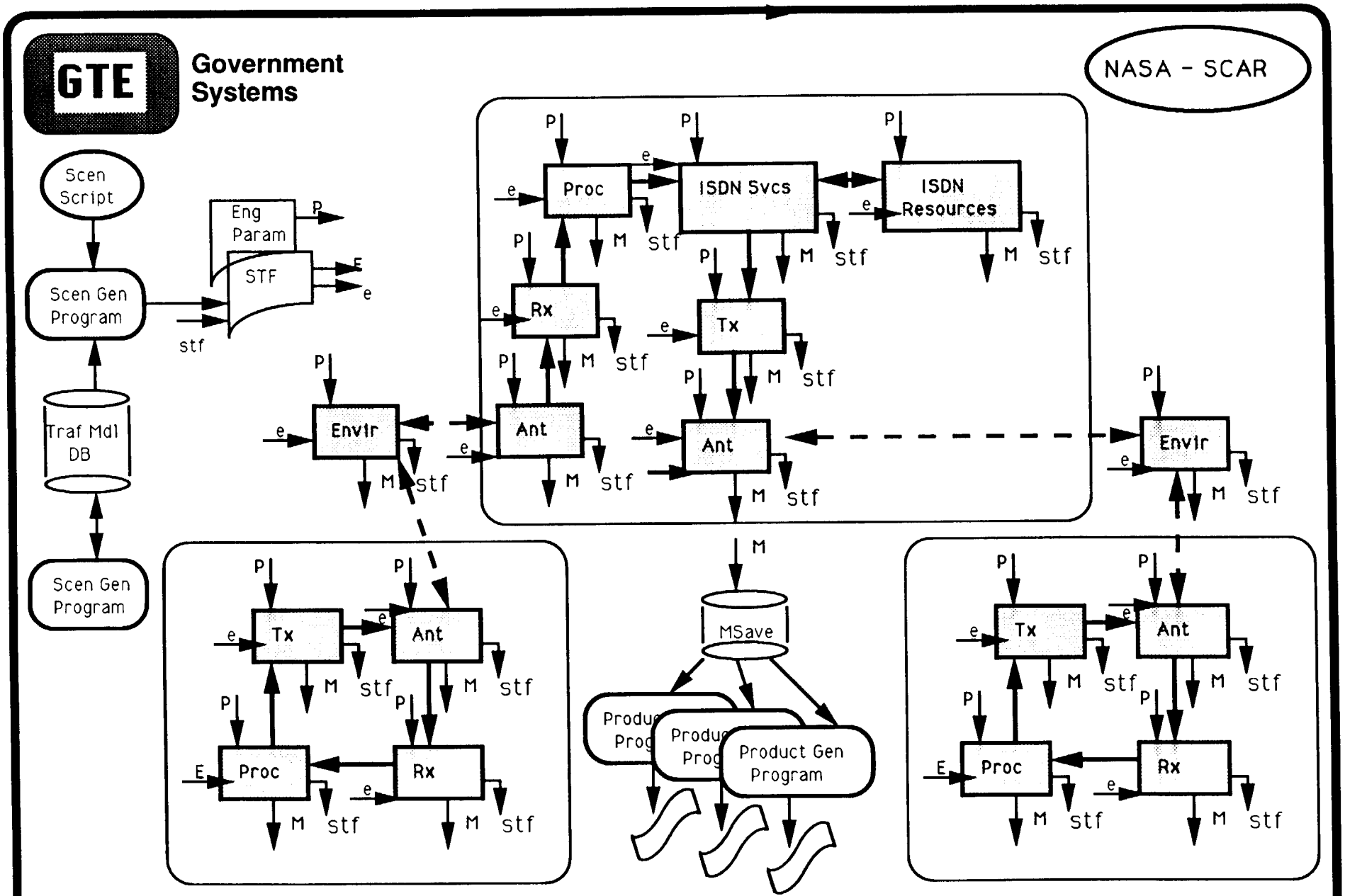

Figure 3.5-1 SCAR Network Model Systems

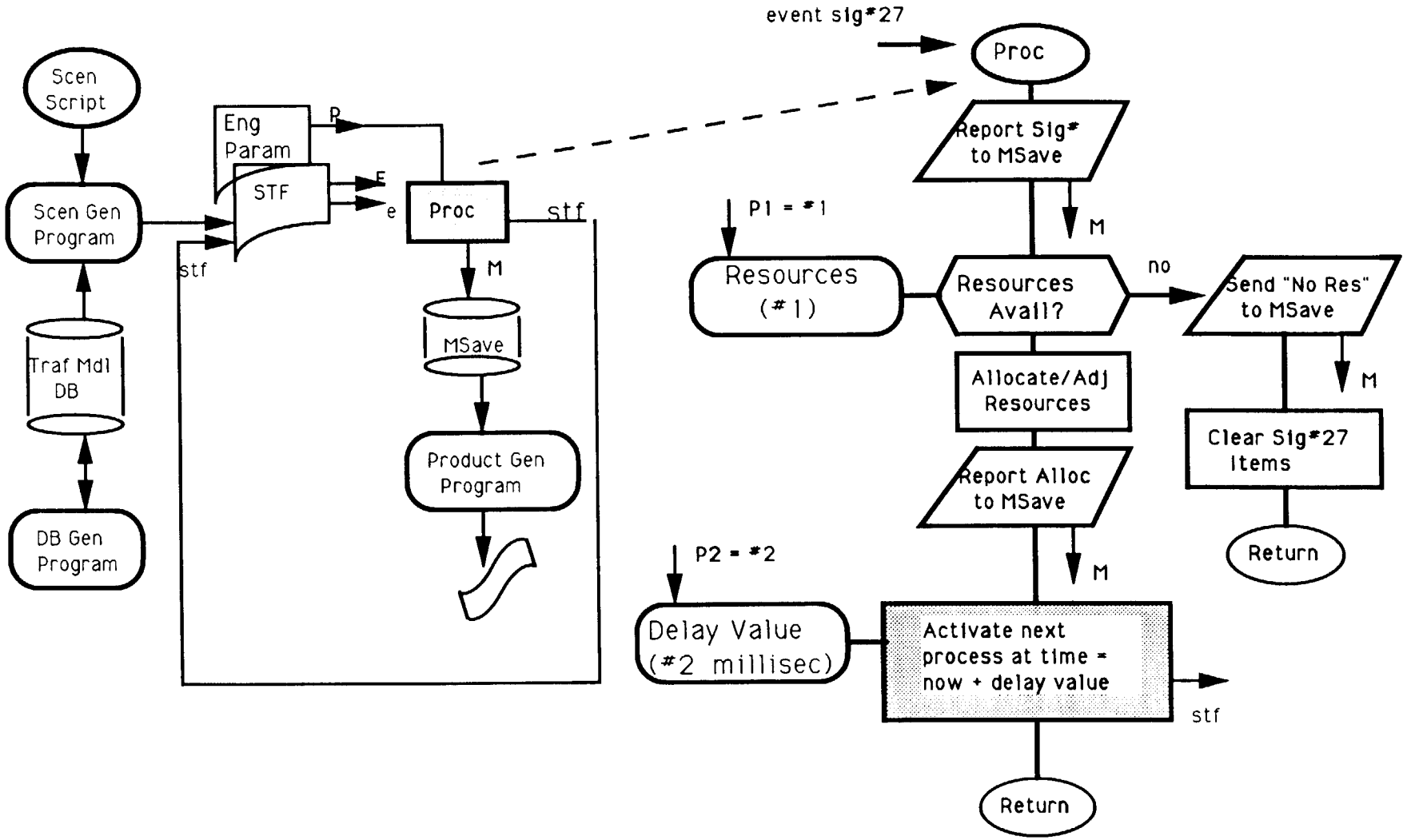

Figure 3.6-1 SCAR Network Model Simulation Software

3.7 Multi-Terminal SCAR Simulations

The Figure 3.7-1, "Multi-Terminal SCAR Model", depicts a satellite-based switch using on-board control to simulate communications services between terminals on the left. This same model is also capable of simulating central offices on the right. Such simulations can be used as a vehicle for analyzing the protocol messages flow among all the users connected to the satellite.

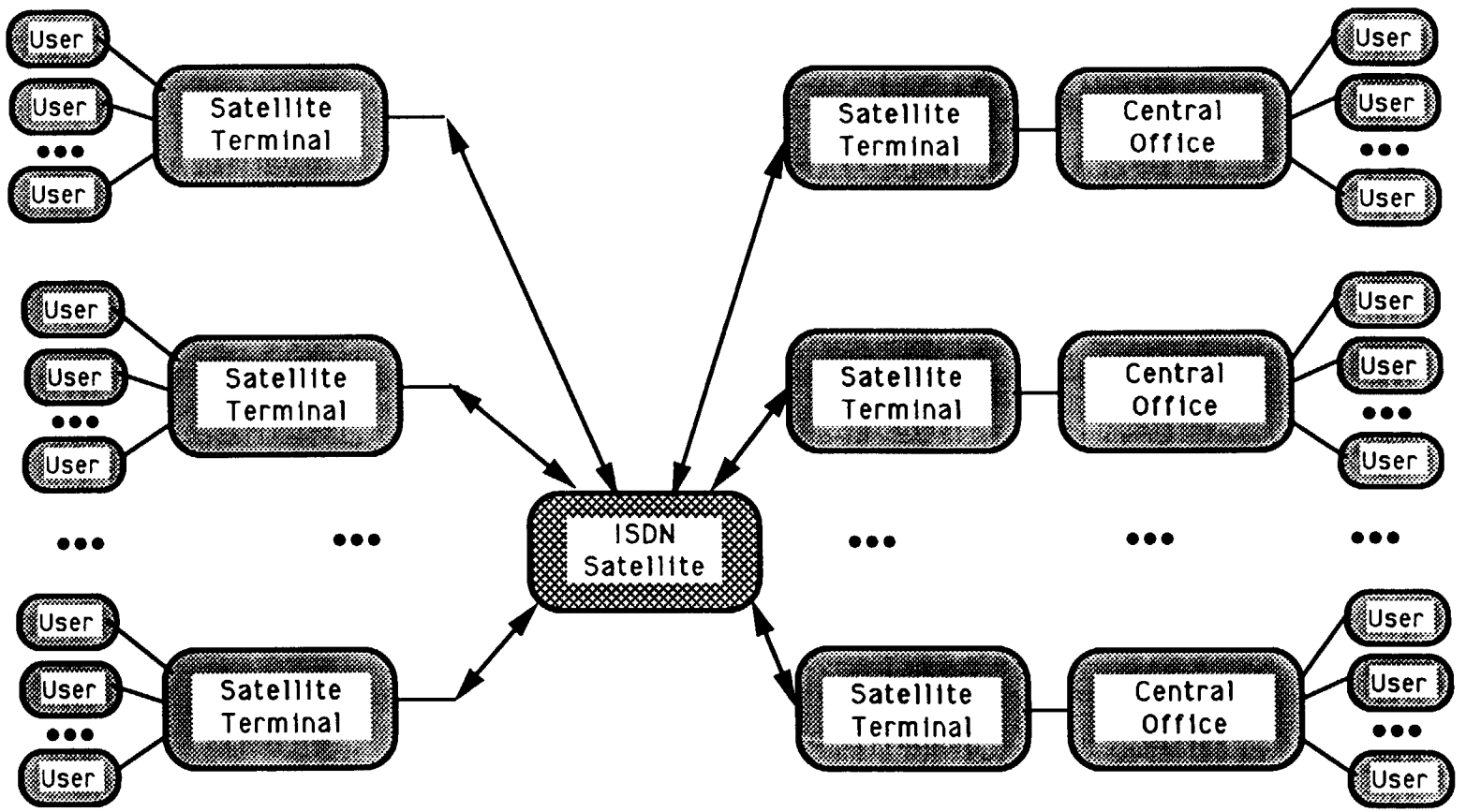

Figure 3.7-1 FSIS Multi-Terminal SCAR Model

SECTION 4

Simulation Components and Processes

4.1 Introduction

The simulation context of the previous sections is now applied to the ISIS and FSIS architectures. The FSIS simulation focuses on the on-board satellite ISDN circuit switched protocols: call control (Q931), LAPD (Q921), PRI (I431), BRI (I430), and SS7 (ISUP). Whereas the ISIS simulation addresses ground based call management using these same protocols supplemented by special order-wire (OW) commands between the satellite and Master Control Station (MGS). The D-channel protocol messages and their associated timing, propagation, processing, and execution are the main concerns of both these models. The B-channels are modeled as resources to be allocated and released as their use and availability dictate.

As illustrated in Figure 4.1-1, "FSIS/SCAR Model Systems", the FSIS system provides the ISDN user access via VSATs connected with ISDN Satellite Terminal Adapters (ISTAs). The FSIS simulation use D-channel signalling and those parts of the ISUP necessary for call control. This approach enables an advanced satellite to provide nation-wide ISDN using an on-board call control and B-channel switching architecture. The ultimate aim of this aspect of this SCAR Program is to move all ISDN functions on-board the satellite for the next generation ISDN communications satellite design.

In both cases, ISIS and FSIS, the simulation analyses will be obtained from engineering software models of their major subsystems of the ISDN communications satellite architecture and their appropriate ground terminations. Discrete event simulation experiments will be performed with these models using various traffic scenarios, design parameters, and operational procedures and performance measures.

4.2 Definition and Purpose

Both ISIS and FSIS simulations consist of a number of VSATs connected to an ISDN satellite via a single hop. The VSATs will exchange ISDN traffic on a demand access, circuit switched basis. The purpose is to investigate the throughput, response time, blocking probability, and robustness of these two ISDN satellite architectures in a benign environment to provide a performance measures baseline and to investigate protocol timing issues at the lower layer levels. Particular attention will focus on the timing and time-outs associated with the ISDN physical layer protocol. These simulations will also deal with issues pertinent to the traffic model derived in Phase I of for the NASA SCAR Progam.

4.3 Simulation Structures

Both the ISIS and FSIS simulation will be described in the same context. A top view of the architecture is presented at the communication component level. This provides visibility into the architecture and links for these major communication components of the engineering models that are used to represent them. The next view treats these models as simulation processes and connects them in an end-to-end diagram representing the protocol flow. To ease the routing algorithm for the simulation a sequential number was ascribed to each process, Process Index (PI). This PI integer uniquely defines the specific occurrence of the process, its neighbors at that time, and the direction of protocol flow. The last view tabulates these processes into a pictorial matrix that associates each of them with their

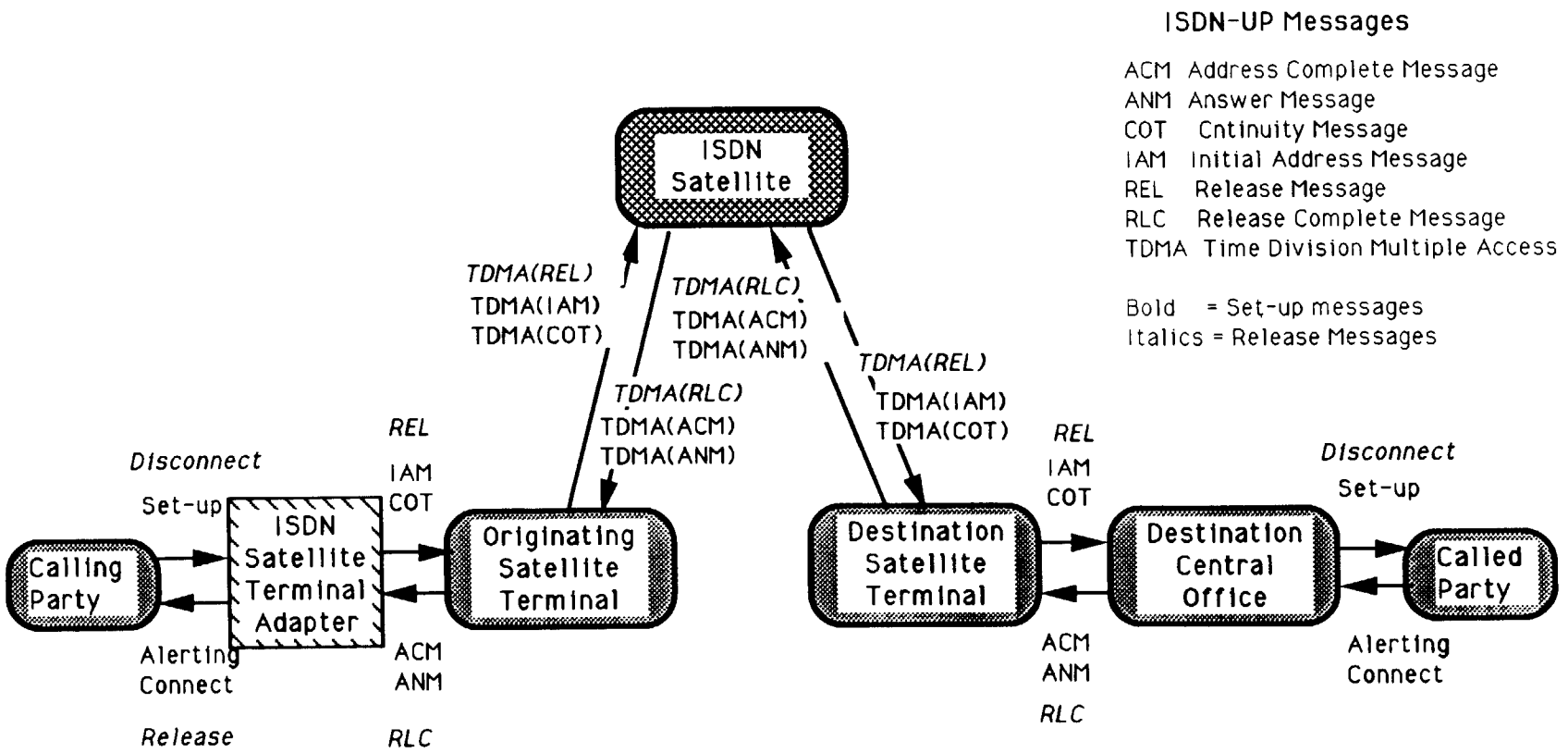

Figure 4.1-1 FSIS SCAR Model Systems

unique process index. The sequential aspects of this representation form a sort of process index "racetrack" pattern that can be used to visualize the protocol hand-off from one PI element to next.

For the FSIS architecture, seven major communication components are connected by six interfaces. Figure 4.3-1., "FSIS Simulation Communication Components", shows the ISDN Telephone, ISDN Satellite Terminal Adapter, VSAT Satellite Terminal and the FSIS Satellite connected by the S-Interfaces, U-Interfaces, and Propagation. Figure 4.3-2., "FSIS End-to-End Simulation Processes", are connected into a network using the Process Index (PI) as a sequence identification mechanism for tracking protocol flow. The processes are aligned with the major communication components depicted at the top of the page. Figure 4.3-3., "FSIS Simulation Communication Components and Model Processes Racetrack", lists all the simulation processes along with their PI numbers. The reference numbers are keyed to the text in this section that provide more detail about both the communication components and the processes. The FSIS simulation architecture statistics include:

4 types of major Communication Components
16 types of simulation modules (processes)
77 process indexes
4.8 factor of software reuse (77 / 16)

For the ISIS architecture, nine major communication components are connected by eight interfaces. Figure 4.3-4., "ISIS Simulation Communication Components", shows the ISDN Telephone, ISDN Satellite Terminal Adapter, VSAT Satellite Terminal, the FSIS Satellite, and the Master Ground Station connected by the S-Interfaces, U-Interfaces, and Propagation. Figure 4.3-5., "ISIS End-to-End Simulation Processes", are connected into a network using the Process Index (PI) as a sequence identification mechanism for tracking protocol flow. Figure 4.3-6., "FSIS Simulation Communication Components and Model Processes Racetrack", lists all the simulation processes along with their PI numbers. The reference numbers are keyed to the text in this section that provide more detail about both the communication components and the processes. The ISIS simulation architecture statistics include:

5 types of major Communication Components
18 types of simulation modules (processes)
109 process indexes
6.0 factor of software reuse (109 / 18)

The commonality factor between the ISIS and FSIS architectures is 89% (16 common modules of 18 modules). The following sections describes each of these ISIS and FSIS communication components in terms of their implementing modeling processes.

4.3.1 ISIS and FSIS Satellite Communication Component

The advanced ISDN communications satellite design under the NASA SCAR Program uses as its design starting point an ISDN switch in orbit. A user of the ISDN satellite requests services using ISDN protocols. These ISDN protocols are routed to the satellite via the VSATs and ISTAs . Depending on the communication satellite design, ISIS or FSIS, these ISDN protocols processed differently.

For FSIS, the ISDN satellite operations are modeled by an uplink receiving antenna (RxAnt 30) and receiver (Rx 30) that are connected to the on-board ISDN order-wire processor (FSISO). See Figure 4.3-1. The FSISO either routes the protocol messages to

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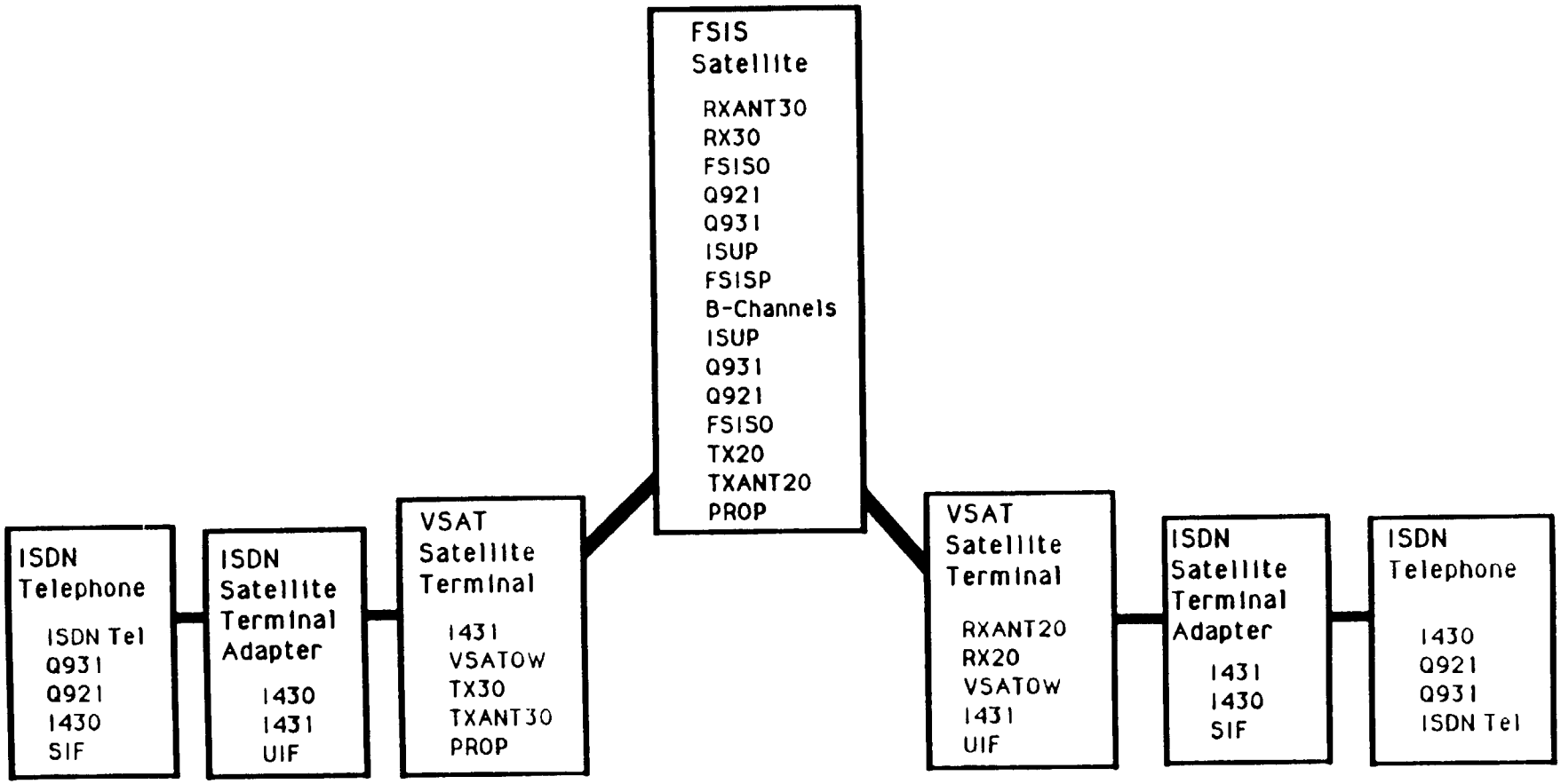

Figure 4.3-1 FSIS Simulation Communication Components

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FSIS Commu Components
Mar 17, 1992

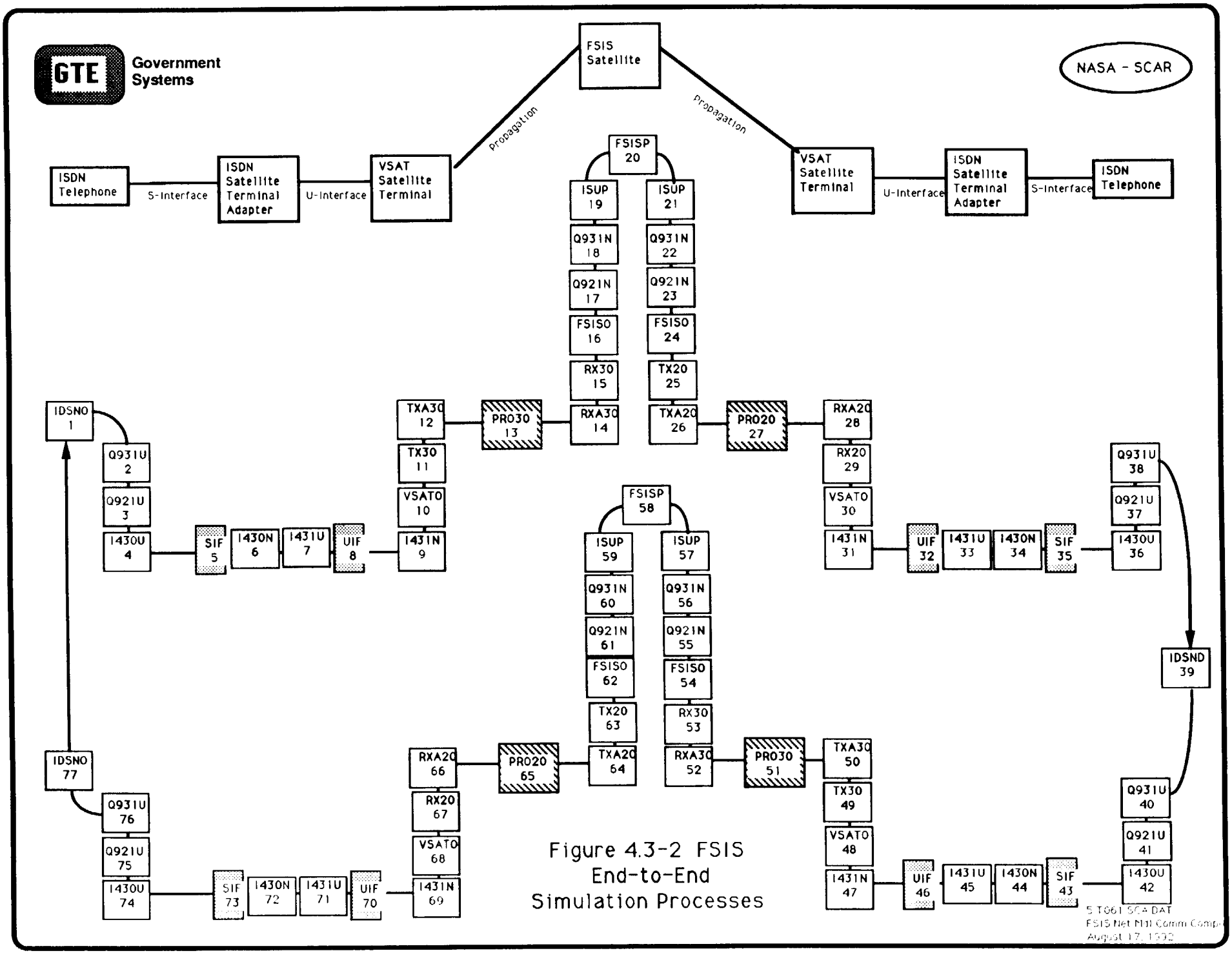


Figure 4.3-2 FSIS End-to-End Simulation Processes

5 T061 SCA DAT
FSIS Net Mtl Comm Comp
August 17, 1992

Comm Component: Para # 4.3.5	Process Index (PI)	Model Processes:	FSIS Rpt		Model Processes:	
ISDN Tel	1	ISDNO (Tel)	Para #	4.4.5	ISDNO (Tel)	77
	2	Q.931U (User)		4.4.11	Q.931U (User)	76
	3	Q.921U (User)		4.4.10	Q.921U (User)	75
	4	I430U		4.4.3	I430U	74
4.3.7	5	SIF		4.4.14	SIF	73
4.3.4						
ISTA	6	I430N		4.4.3	I430N	72
	7	I431U		4.4.4	I431U	71
4.3.8	8	UIF		4.4.17	UIF	70
4.3.3						
VSAT	9	I431N		4.4.4	I431N	69
	10	VSATO (OW)		4.4.18	VSATO (OW)	68
	11	Tx (30)		4.4.12	Rx (20)	67
	12	TxAnt (30)		4.4.13	RxAnt (20)	66
4.3.6	13	Propa (30)		4.4.9	Propa (20)	65
4.3.1						
FSIS ISDN	14	RxAnt (30)		4.4.16	TxAnt (20)	64
Comm Satellite	15	Rx (30)		4.4.15	Tx (20)	63
Poss Bypass	16	FSISO (OW)		4.4.2	FSISO (OW)	62
	17	Q.921N (Network)		4.4.10	Q.921N (Network)	61
	18	Q.931N (Network)		4.4.11	Q.931N (Network)	60
	19	ISUP		4.4.6	ISUP	59
CC/ResMgt/ResAlloc	20	FSISP (Proc)	BCh	4.4.1	FSISP (Proc)	58
	21	ISUP		4.4.6	ISUP	57
	22	Q.931N (Network)		4.4.11	Q.931N (Network)	56
	23	Q.921N (Network)		4.4.10	Q.921N (Network)	55
Poss Bypass	24	FSISO (OW)		4.4.2	FSISO (OW)	54
	25	Tx (20)		4.4.12	Rx (30)	53
	26	TxAnt (20)		4.4.13	RxAnt (30)	52
4.3.6	27	Propa (20)		4.4.9	Propa (30)	51
4.3.3						
VSAT	28	RxAnt (20)		4.4.16	TxAnt (30)	50
	29	Rx (20)		4.4.15	Tx (30)	49
	30	VSATOW		4.4.18	VSATOW	48
	31	I431N		4.4.4	I431N	47
4.3.8	32	UIF		4.4.17	UIF	46
4.3.4						
ISTA	33	I431U		4.4.4	I431U	45
	34	I430N		4.4.3	I430N	44
4.3.7	35	SIF		4.4.14	SIF	43
4.3.5						
ISDN Tel	36	I430U		4.4.3	I430U	42
	37	Q.921U (User)		4.4.10	Q.921U (User)	41
	38	Q.931U (User)		4.4.11	Q.931U (User)	40
	39	ISDND (Tel)		4.4.5	ISDND (Tel)	

Figure 4.3-3. FSIS Simulation Communication Components and Model Processes Racetrack

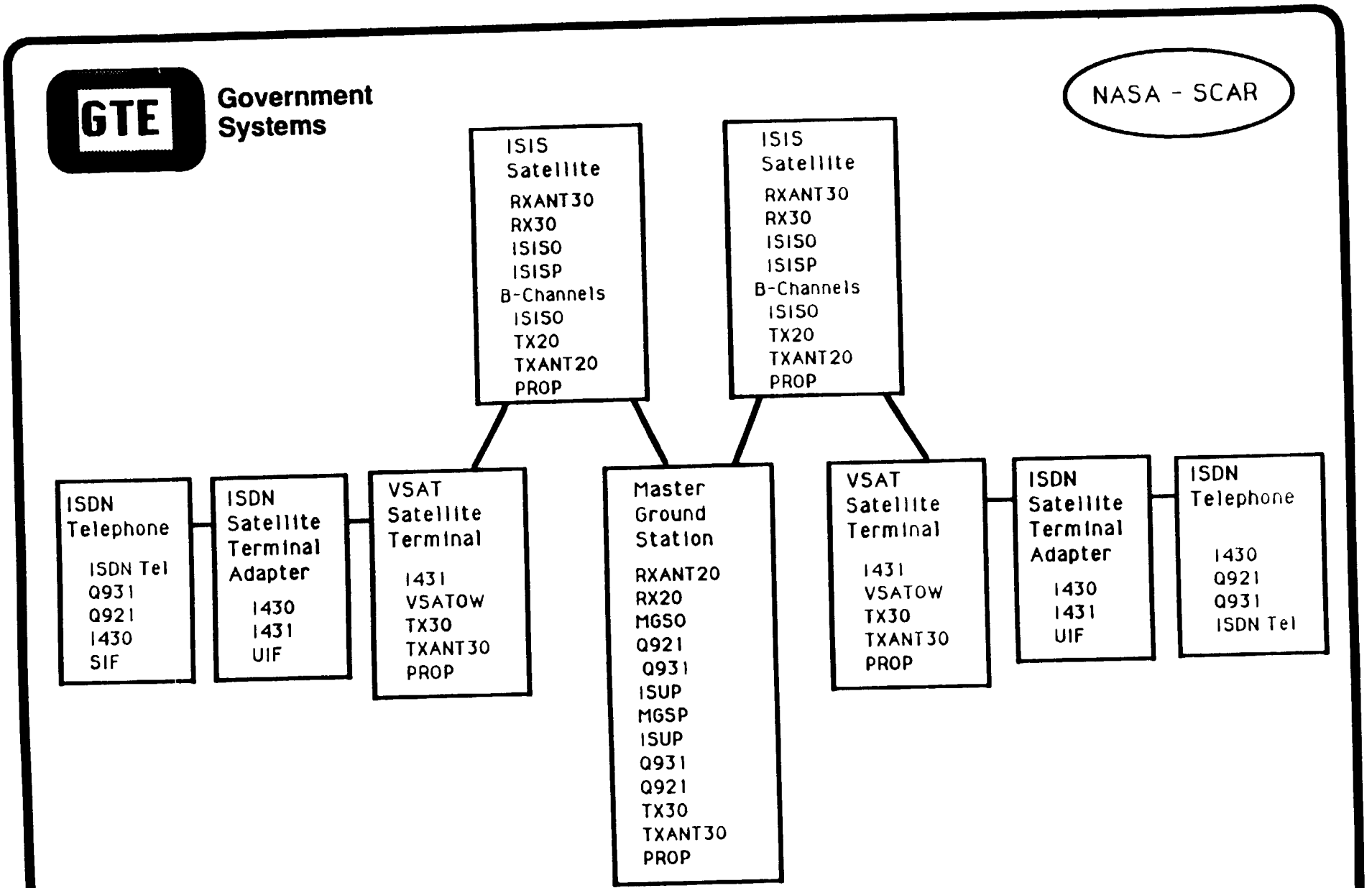


Figure 4.3-4 ISIS Simulation Communication Components

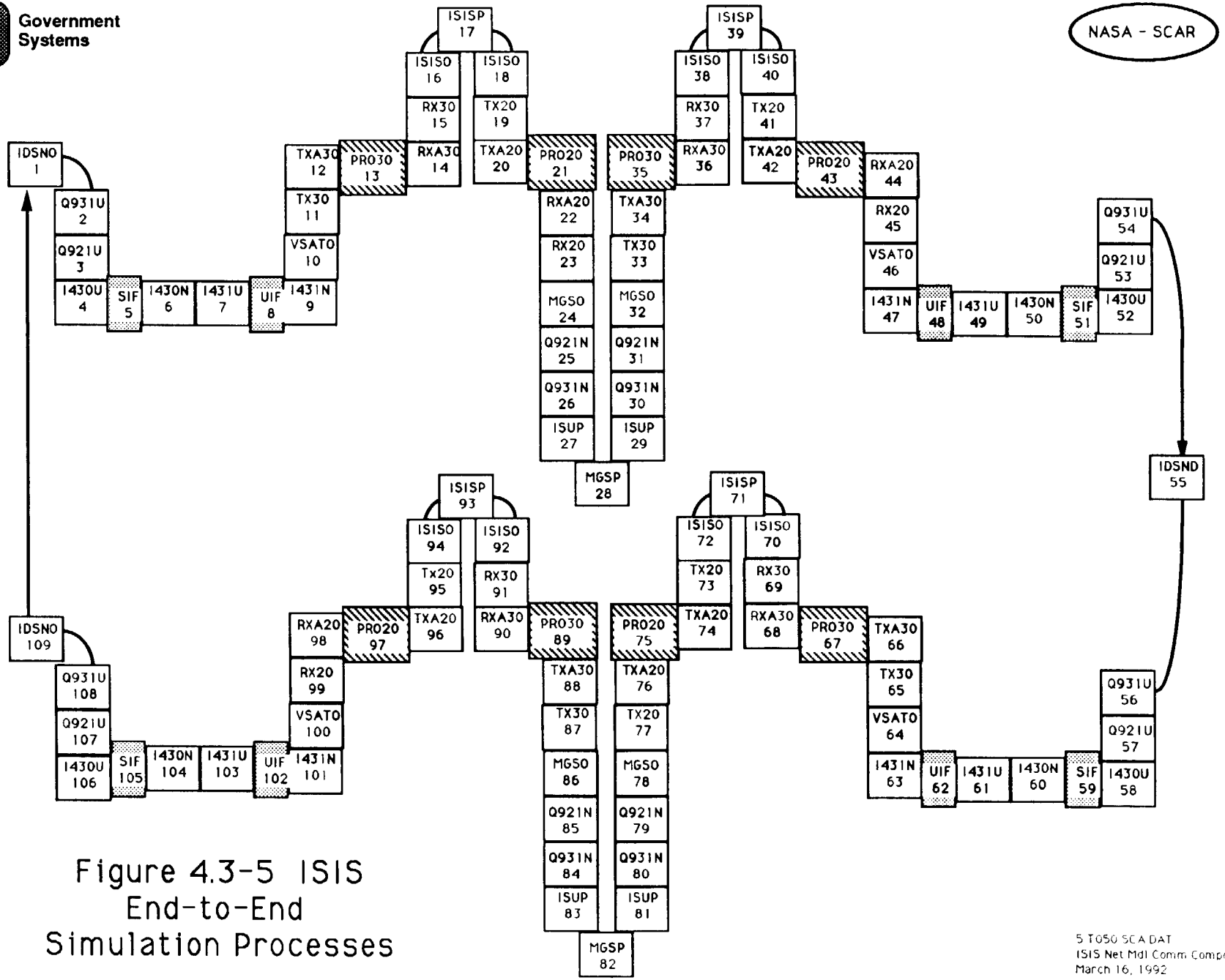


Figure 4.3-5 ISIS End-to-End Simulation Processes

5 T050 SCA DAT
ISIS Net Mdl Comm Compo
March 16, 1992

Comm Component: Para # 4.3.5	Process Index (PI)		Model Processes:		Sim Rpt	Model Processes:		PI
ISDN Tel	1	|	ISDNO (Tel)	Para #	4.4.5	ISDNO (Tel)		109
	2	|	Q.931U (User)		4.4.11	Q.931U (User)	^	108
	3	v	Q.921U (User)		4.4.10	Q.921U (User)	|	107
	4		I430U		4.4.3	I430U	|	106
4.3.7	5		SIF		4.4.14	SIF		105
4.3.4								
ISTA	6		I430N		4.4.3	I430N		104
	7		I431U		4.4.4	I431U		103
4.3.8	8		UIF		4.4.17	UIF		102
4.3.3								
VSAT	9	|	I431N		4.4.4	I431N		101
	10	|	VSATO (OW)		4.4.18	VSATO (OW)	^	100
	11	v	Tx (30)		4.4.12	Rx (20)	|	99
	12		TxAnt (30)		4.4.13	RxAnt (20)	|	98
4.3.6	13		Propa (30)		4.4.9	Propa (20)		97
4.3.1								
ISIS ISDN	14		RxAnt (30)		4.4.16	TxAnt (20)		96
Comm Satellite	15		Rx (30)		4.4.15	Tx (20)		95
Poss Bypass	16	|	ISISO (OW)		4.4.2	ISISO (OW)	^	94
ResAlloc	17	|	ISISP (Proc)	BCh	4.4.1	ISISP (Proc)	|	93
Poss Bypass	18	v	ISISO (OW)		4.4.2	ISISO (OW)	|	92
	19		Tx (20)		4.4.12	Rx (30)		91
	20		TxAnt (20)		4.4.13	RxAnt (30)		90
4.3.6	21		Propa (20)		4.4.9	Propa (30)		89
4.3.2								
Master Ground	22		RxAnt (20)		4.4.16	TxAnt (30)		88
Station MGS	23		Rx (20)		4.4.15	Tx (30)		87
Poss Bypass	24		MGSO (OW)		4.4.7	MGSO (OW)		86
	25		Q.921N (Network)		4.4.10	Q.921N (Network)		85
	26		Q.931N (Network)		4.4.11	Q.931N (Network)		84
	27	|	ISUP		4.4.6	ISUP	^	83
CC/ResMgt/GenProto+-	28	|	MGS (Proc)		4.4.8	MGS (Proc)	|	82
	29	v	ISUP		4.4.6	ISUP	|	81
	30		Q.931N (Network)		4.4.11	Q.931N (Network)		80
	31		Q.921N (Network)		4.4.10	Q.921N (Network)		79
Poss Bypass	32		MGSO (OW)		4.4.7	MGSO (OW)		78
	33		Tx (30)		4.4.12	Rx (20)		77
	34		TxAnt (30)		4.4.13	RxAnt (20)		76
4.3.6	35		Propa (30)		4.4.9	Propa (20)		75
4.3.1								
ISIS ISDN	36		RxAnt (30)		4.4.16	TxAnt (20)		74
Comm Satellite	37		Rx (30)		4.4.15	Tx (20)		73
Poss Bypass	38	|	ISISO (OW)		4.4.2	ISISO (OW)	^	72
ResAlloc	39	|	ISISP (Proc)	BCh	4.4.1	ISISP (Proc)	|	71
Poss Bypass	40	v	ISISO (OW)		4.4.2	ISISO (OW)	|	70
	41		Tx (20)		4.4.12	Rx (30)		69
	42		TxAnt (20)		4.4.13	RxAnt (30)		68
4.3.6	43		Propa (20)		4.4.9	Propa (30)		67
4.3.3								
VSAT	44		RxAnt (20)		4.4.16	TxAnt (30)		66
	45	|	Rx (20)		4.4.15	Tx (30)	^	65
	46	|	VSATOW		4.4.18	VSATOW	|	64
	47	v	I431N		4.4.4	I431N	|	63
4.3.8	48		UIF		4.4.17	UIF		62
4.3.4								
ISTA	49		I431U		4.4.4	I431U		61
	50		I430N		4.4.3	I430N		60
4.3.7	51		SIF		4.4.14	SIF		59
4.3.5								
ISDN Tel	52		I430U		4.4.3	I430U		58
	53	|	Q.921U (User)		4.4.10	Q.921U (User)	^	57
	54	|	Q.931U (User)		4.4.11	Q.931U (User)	|	56
	55	v	ISDND (Tel)		4.4.5	ISDND (Tel)	|	

Figure 4.3-6 ISIS Simulation Communication Components and Model Processes Racetrack

the ISDN satellite downlink or routes them through the protocol conversion modules: Q921N, Q931N, and ISUP to the on-board protocol processor (FSISP). The FSISP acts on all protocol messages destined for this satellite. Reply protocol messages follow a reverse protocol excursion back to their destination. The ISDN downlink is modeled by a downlink transmitter (Tx20) and an associated downlink transmitting antenna (TxAnt20). Both the downlink and uplink propagation are modeled by propagation (Prop) process that delays these protocol messages as a function of distance between the satellite and the ground terminal.

For ISIS, the ISDN satellite operations are modeled by an uplink receiving antenna (RxAnt 30) and receiver (Rx 30) that are connected to the on-board ISDN order-wire processor (ISISO). See Figure 4.3-4. The ISISO either routes the protocol messages to the VSAT satellite downlink or to the MGS satellite downlink. The MGS acts on all protocol messages destined for this satellite. The ISIS on-board processing acts on the commands form the MGS to switch the allocated B-channels as directed by order wire commands. Both the VSAT and MGS downlinks are modeled by a downlink transmitter (Tx20) and an associated downlink transmitting antenna (TxAnt20). Both the downlink and uplink propagation are modeled by propagation (Prop) process that delays these protocol messages as a function of distance between the satellite and the respective ground terminal.

4.3.2 Master Ground Station (MGS) Communication Component

The ISDN Master Ground Station (MGS) serves as the ground based ISDN protocol analysis and decision component for satellite not capable of performing these functions. The MGS operations are modeled by a downlink receiving antenna (RxAnt 20) and receiver (Rx 20) that are connected to the ground based order wire processor (MGSO). See Figure 4.3-4. The MGSO either routes the protocol messages to the ISDN satellite uplink or routes them through the protocol conversion modules: Q921N, Q931N, and ISUP to the ground based protocol processor (MGSP). The MGSP acts on all protocol messages destined to it.. Reply protocol messages follow a reverse protocol excursion back to their destination. The MGS uplink is modeled by an uplink transmitter (Tx30) and an associated uplink transmitting antenna (TxAnt30). Both the downlink and uplink propagation are modeled by propagation (Prop) process that delays these protocol messages as a function of distance between the satellite and the MGS.

4.3.3 VSAT Communication Component

The VSAT user terminal represents the ISDN user entry into the ISDN communications satellite. For both the ISIS and FSIS architecture, the VSAT is generic terminal capable of converting I431 protocol to uplink signals and converting downlink signals to I431 protocol. The VSAT connects the user with U-interface and connects to the ISDN satellite with a propagation (Prop) interface. As such the VSAT represents the exchange termination (ET) for the user. The VSAT converts ISDN protocol messages into TDMA uplink signals in one direction and converts the downlink signals to ISDN protocols in the other direction.

The VSAT operations are modeled by a TDMA downlink receiving antenna (RxAnt20) and receiver (Rx20) that are connected to the VSAT order-wire processor (VSATO). The VSATO translates all downlink signals into I431 protocols messages. The I431 process provides the 1,544 kbps primary rate ISDN interface at the U-interface level.

The VSAT TDMA uplink operations are modeled in similar manner to convert ISDN protocols to uplink signals. The ISDN protocols come to the I431 process via the U interface. The VSATO converts the I431 protocol into a TDMA format for uplink transmission via Tx30 and TxAnt30 to ISDN communications satellite. Both the downlink and uplink propagation are modeled by the propagation (Prop) process that delays the protocol messages as a function of distance between the satellite and the VSAT.

4.3.4 ISDN Satellite Terminal Adapter (ISTA) Communication Component

The ISDN satellite terminal adapter (ISTA) represents the user's NT2 and NT1 connection between the user at the S-interface and the exchange termination (ET) at the U-interface. It represents protocol conversion necessary for aggregating a number of BRI services in a PRI link for ultimate translation into a TDMA uplink. For a downlink the ISTA also converts a PRI connection into a BRI service connections.

The ISTA operations are modeled by a Layer 1, physical protocol conversion process (I430) process at the S-interface. These protocols are converted up and down the OSI layers to match the S-interface BRI protocols to the U-interface PRI protocols. The translation process converts I430 protocols into I431 protocols in the S-interface to U-interface direction. The reverse sequence of processes models the U-interface to S-interface direction.

4.3.5 ISDN Telephone User Communication Component

For the FSIS Network Model the ISDN telephone represents the source and sink of all ISDN call connections. The off-hook and on-hook conditions are used as a starting point for the call connection protocol sequences that are converted along the OSI layer chain to the S-interface of the network termination (NT).

The ISDN Telephone operations are modeled by a human interface process (ISDNO and ISDND) that provides the on-hook and off-hook conditions. The ISDNO process act as originator of the Layer 3 protocol sequence using the Q931 messages that are converted down the OSI layers by the Q931, Q921 and I430 processes to S-Interface signals. That sequence is triggered by the initiating Request and Terminating events on the STF. The ISDND process represents the destination user in the same way as ISDNO portrays the originator. The reverse sequence of protocol processes models the S-interface to ISDND direction.

4.3.6 Propagation Communication Component

Both the downlink and uplink propagation in both ISIS and FSIS architectures account for the time delay experienced by a signal as it propagates between the ISDN satellite and any ground terminal. A significant amount of time is spent in signal propagation. Propagation is modeled by a single propagation (Prop) process that delays the signal as a function of distance between the satellite and the ground terminal. That distance depends on the satellite orbit and topology and the terminal distribution. These propagation distance changes as a function of time, origin and destination. For a particular simulation these satellite to earth station distances may pre-calculated and stored as part of the City array or calculated on a call by call basis.

4.3.7 S-Interface Communication Component

The S-interface component provides the BRI connectivity between the ISDN user and the ISTA. This connection is similar to most wiring configuration which can be used to connect to an NT. These configurations can be divided into three types:

- A single installation where only one terminal is connected to an NT
- A multi-terminal installation where several terminals are connected to an NT1 via a passive bus
- A multi-terminal installation where several terminals are connected to an NT1 or an NT2 in a star configuration

At the outset both the ISIS and FSIS architecture uses a single point installation between the ISDN Telephone and the VSAT. This allows the use of up to 1000m of cable to assure maximum of 6 dB attenuation at 96 kHz. This cable length will provide a signal round trip delay of 10 to 42 microseconds from the transmitter to the receiver.

The S-interface is modeled by a single process (SIF) that delays the message as a function of the round trip delay. For both the ISIS and FSIS Network Model all protocol messages are sent on the D-channel and therefore have a constant delay once the D-channel contention has been resolved.

4.3.8 U-Interface Communication Component

The U-interface component provides the transfer of information that takes place on the two wire circuit between the ISTA and the VSAT. For both the ISIS and FSIS architecture echo cancelling is used. Echo cancelling is characterized by simultaneous transmission in both direction, full duplex, elimination of echo, and a bit rate of 160 kbps. The 144 kbps are used for the 2B+D BRI information and the other 16 kbps is used for synchronization, operations, and maintenance.

The U-interface is modeled by a single process (UIF) that delays the messages as a function of its BRI rate. For both the ISIS and FSIS Network Model all protocol messages are sent on the D-channel and therefore have a constant delay.

4.4 ISIS and FSIS Simulation Processes

This section describes the software simulation processes that make up the communication components of both the ISIS and FSIS Network architectures. Their use in the ISIS and FSIS end-to end simulation processes diagram depicted in Figures 4.3-5 and 4.3-2, respectively. These processes are the software modules that implement the communication functions being modeled. As indicated above, each of these processes/modules is re-used in a number of the communication components that make up the ISIS and FSIS Network Models. The same description format is used in order to provide a direct comparison between the processes.

4.4.1 ISDN Protocol Process -- ISISP/FSISP

The ISDN Protocol Processor process accepts ISUP command messages; takes the appropriate call control action of assigning and relinquishing B-channel resources; sends appropriate ISUP status messages. It also blocks calls when resources are not available and generates call retries.

4.4.2 Order Wire Process -- ISISO, FSISO

The Order Wire Process accepts TDMA signals from the VSAT via the uplink receiver (Rx30) and converts them to ISDN basic access frames and routes them to the Q921 process. The protocol conversion process continues up the the Q931 and ISUP layers to the ISDN Protocol Processor (FSISP). On the other side the ISISO, FSISO and MGSO processes accepts ISDN basic access frames from the Q921 process, convert them to TDMA signals and routes them to the satellite downlink transmitter.

4.4.3 I430 Process

The I430 process is based on the CCITT Recommendation I.430, Basic User Interface - Layer 1 Specification, for the point-to-point operation at Layer 1 for a single transmitter (source) and receiver (sink) are active at one time. The nominal transmitted bit rate at the interface is cited as 192 kbps in both direction of transmission. The activation/deactivation sequence shown in Figure 4.4.3-1, "Layer 1 Protocol Activation/Deactivation" will be used. The processing of associated management primitives is reserved for future implementations. The I430 process will propagate all higher layer messages without error to and from the S-interface via the Info3 and Info4 transmissions in F7-Activated and G3-Active states.

4.4.4 I431 Process

The I431 process is based on the CCITT Recommendation I.431, Primary Rate User-Network Interface - Layer 1 Specification, for the point-to-point operation at Layer 1 for a single transmitter (source) and receiver (sink) are active at one time. The nominal transmitted bit rate at the interface is cited as 1544 kbps in both direction of transmission. The interfaces for the primary rate user-network interface is active at all times. No activation/deactivation are applied to the interface. The F1-Operational State and the G1-Operational State are assumed to be active. The other fault condition states are left for future implementations.

4.4.5 ISDN Telephone Process -- ISDNO, ISDND

The ISDN Telephone process is based on human interface that requests and terminates ISDN telephone calls. The ISDNO process acts as a source by generating a Layer 3 protocol sequence that triggers the Q931 process. The timing and content of these initiating messages are obtained from the scenario traffic file (STF).

4.4.6 ISUP Process

The ISUP process provides its end-user with the capability to establish, supervise, and terminate basic bearer services. As currently defined, the ISUP is restricted to 64 kbps switched connections. The message structures and functional procedures for carrying out ISUP tasks are given in CCITT Recommendations Q.730, Q761 to Q.764, and Q.766. For the FSIS Network Model, the ISUP functions are performed within the ISDN Satellite. For ISIS the ISUP functions are performed by the MGS.

4.4.7 MGS Order Wire Process -- MGSO

The Mission Ground Station (MGS) order wire process accepts TDMA signals from the ISIS satellite downlink receiver and converts them to ISDN basic access frames and routes them to the Q921 process. The protocol conversion process continues up the the Q931

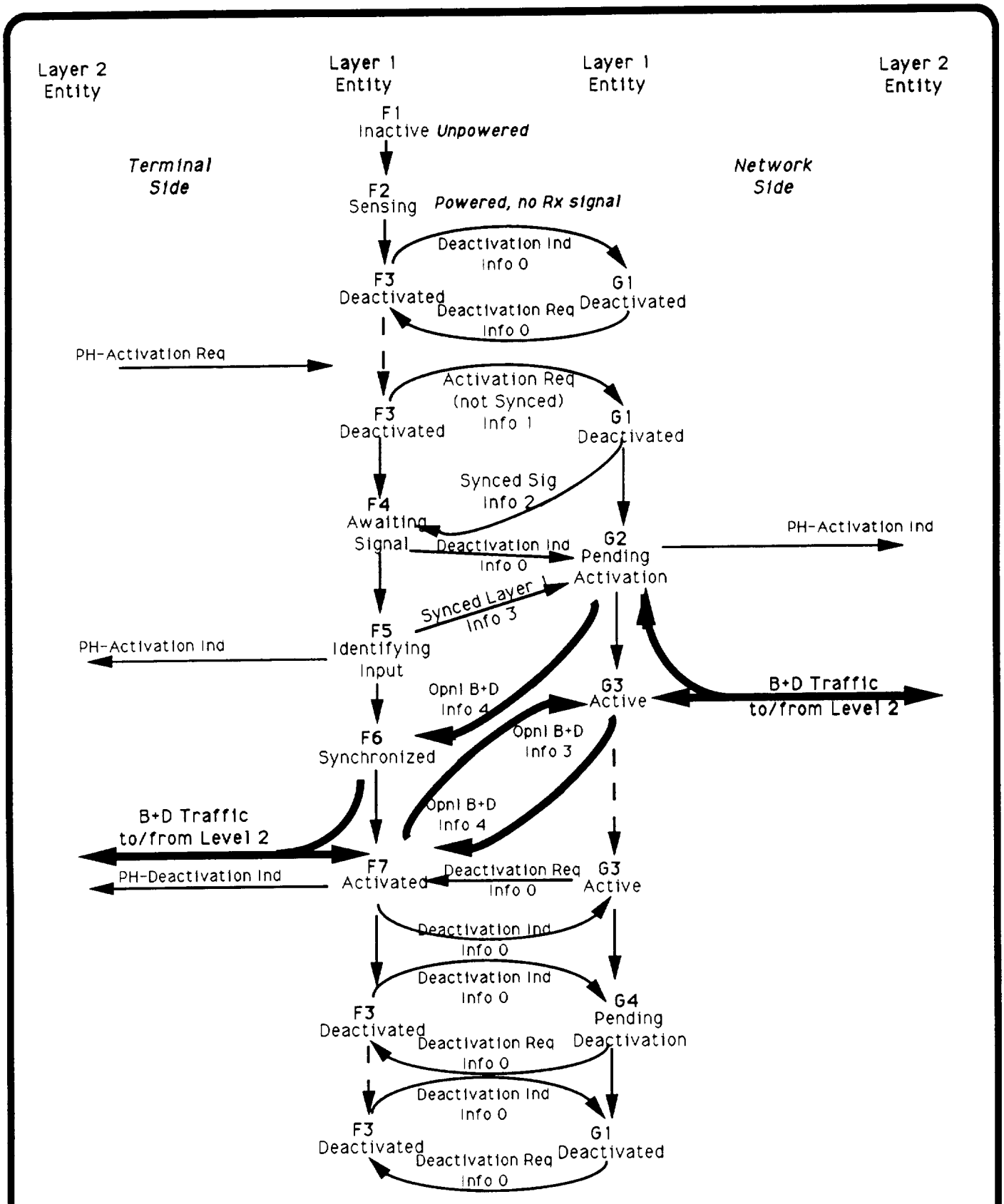


Figure 4.4.3-1 Layer 1 Protocol Activation/Deactivation

and ISUP layers to the ISDN Protocol Processor (MGSP). On the other side, the MGSO process accepts ISDN basic access frames from the Q921 process, convert them to TDMA signals and routes them to the ISIS satellite uplink transmitter (Tx30).

4.4.8 MGS Processor Process

The Mission Ground Station (MGS) ISDN Protocol Processor process accepts ISUP command messages; takes the appropriate order wire call control action of assigning and relinquishing B-channel resources; sends appropriate ISUP status messages.

4.4.9 Propagation Process

The Propagation (Prop) process models all space propagation aspects for both the ISIS and FSIS Network Model. The distance between transmitter and receiver reduces the amount of energy (SigPropEnergy) available at the receiver. The weather conditions also affect the SigPropEnergy and are included in this Prop process. The notation "**" is used to represent 20Ghz, 30Ghz, or other frequencies as appropriate.

4.4.10 Q921 Process

The Q921 process provides data link peer-to-peer exchange of information of the Link Access Procedures on the D-channel, LAPD. The CCITT Recommendation Q.921, ISDN User-Network Interface - Data Link Layer Specification provide a description of the procedures and function of LAPD. This LAPD protocol is used in the IDSNO and ISDND, ISTA, and the VSAT communication components to assure error free peer-to-peer protocol message exchanges in the D-channel.

4.4.11 Q931 Process

The Q931 process provides procedures for establishing, maintaining, and clearing network connections at the ISDN user-network interface. Messages are exchanged over the D-channel. The CCITT Recommendation Q.931, ISDN User-Network Interface Layer 3 Specification for Basic Call Control provide a description of the procedures and functions. For the ISIS Network Model this Q.931 protocol is used in the ISDN0, ISDND, ISTA, and the VSAT communications component to assure error free peer-to-peer protocol message exchanges in the D channel. The Q931 protocol implementation is described in Appendix D, "Q.931 Protocol Simulation".

4.4.12 Rx ** Process

The Rx** process models all receivers of both the ISIS and FSIS Network Architectures. The "**" notation is place holder for 20Ghz, 30Ghz, or other frequencies that represent the downlink and uplink frequencies of the Network Models. The receivers have a sensitivity parameter that set the energy values below which a signal is not accepted. For signal energy below the receiver sensitivity the whole message is consider loss. That message is logged to the MSave file as a lost message together with the time/subsystem that failed it. The message is not propagated.

4.4.13 RxAnt ** Process

The RxAnt** process models all receiver antennas of the FSIS Network Model. The "**" notation is place holder for 20Ghz, 30Ghz, or other frequencies that represent the downlink

and uplink frequencies of the ISIS or FSIS Network architectures. The receiver antennas have a number of parameters that reflect its design. RxAnt**BW represents the antenna beam; RxAnt**G sets the antenna gain; RxAnt**Lat and RxAnt**Lon indicate the antenna subpoint location; RxAnt**Dwell represents the antenna dwell time at a location; RxAnt**HopFreq represents its hop frequency; and RxAnt**Scan provides the antenna scan rate. To be received by the corresponding receiver the transmitted energy must coincide with all these antenna parameters.

4.4.14 SIF Process

The SIF process models the S-interface between the user ISDN Telephone and the ISDN Satellite Terminal Adapter (ISTA). For the FSIS Network Model, the SIF Process provides basic rate ISDN (BRI) connectivity for the I.430 Basic Access Frames.

4.4.15 Tx ** Process

The Tx** process models all transmitters of the FSIS Network Model. The "**" notation is place holder for 20Ghz, 30Ghz or other frequencies that represent the ISIS and FSIS downlink and uplink frequencies. The transmitters are modeled as isotropic radiators that added to the signal being transmitted with SigPropEnergy value. This value is mitigated by the TxAnt**, propagation (Prop) and RxAnt** processes, and finally used by the Rx** process to accept the message. .

4.4.16 TxAnt ** Process

The TxAnt** process models all transmitter antennas of the FSIS network Model. The "**" notation is place holder for 20Ghz, 30Ghz or other frequencies that represent the ISIS and FSIS downlink and uplink frequencies. The transmitter antennas have a number of parameters that reflect its design. TxAnt**BW represents the antenna beam; TxAnt**Gain sets the antenna gain; TxAnt**Lat and TxAnt**Lon indicate the antenna subpoint location; TxAnt**Dwell represents the antenna dwell time at a location; TxAnt**HopFreq represents its hop frequency; and TxAnt**Scan provides the antenna scan rate. To be received by the corresponding receiver antenna, the transmitted antenna energy must coincide with all these antenna parameters.

4.4.17 UIF Process

The UIF process models the U-interface between the ISDN Satellite Terminal Adapter (ISTA) and the VSAT. For the FSIS Network Model, the UIF process provides primary rate ISDN (PRI) connectivity for the I431 signals.

4.4.18 VSAT Order Wire Process

The VSAT Order Wire process accepts ISDN Basic Access Frame and converts them to TDMA Signal and conversely.

4.5. ISIS/FSIS Simulation Run (SimRun) Outputs

All the selected display data are updated throughout the simulation execution as the call setup and call termination processes are activated. When selected, the histogram continually plots the call requests as function of time providing excellent visibility into the scenario evolution. In the minimal graphics mode only the percent of simulation completeness is displayed.

4.5.1 Run-time Z-Chart Display

The Z-Chart Trace plots the output showing the migration of the "Rqst" and "Term" protocols through the set-up and termination processes. The Z-Chart ordinate represent the Process Index (PI) number associated with each communication function/process. The time elapsed within each communication function (PI) is plotted along the abscissa. The result is a time history trace of communication processes activated as a function of time it took for them to perform their respective functions.

In relation to the Z-Chart Trace the simulation progress from process to process is depicted as a time-line constantly edging towards increasing time. The longer times are associated with propagation and are plotted as long steps among more evenly spaced inter-process steps. The call connection (Rqst) display is depicted as a number of line segments connected by long steps representing all the VSAT/ISDN Satellite propagation links used in the call setup procedures. The "Seconds of Day" window in the output graphic displays the exact time down to millisecond of the data being plotted on the Z-Chart Trace graphic.

4.5.1 Run-time Bearer Services Display

Bearer services are displayed as their resources are allocated and deallocated for the circuit switched 64 Kbps (CS64), circuit switched 128 Kbps (CS128), X.25 access on the D-Channel (DX25), B-Channel Frame Relay (BFR) and telemetry (TLM).

Call status are displayed in terms of number of total calls attempted, the number of calls in the call reference buffer, the number of calls blocked, and the percentage of calls blocked.

As mentioned above, the MSave file, when selected, provides the principal post simulation data for analyses. These data are read directly by the ProGen program and combined into a single MSave for analysis.

4.6 ISIS/FSIS Product Generation (ProGen) Outputs

The FSIS Build 3 ProGen outputs consist of six data files: MSaveInt.DAT, MSaveTxt.DAT, ZChart.DAT, CallData.DAT, ThruPut.DAT, and RespTime.DAT. These products apply equally well for both the ISIS and FSIS architectures. Each data file is generated under menu control within the ProGen software for both ISIS and FSIS.

4.6.1 MSave Integer Data

The **MSaveInt.DAT** file is a single file containing selected MSave##.DAT files generated by the SimRun Program. These original MSave files were saved in smaller increments to save on array space within SimRun software. But, for ProGen, the MSave data are more easily analyzed using a single combined MSave file.

4.6.2 MSave Text Data

The **MSaveTxt.DAT** file consists of the identical data as the MSaveInt.DAT. The "Int" version contains the integer values generated by the SimRun software. Whereas, the "Txt" version contains the text equivalent of the combined MSave file data that will be used by the ProGen software.

4.6.3 Z-Chart Product

The **ZChart.DAT** file is a matrix of MSaveTxt.DAT data plotted to show the protocol interactions among the various protocol entities as a function of time. Three of these Z-Charts have been plotted to show the variation of protocol interactions that result from a blocked call, a call connection and a call disconnection. The are described in Appendix I, "Description of Z Chart Trace".

4.6.4 Call Data Product

The Call Data Product, **CallData.DAT**, consists of a tabular representation on a call by call basis. The Call Reference Number, Request Time, Blocked Time, Connection Time, Disconnect Request Time, Disconnect Time and Bearer Service are read from the MSave data. The Call Duration is calculated from the Call Connect Time and Call Disconnect Time in seconds. This Call Data Product provides a quick view of the simulation results. It is used a sanity check of the scenario; a quick estimate of the traffic duration; and a view of the blocked traffic and its recovery. The Call Data Product for both the STF01.DAT and STF06.DAT scenarios are described in Appendix F, "Basic ISDN Satellite Call Data Product".

4.6.5 Response Time Product

The Response Time Product, **RespTime.DAT,** consists of a tabular representation on a call by call basis. The Call Reference Number, Request Time, Blocked Time, Connection Time, Disconnect Request Time, and Disconnect Time are read from the MSave data. The Connection Response Time and the Disconnection Response Time are calculated from the Call Request Time and the Call Connect Time, and the Disconnect Request Time and Call Disconnect Time in milliseconds, respectively.

This Response Time Product provides a view of the both these response times on a call by call basis. For the present FSIS model the results are identical for all calls and all scenarios due to the fixed delays associated with each communication process being presently models. These times fall within each respective protocol timer and thereby provide the first order viability for ISDN satellites even in geosynchronous orbits. The Response Time Product for both the STF01.DAT and STF06.DAT scenarios are described in Appendix G, "ISDN Satellite Response Time Product".

4.6.6 Throughput Product

The Throughput Product, **ThruPut.DAT,** displays the change in ISDN throughput bandwidth as a function of the allocation of ISDN satellite communication resources. The Throughput display consists of CallREf#, Simulation Time, Bearer Service, Action, Throughput (Kbps), Number of D-Channels in use, and Number of B-Channels in use.

This Throughput Product provides a view of the simulation throughput results. It provides the ability to track the ISDN satellite throughput as a function of time; provides estimates of the peak traffic; and provides visibility into the satellite quiet periods.

All these files can displayed under menu control and are also capable of being output to a printer using Word Perfect® 5.1. These data and products will serve as the bases for further ISDN communication satellite analyses. The throughput data can be plotted using Lotus® 1-2-3 Spreadsheet software as shown in Appendix H, "ISDN Satellite Throughput Product".

SECTION 5

SUMMARY

5.1 General

This Simulator Development task completion report presented the complete end-to-end protocol architecture for both ISIS and FSIS suitable for discrete event simulation. The simulation processes are applicable to both the the Interim Service ISDN Satellite (ISIS) and the Full Service ISDN Satellite (FSIS). The ultimate aim of this aspect of the SCAR Program is the design of a new advanced ISDN communications satellite. The technical and operational parameters for this ISDN advanced communications satellite design will be obtained by exercising engineering software models of the major subsystems of the ISDN communications satellite architecture. Discrete event simulation experiments will be performed with these ISIS and FSIS models using various traffic scenarios, technical parameters, and operational procedures. The data from these simulations will be analyzed using the performance measures discussed in previous NASA SCAR reports.

5.2 Review

After an introduction that provided the background and scope of this NASA SCAR Program, the use of modeling and simulation to determine the parameters for the advanced ISDN communications satellite design was presented. An overview of the modeling and simulation tasks included a brief description of the software programs for the effort. Section 3 discussed the SCAR simulation development and methodology used to determine the design parameters for the SCAR advanced ISDN communications satellite design. Particular attention was given to the comparison between the ISIS and FSIS simulations since over 80% of the software modules will be re-used between them. The two main sections of this task completion report are Section 4.3, Simulation Structures, which include a descriptions of both ISIS and FSIS architectures down to the process level and Section 4.4, Simulation Processes, which provides a detail description of each process.

Several appendices are included to provide more details on the Scenario Traffic File (STF), Process Array Structure, the Traffic Model Database, the Q.931 Protocol Simulation, the Measurement Save (MSave) file, and the products of: ISDN Satellite Call Data, ISDN Satellite Response Time, ISDN Satellite Throughput, and Z-Chart Trace..

5.3 Continuing Efforts

The research in the simulator development task has been satisfactorily completed and the results are capable of supporting the NASA SCAR Program. The implementation of the FSIS Network architecture into SIMSCRIPT II.5 code has resulted into the delivery of three software builds: FSIS Build 1, FSIS Build 2, and FSIS Build 3. The benefits associated with the development of the ISIS architecture has been discussed in several Technical Program Reviews and will most likely be refined as part of Option II. As shown in Figure 5.3-1, "Typical ISDN Configuration with ISIS, FSIS, and BSIS Overlay", the ultimate goal is to assure that ISDN communication satellites are a viable component option for networks of the future.

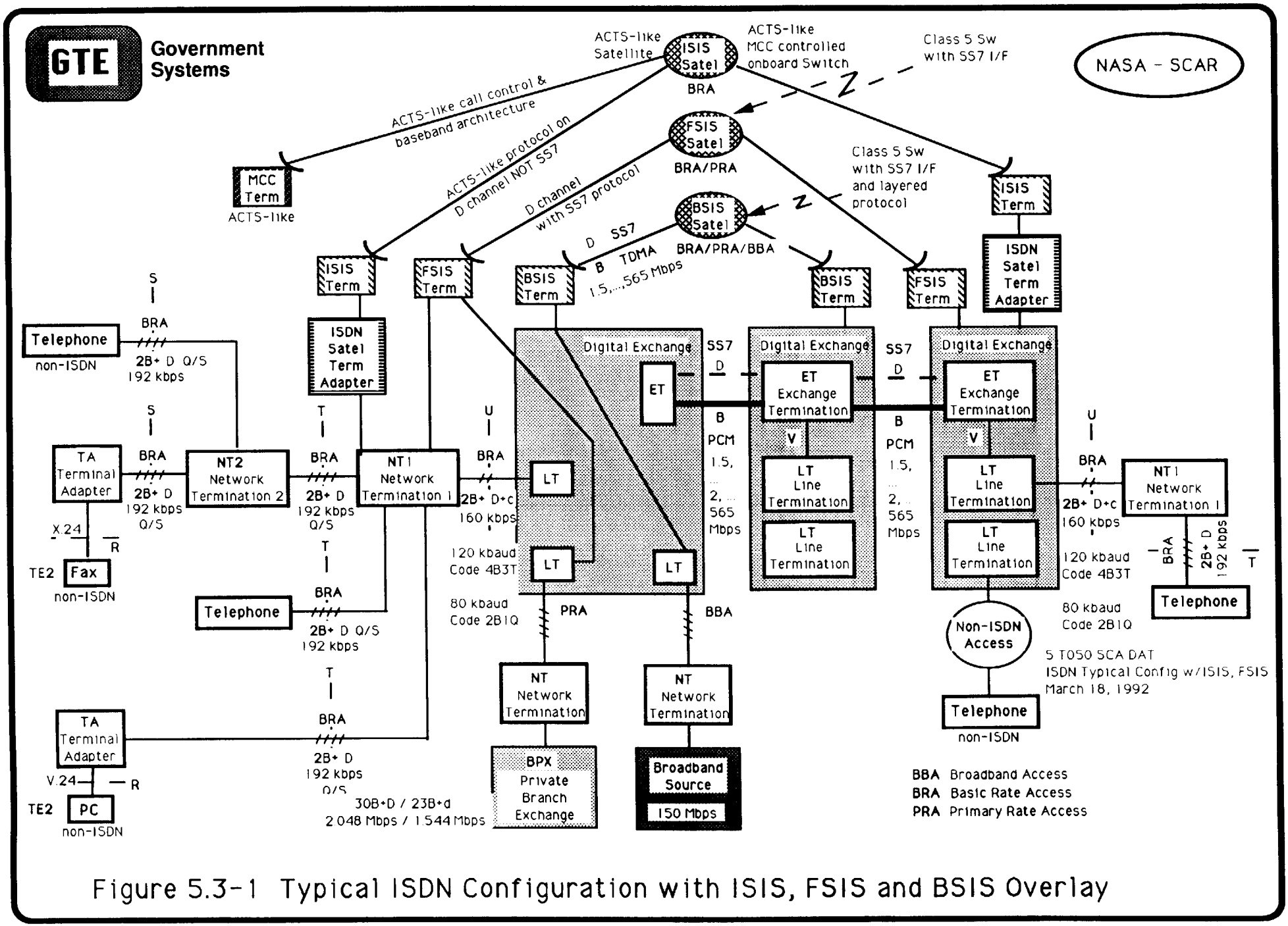


Figure 5.3-1 Typical ISDN Configuration with ISIS, FSIS and BSIS Overlay

APPENDIX A

Scenario Traffic File (STF) Structure

Two copies of the STFs used in FSIS Build 3 are provided in this appendix. STF01.DAT depicts a single B-Channel, CS64, request scenario of 3 minute calls between Washington DC and Los Angeles CA from 1601 seconds-of-day until 39631 seconds-of-day. Nearly 200 hundred call requests are made over this period of ten hours. The accompanying histogram shows the traffic scenario structure.

STF06.DAT depicts an all bearer services: CS64, CS128, DX25, BFR, and TLM scenario between Washington DC and Denver CO from 137 seconds-of-day until 36013 seconds-of-day. Over 1100 hundred call requests are made over this period of ten hours. The accompanying histogram shows the traffic scenario structure.

The STF is a sequence of records that reflects the actions of an input ISDN communications scenario. Each STF record represents a call request, "Rqst", and a call termination, "Term", in the scenario sequence. The STF is a time ordered list of these Rqst/Term events that is presented to the discrete event simulation as initiating events for a particular scenario. This STF list is read by the SIMSCRIPT II.5 discrete event simulation program by an external process. The external process, called STF, activates the initiating protocol requester process ISDNO - ISDN Originator. That protocol is passed from process to process being analyzed and acted upon along the way. For FSIS Build 3, a single STF initiating event activates over 200 internal events for every "Rqst" event and 100 internal events for every "Term" event when the call is connected. If a call is blocked (125 internal events), the FSISP process uses **retry algorithm** that adds 1 minute to both the call Rqst and Call Term times before it re-activates the call Rqst.

Even though only four fields are visible in the STF presented in this appendix, five fields actually make up each record of the STF. The first field "STF" is used by SIMSCRIPT II.5 to identify it as the external file it belongs to. Since process STF is the external process reading this file, this "STF" field must precede each record.

The second field "1601." of the first record is a real variable representing the simulation time in seconds. The action of the external process STF is to activate process ISDNO at that time as part of the simulation.

The next six characters after the decimal point form the Call Reference Number for that event record. The Call Reference Number uniquely identifies the service being requested and is used for every action concerning the call. The I6 format blanks leading zeroes and the following field, which is also I6, blends into the Call Reference Number making look like a single number. The first 8 records in the STF presented have the following Call Reference Numbers:

94, 95, 96, 97, 98, 99,1,100

The next field is a combination of a number of integer sub-fields. The field:

115224

is decomposed into the following information elements:

1 represents the Operation being requested.
In this case 1 stands for "Rqst".
Whereas, a 2 in that position would mean "Term"

1 represent the bearer service being requested.
For FSIS Build 3:
1 :: CS64 means a single B-Channel, 64 Kbps
2 :: CS128 means two B-Channels,128 Kbps
3 :: DX25 means uses existing signal channel, D-Channel, 16 Kbps
4 :: BFR mean B Frame Relay uses two B-Channels, 128 Kbps
5 :: TLM means telemetry uses existing signal channel, 16 Kbps

52 represents the originating city identification
with scenario generation. 52 = Washington DC

24 represents the destination city identification
with scenario generation. 24 = Los Angeles

The last field, 1860., represents the termination time for the call in seconds-of-day. If the call request is successfully connected then this Term time is used to activate a call termination sequence using that value of time.

The **Term time** is derived from the Traffic Model database known as SCAR Database 5, shown in this appendix. The Term time for "Voice" applications is given in minutes. That value is used for the Scenario Generation, ScenGen, software to randomly pick a Term time about that value. For the other applications message length in KiloByte per seconds. For those applications the equivalent B-Channel time is calculated, randomized, and used as the Term time. If the application is used in other than a single B-Channel link, the FSIS Processor, FSISP, adjusts the Term time accordingly.

The first record of the STF is decoded as follows:

Request a single B-channel from Washington DC to Los Angeles at 1601 seconds-of-day (26min 41sec after mid-night)
using Call Reference Number #94, and

Terminate the service associate
with Call Reference Number #94.
at 1860 seconds-of-day (31min 00sec after mid-night).

The result is that a B-Channel was allocated to Call Reference #94 for 4 minutes and 19 seconds.

STF41.D

```
STF    1601.     94115224   1860*
STF    3201.     95115252   3377*
STF    4801.     96115224   5075*
STF    6401.     97115252   6690*
STF    8001.     98115224   8138*
STF    9601.     99115252   9758*
STF   11111.      1112452  11159*
STF   11201.    100115224  11429*
STF   11421.      2112424  11642*
STF   11731.      3112452  11880*
STF   12041.      4112424  12178*
STF   12351.      5112452  12627*
STF   12661.      6112424  13026*
STF   12801.    101115252  12979*
STF   12971.      7112452  13152*
STF   13281.      8112424  13504*
STF   13591.      9112452  13832*
STF   13901.     10112424  14102*
STF   14211.     11112452  14506*
STF   14401.    102115224  14653*
STF   14521.     12112424  14694*
STF   14831.     13112452  14956*
STF   15141.     14112424  15303*
STF   15451.     15112452  15491*
STF   15761.     16112424  15854*
STF   16001.    103115252  16246*
STF   16071.     17112452  16162*
STF   16381.     18112424  16623*
STF   16691.     19112452  16852*
STF   17001.     20112424  17219*
STF   17311.     21112452  17346*
STF   17601.    104115224  17696*
STF   17621.     22112424  17840*
STF   17931.     23112452  17984*
STF   18241.     24112424  18457*
STF   18551.     25112452  18835*
STF   18861.     26112424  19058*
STF   19171.     27112452  19478*
STF   19201.    105115252  19403*
STF   19481.     28112424  19797*
STF   19791.     29112452  20027*
STF   20101.     30112424  20238*
STF   20411.     31112452  20729*
STF   20721.     32112424  20931*
STF   20801.    106115224  21012*
STF   21031.     33112452  21268*
STF   21341.     34112424  21489*
STF   21651.     35112452  21715*
STF   21961.     36112424  22281*
STF   22271.     37112452  22425*
STF   22401.    107115252  22594*
STF   22581.     38112424  22690*
STF   22891.     39112452  23057*
STF   23201.     40112424  23389*
```

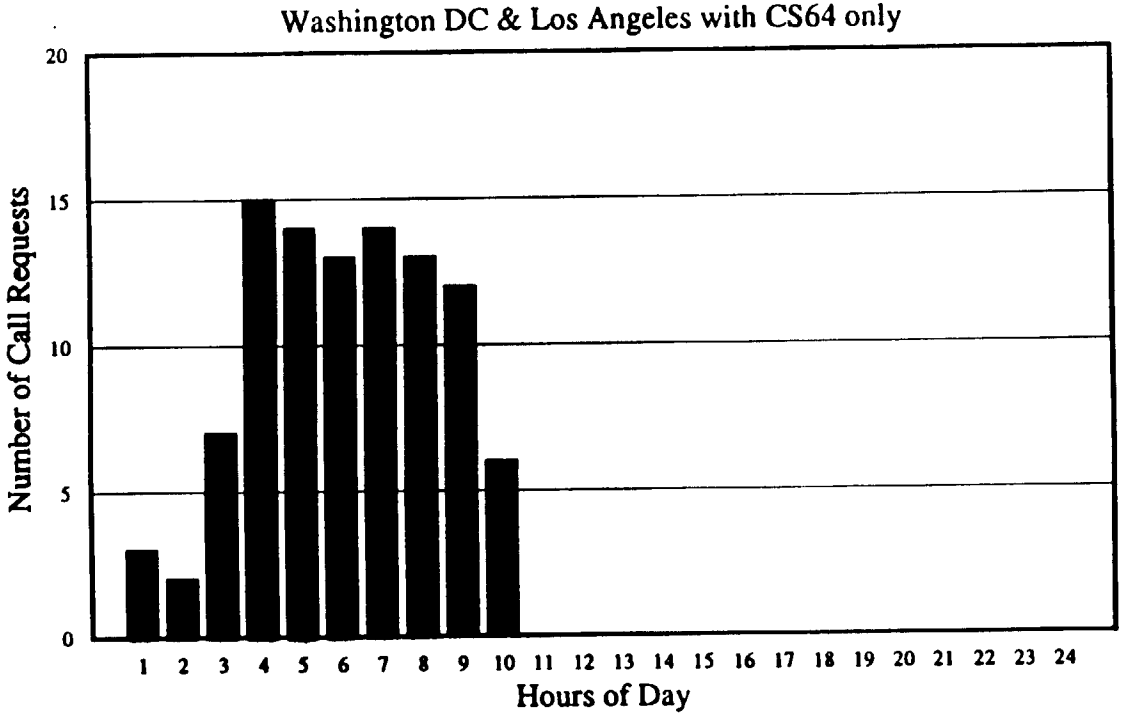
```
STF  23511.    41112452 23749*
STF  23821.    42112424 23972*
STF  24001.   108115224 24075*
STF  24131.    43112452 24291*
STF  24441.    44112424 24741*
STF  24751.    45112452 24862*
STF  25061.    46112424 25296*
STF  25371.    47112452 25574*
STF  25601.   109115252 25821*
STF  25681.    48112424 25888*
STF  25991.    49112452 26029*
STF  26301.    50112424 26439*
STF  26611.    51112452 26885*
STF  26921.    52112424 27125*
STF  27201.   110115224 27627*
STF  27231.    53112452 27505*
STF  27541.    54112424 27720*
STF  27851.    55112452 27938*
STF  28161.    56112424 28420*
STF  28471.    57112452 28542*
STF  28781.    58112424 29057*
STF  28801.   111115252 29064*
STF  29091.    59112452 29344*
STF  29401.    60112424 29498*
STF  29711.    61112452 29828*
STF  30021.    62112424 30251*
STF  30331.    63112452 30445*
STF  30641.    64112424 30673*
STF  30951.    65112452 31130*
STF  31261.    66112424 31414*
STF  31571.    67112452 31681*
STF  31881.    68112424 32155*
STF  32191.    69112452 32436*
STF  32501.    70112424 32589*
STF  32811.    71112452 32856*
STF  33121.    72112424 33233*
STF  33431.    73112452 33678*
STF  33741.    74112424 33762*
STF  34051.    75112452 34210*
STF  34361.    76112424 34400*
STF  34671.    77112452 34724*
STF  34981.    78112424 35269*
STF  35291.    79112452 35375*
STF  35601.    80112424 35820*
STF  35911.    81112452 36023*
STF  36221.    82112424 36512*
STF  36531.    83112452 36757*
STF  36841.    84112424 37121*
STF  37151.    85112452 37227*
STF  37461.    86112424 37622*
STF  37771.    87112452 37951*
STF  38081.    88112424 38304*
STF  38391.    89112452 38562*
STF  38701.    90112424 38996*
```

```
STF   39011.     91112452 39308*
STF   39321.     92112424 39459*
STF   39631.     93112452 39823*
```

GTE Government Systems

NASA - SCAR

ISDN Satellite Build 3 Traffic Scenario



Wash DC & Los Angeles, Comm, Voice(I)
8 T063 SR_B03 STF01HST.123 Jul 6, 1992 (with Wrap-around)

STF06.DAT

```
STF     137.    403115252    163*
STF     137.    755135252    140*
STF     205.    614125215    226*
STF     273.    404115215    310*
STF     273.    756135215    283*
STF     273.    966145215    312*
STF     409.    405115252    419*
STF     409.    615125252    444*
STF     409.    757135252    422*
STF     545.    406115215    569*
STF     545.    758135215    573*
STF     545.    967145252    563*
STF     613.    616125215    653*
STF     681.    407115252    700*
STF     681.    759135252    704*
STF     817.    408115215    851*
STF     817.    617125252    858*
STF     817.    760135215    844*
STF     817.    968145215    853*
STF     824.   1072155215    855*
STF     953.    409115252    954*
STF     953.    761135252    978*
STF    1021.    618125215   1060*
STF    1089.    410115215   1113*
STF    1089.    762135215   1118*
STF    1089.    969145252   1114*
STF    1153.    371115252   1164*
STF    1225.    411115252   1252*
STF    1225.    619125252   1272*
STF    1225.    763135252   1256*
STF    1361.    412115215   1381*
STF    1361.    764135215   1374*
STF    1361.    970145215   1362*
STF    1429.    620125215   1441*
STF    1497.    413115252   1556*
STF    1497.    765135252   1539*
STF    1601.    353115252   1785*
STF    1633.    414115215   1668*
STF    1633.    621125252   1686*
STF    1633.    766135215   1656*
STF    1633.    971145252   1653*
STF    1647.   1073155252   1686*
STF    1769.    415115252   1806*
STF    1769.    767135252   1799*
STF    1837.    622125215   1869*
STF    1905.    416115215   1947*
STF    1905.    768135215   1943*
STF    1905.    972145215   1939*
STF    2041.    417115252   2058*
STF    2041.    623125252   2071*
STF    2041.    769135252   2060*
STF    2177.    418115215   2212*
STF    2177.    770135215   2199*
STF    2177.    973145252   2192*
```

STF	137.	403115252	163*
STF	137.	755135252	140*
STF	205.	614125215	226*
STF	273.	404115215	310*
STF	273.	756135215	283*
STF	273.	966145215	312*
STF	409.	405115252	419*
STF	409.	615125252	444*
STF	409.	757135252	422*
STF	545.	406115215	569*
STF	545.	758135215	573*
STF	545.	967145252	563*
STF	613.	616125215	653*
STF	681.	407115252	700*
STF	681.	759135252	704*
STF	817.	408115215	851*
STF	817.	617125252	858*
STF	817.	760135215	844*
STF	817.	968145215	853*
STF	824.	1072155215	855*
STF	953.	409115252	954*
STF	953.	761135252	978*
STF	1021.	618125215	1060*
STF	1089.	410115215	1113*
STF	1089.	762135215	1118*
STF	1089.	969145252	1114*
STF	1153.	371115252	1164*
STF	1225.	411115252	1252*
STF	1225.	619125252	1272*
STF	1225.	763135252	1256*
STF	1361.	412115215	1381*
STF	1361.	764135215	1374*
STF	1361.	970145215	1362*
STF	1429.	620125215	1441*
STF	1497.	413115252	1556*
STF	1497.	765135252	1539*
STF	1601.	353115252	1785*
STF	1633.	414115215	1668*
STF	1633.	621125252	1686*
STF	1633.	766135215	1656*
STF	1633.	971145252	1653*
STF	1647.	1073155252	1686*
STF	1769.	415115252	1806*
STF	1769.	767135252	1799*
STF	1837.	622125215	1869*
STF	1905.	416115215	1947*
STF	1905.	768135215	1943*
STF	1905.	972145215	1939*
STF	2041.	417115252	2058*
STF	2041.	623125252	2071*
STF	2041.	769135252	2060*
STF	2177.	418115215	2212*
STF	2177.	770135215	2199*
STF	2177.	973145252	2192*

STF	2245.	624125215	2258*
STF	2305.	372115215	2337*
STF	2313.	419115252	2332*
STF	2313.	771135252	2326*
STF	2449.	420115215	2472*
STF	2449.	625125252	2479*
STF	2449.	772135215	2468*
STF	2449.	974145215	2473*
STF	2470.	1074155215	2492*
STF	2585.	421115252	2626*
STF	2585.	773135252	2603*
STF	2653.	626125215	2674*
STF	2721.	422115215	2763*
STF	2721.	774135215	2755*
STF	2721.	975145252	2746*
STF	2857.	423115252	2901*
STF	2857.	627125252	2888*
STF	2857.	775135252	2882*
STF	2993.	424115215	3020*
STF	2993.	776135215	3001*
STF	2993.	976145215	3017*
STF	3061.	628125215	3093*
STF	3129.	425115252	3164*
STF	3129.	777135252	3142*
STF	3201.	354115215	3455*
STF	3265.	426115215	3280*
STF	3265.	629125252	3295*
STF	3265.	778135215	3269*
STF	3265.	977145252	3292*
STF	3293.	1075155252	3315*
STF	3401.	427115252	3440*
STF	3401.	779135252	3417*
STF	3457.	373115252	3474*
STF	3469.	630125215	3499*
STF	3537.	428115215	3556*
STF	3537.	780135215	3554*
STF	3537.	978145215	3561*
STF	3673.	429115252	3689*
STF	3673.	631125252	3695*
STF	3673.	781135252	3681*
STF	3809.	430115215	3851*
STF	3809.	782135215	3841*
STF	3809.	979145252	3822*
STF	3877.	632125215	3912*
STF	3945.	431115252	3994*
STF	3945.	783135252	3963*
STF	4081.	432115215	4105*
STF	4081.	633125252	4112*
STF	4081.	784135215	4085*
STF	4081.	980145215	4112*
STF	4116.	1076155215	4142*
STF	4217.	433115252	4254*
STF	4217.	785135252	4233*
STF	4285.	634125215	4299*

STF	4353.	434115215	4379*
STF	4353.	786135215	4394*
STF	4353.	981145252	4373*
STF	4489.	435115252	4512*
STF	4489.	635125252	4511*
STF	4489.	787135252	4512*
STF	4609.	374115215	4629*
STF	4625.	436115215	4636*
STF	4625.	788135215	4650*
STF	4625.	982145215	4664*
STF	4693.	636125215	4699*
STF	4761.	437115252	4779*
STF	4761.	789135252	4782*
STF	4801.	355115252	5136*
STF	4897.	438115215	4917*
STF	4897.	637125252	4913*
STF	4897.	790135215	4920*
STF	4897.	983145252	4948*
STF	4939.	1077155252	4951*
STF	5033.	439115252	5062*
STF	5033.	791135252	5079*
STF	5101.	638125215	5133*
STF	5169.	440115215	5191*
STF	5169.	792135215	5211*
STF	5169.	984145215	5197*
STF	5305.	441115252	5322*
STF	5305.	639125252	5356*
STF	5305.	793135252	5310*
STF	5441.	442115215	5473*
STF	5441.	794135215	5484*
STF	5441.	985145252	5442*
STF	5509.	640125215	5527*
STF	5577.	443115252	5609*
STF	5577.	795135252	5630*
STF	5713.	444115215	5718*
STF	5713.	641125252	5735*
STF	5713.	796135215	5734*
STF	5713.	986145215	5718*
STF	5761.	375115252	5798*
STF	5761.	396125215	5801*
STF	5762.	1078155215	5779*
STF	5849.	445115252	5888*
STF	5849.	797135252	5872*
STF	5917.	642125215	5929*
STF	5985.	446115215	6012*
STF	5985.	798135215	6008*
STF	5985.	987145252	6013*
STF	6121.	447115252	6165*
STF	6121.	643125252	6144*
STF	6121.	799135252	6139*
STF	6257.	448115215	6300*
STF	6257.	800135215	6293*
STF	6257.	988145215	6277*
STF	6325.	644125215	6345*

STF	6393.	449115252	6413*
STF	6393.	801135252	6423*
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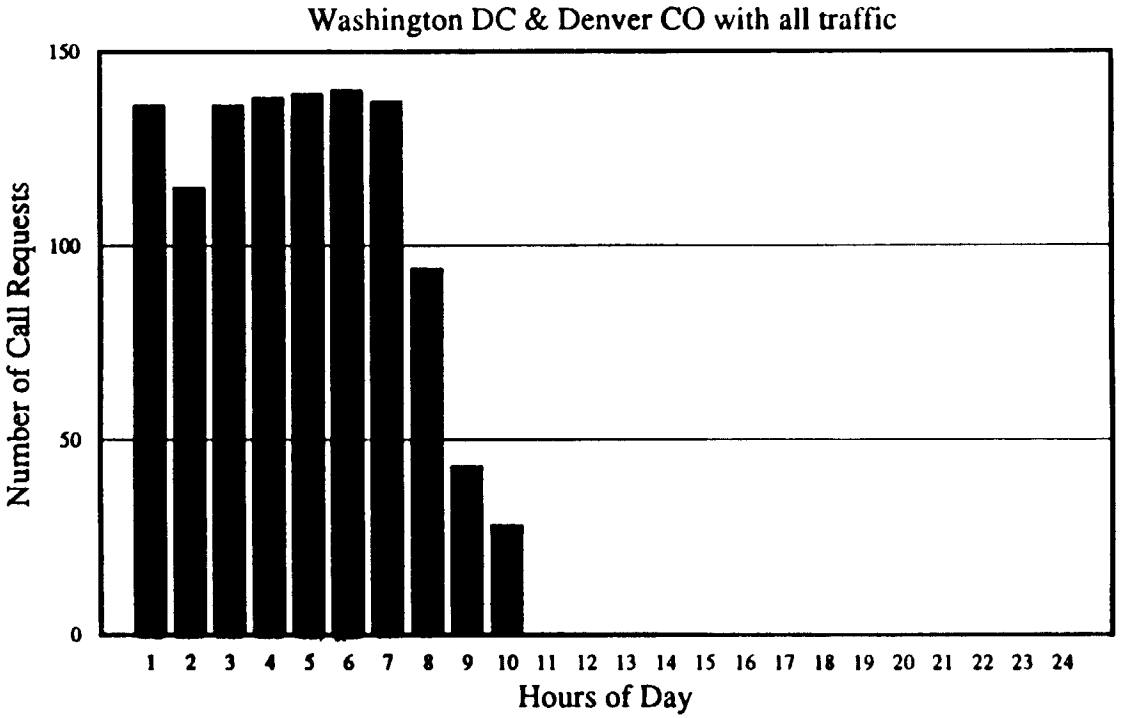
ISDN Satellite Build 3 Traffic Scenario



Wash DC & Denver, CS64, CS128, DX25, BFR and TLM
8 T063 SR_ B03 STF06HST.123 Jul 6, 1992 (with Wrap-around)

Application vs ISDN Bearer Service, Message Length Database

SCAR Database 5.

APPLICATION	*CS64KBPS* %	*CS128KBPS* %	*DX25* %	*BFRAMERELY* %	*TELEMETRY* %	*Check Normalization* %	*Messsage HOLDTIME* *min*	*Message Length* *kbytes*
Voice(interactive)	100.0	0.0	0.0	0.0	0.0	100.0	3.0	0
Voice(message)	100.0	0.0	0.0	0.0	0.0	100.0	1.5	0
Facsimile	80.0	15.0	2.0	3.0	0.0	100.0	0.0	160
FileTransfer	30.0	20.0	30.0	15.0	5.0	100.0	0.0	216
VideoBroad	25.0	40.0	0.0	35.0	0.0	100.0	0.0	9600
VideoConfe	30.0	40.0	0.0	30.0	0.0	100.0	0.0	57600
Interactivedata	20.0	10.0	40.0	10.0	20.0	100.0	0.0	27
Transaction	20.0	20.0	40.0	10.0	10.0	100.0	0.0	27
Teletex	10.0	10.0	40.0	20.0	20.0	100.0	0.0	75
Communications Check Sum:	415.0	155.0	152.0	123.0	55.0	900.0		
						900.0		

APPENDIX B

Process Array (ProcAr) Structure

A copy of the ProcAr used in FSIS Build 3 is provided in this appendix.

The ProcAr is a matrix of engineering data that determines all the parameters associated with the discrete event simulation. Each row of the ProcAr represents parameters associated with the Process Index (PI) identified in the first element of that row. Up to 9 parameters can be associated with each PI.

Since PI's represent a diversity of communication functions, such as protocol analysis, receiving, transmitting, allocating, each row consists of a diversity of technical parameters.

For protocol analysis such parameters as timer values, state number are important. For the receiving function such things as receiver threshold, noise figures, BER are meaningful. For the transmitting the functions of power gain and transmitting frequency play an important part. In essence, each record has parameters that pertain exclusively to that PI.

For example, only one software module is used for the receiving function, Rx. But that receiving function takes on the characteristic provided by the ProcAr record values for the PI position it is model. It uses difference values for a 20GHz receiver than it does for a 30GHz receiver. ProcAr technical parameters for a space based transmitters and ground based transmitters will be determined by the PI position they play in the simulation.

The first column of the ten column ProcAr shown in this appendix contains the PI number. The second column shows the delay time, in milliseconds, required for that PI to perform all its tasks. Of particular interest is the value 57 for PI's: 13, 27, 51, and 65 actually represents 5.7 msecs per 1000 miles of propagation distance. Those PI's use the propagation process that multiplies this value by the distance in miles between a particular transmitter and receiver combination. For FSIS Build 3, that distance value was calculated for each transmitted signal using the coordinates of the transmitting city and the location of a geo-synchronous satellite at 94 degrees west (-94) longitude at the the equator and a 22,000 mile altitude. These satellite parameters are determine by PI=78 in ProcAr matrix. A number of entries in ProcAr include the power losses, antenna gains, and receiver thresholds were obtained from ACTS data. Timer values were obtained from the CCITT "Blue Book" for protocol associated with the Q.931, Q.921, I430, and I431.

ISDNO	D(msec								
1	10	0	0	0	0	0	0	0	0
Q931U	D(msec	UgInit	UgT303	UgT310	UdInit	UdT313			
2	10	0	4000	10000	0	4000	0	0	0
Q921U	D(msec								
3	1	0	0	0	0	0	0	0	0
I430U	D(msec	F-Init	T3(mse						
4	1	3	30000	0	0	0	0	0	0
SIFXX	D(msec								
5	1	0	0	0	0	0	0	0	0
I430N	D(msec	G-Init	T1(mse						
6	1	1	100	0	0	0	0	0	0
I431U	D(msec								
7	1	0	0	0	0	0	0	0	0
UIFXX	D(msec								
8	1	0	0	0	0	0	0	0	0
I431N	D(msec								
9	1	0	0	0	0	0	0	0	0
VSATO	D(msec								
10	2	0	0	0	0	0	0	0	0
TXX30	D(msec	F(GHz)	P(dBW)						
11	1	30	66	0	0	0	0	0	0
TXA30	D(msec	F(GHz)	P(dB)	BW(deg	HR(Mse				
12	1	30	0	10	0	0	0	0	0
PRO30	D.msec	F(GHz)	P.db/K						
13	57	30	-96	0	0	0	0	0	0
RXA30	D(msec	F(GHz)	P(dB)	BW(deg	HR(Mse				
14	1	30	28	40	0	0	0	0	0
RXX30	D(msec	F(GHz)	P(dB)	T(dBW)					
15	1	30	50	-70	0	0	0	0	0
FSISO	D(msec								
16	5	0	0	0	0	0	0	0	0
Q921N	D(msec								
17	1	0	0	0	0	0	0	0	0
Q931N	D(msec	NgInit	NdT303	NdT310	NdInit				
18	10	0	4000	10000	0	0	0	0	0
ISUPX	D(msec								
19	10	0	0	0	0	0	0	0	0
FSISP	D(msec	F(MHz)	CRBMx(	CRBAv(	BChMx(	BChAv(			
20	10	10	2	2	5	5	0	0	0
ISUPX	D(msec								
21	10	0	0	0	0	0	0	0	0
Q931N	D(msec	NgInit	NdT303	NdT310	NdInit				
22	10	0	4000	10000	0	0	0	0	0
Q921N	D(msec								
23	1	0	0	0	0	0	0	0	0
FSISO	D(msec								
24	5	0	0	0	0	0	0	0	0
TXX20	D(msec	F(GHz)	P(dBW)						
25	1	20	64	0	0	0	0	0	0
TXA20	D(msec	F(GHz)	P(dB)	BW(deg	HR(Mse				
26	1	20	0	10	5	0	0	0	0
PRO20	D.msec	F(GHz)	P.dB/K						
27	57	20	-94	0	0	0	0	0	0
RXA20	D(msec	F(GHz)	P(dB)	BW(deg	HR(Mse				
28	1	20	30	10	0	0	0	0	0
RXX20	D(msec	F(GHz)	P(dB)	T(dBW)					
29	1	20	50	-70	0	0	0	0	0
VSATO	D(msec								
30	2	0	0	0	0	0	0	0	0
I431N	D(msec								
31	1	0	0	0	0	0	0	0	0
UIFXX	D(msec								
32	1	0	0	0	0	0	0	0	0
I431U	D(msec								
33	1	0	0	0	0	0	0	0	0
I430N	D(msec	G-Init	T1(mse						

34	1	1	100	0	0	0	0	0	0
SIFXX	D(msec								
35	1	0	0	0	0	0	0	0	0
I430U	D(msec	F-Init	T3(mse						
36	1	3	30000	0	0	0	0	0	0
Q921U	D(msec								
37	1	0	0	0	0	0	0	0	0
Q931U	D(msec	UgInit	UgT303	UgT310	UdInit	UdT313			
38	10	0	4000	10000	0	4000	0	0	0
ISDND	D(msec	T214	T114	T714	T614				
39	10	5	35	5	5	0	0	0	0
Q931U	D(msec	UgInit	UgT303	UgT310	UdInit	UdT313			
40	10	0	4000	10000	0	4000	0	0	0
Q921U	D(msec								
41	1	0	0	0	0	0	0	0	0
I430U	D(msec	F-Init	T3(mse						
42	1	3	30000	0	0	0	0	0	0
SIFXX	D(msec								
43	1	0	0	0	0	0	0	0	0
I430N	D(msec	G-Init	T1(mse						
44	1	1	100	0	0	0	0	0	0
I431U	D(msec								
45	1	0	0	0	0	0	0	0	0
UIFXX	D(msec								
46	1	0	0	0	0	0	0	0	0
I431N	D(msec								
47	1	0	0	0	0	0	0	0	0
VSATO	D(msec								
48	2	0	0	0	0	0	0	0	0
TXX30	D(msec	F(GHz)	P(dBW)						
49	1	30	66	0	0	0	0	0	0
TXA30	D(msec	F(GHz)	P(dB)	BW(deg	HR(Mse				
50	1	30	0	10	0	0	0	0	0
PRO30	D.msec	F(GHz)	P.db/K						
51	57	30	-96	0	0	0	0	0	0
RXA30	D(msec	F(GHz)	P(dB)	BW(deg	HR(Mse				
52	1	30	28	40	0	0	0	0	0
RXX30	D(msec	F(GHz)	P(dB)	T(dBW)					
53	1	30	50	-70	0	0	0	0	0
FSISO	D(msec								
54	5	0	0	0	0	0	0	0	0
Q921N	D(msec								
55	1	0	0	0	0	0	0	0	0
Q931N	D(msec	NgInit	NdT303	NdT310	NdInit				
56	10	0	4000	10000	0	0	0	0	0
ISUPX	D(msec								
57	10	0	0	0	0	0	0	0	0
FSISP	D(msec	F(MHz)	CRBMx(	CRBAv(	BChMx(	BChAv(			
58	10	10	2	2	5	5	0	0	0
ISUPX	D(msec								
59	10	0	0	0	0	0	0	0	0
Q931N	D(msec	NgInit	NdT303	NdT310	NdInit				
60	10	0	4000	10000	0	0	0	0	0
Q921N	D(msec								
61	1	0	0	0	0	0	0	0	0
FSISO	D(msec								
62	5	0	0	0	0	0	0	0	0
TXX20	D(msec	F(GHz)	P(dBW)						
63	1	20	64	0	0	0	0	0	0
TXA20	D(msec	F(GHz)	P(dB)	BW(deg	HR(Mse				
64	1	20	0	10	5	0	0	0	0
PRO20	D.msec	F(GHz)	P.dB/K						
65	57	20	-94	0	0	0	0	0	0
RXA20	D(msec	F(GHz)	P(dB)	BW(deg	HR(Mse				
66	1	20	30	10	0	0	0	0	0
RXX20	D(msec	F(GHz)	P(dB)	T(dBW)					
67	1	20	50	-70	0	0	0	0	0

VSATO	D(msec								
68	2	0	0	0	0	0	0	0	0
I431N	D(msec								
69	1	0	0	0	0	0	0	0	0
UIFXX	D(msec								
70	1	0	0	0	0	0	0	0	0
I431U	D(msec								
71	1	0	0	0	0	0	0	0	0
I430N	D(msec	G-Init	T1(mse						
72	1	1	100	0	0	0	0	0	0
SIFXX	D(msec								
73	1	0	0	0	0	0	0	0	0
I430U	D(msec	F-Init	T3(mse						
74	1	3	30000	0	0	0	0	0	0
Q921U	D(msec								
75	1	0	0	0	0	0	0	0	0
Q931U	D(msec	UgInit	UgT303	UgT310	UdInit	UdT313			
76	10	0	4000	10000	0	4000	0	0	0
ISDNO	D(msec								
77	10	0	0	0	0	0	0	0	0
SATEL	D(msec	Lat(de	Lon(de	Alt(mi					
78	5	0	-94	22000	0	0	0	0	0
SPARM	D(msec	MSRc(#							
79	0	100	0	0	0	0	0	0	0

APPENDIX C

TRAFFIC MODEL DATABASE DATA

This Traffic Model consists of a number of databases: the City Reference DB, ISDN User vs Industry DB, Application vs Industry DB, Application vs Time DB, and Application vs Bearer Services DB.

The "City Reference Database", DB1, identifies the percentage of ISDN users that are associated with the population of fifty-four major cities. Due to paucity of specific ISDN user information this percentage factor will be used as multiplier of population to infer the number of ISDN users in that region. The geographic coordinates of these of these cities together with their US time-zone are included in the Traffic Model in order to provide a sub-point for communications satellite operations. A view of the geographical distribution of these CONUS Traffic Model Cities is shown in "NASA SCAR Traffic Model".

The "ISDN User vs Industry", DB2, apportions the ISDN traffic among twenty-one industries. These data permit the scenario selection on an industry-by-industry basis. This database in used in conjunction with the City Reference Database to further decompose the ISDN service use in terms of industry affiliation.

The "Application vs Industry Database", DB3, further apportions the industry into applications of communication services. This added data granularity permits the selection of scenarios tailored on an application basis. The nine applications are spread across each of the twenty-one industries on a percentage basis too permit each application to contribute in a normalized fashion.

The "Applications vs Time Database", DB4, associates daily time-slots for issuing ISDN service requests on an application basis. These data allows the generation of traffic distributions that are appropriate to the application being used in a scenario. The hours in a day are divided into four unequal time slots along the line of a typical work day: 0001-0800, 0801-1200, 1201-1800, and 1801-2400.

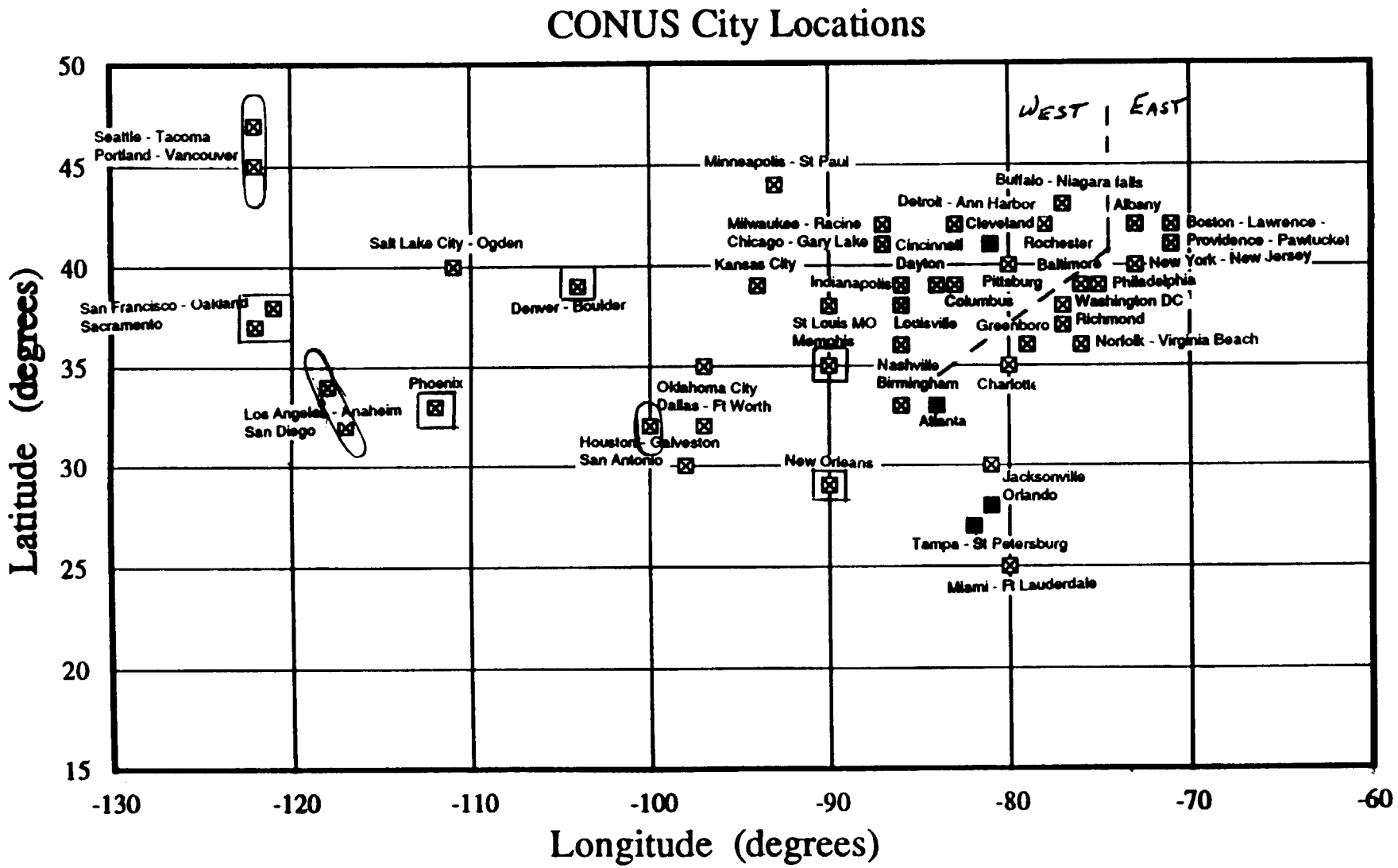
The "Application vs ISDN Bearer Service, Message Length Database", DB5, associates ISDN bearer services with the selected scenario applications. For this SCAR program the following ISDN bearer services have been selected: circuit switched (64 kbps and 128 kbps), D-Channel X.25, B-Channel Frame Relay, and Telemetry. This database also associates the message length and message hold-time with each application. These message duration values provide a measure of the length of time each ISDN bearer service is used.

City Reference Database

SCAR Database 1.

CITYNAME	POPULATION ,000	LATITUDE deg	LONGITUDE deg	ISDNPCT %	TIMEZONE #
Honolulu	838	21	-157	3.30	-5
Anchorage	227	61	-150	3.10	-4
Seattle-Tacoma	2,421	47	-122	3.40	-3
Portland-Vancouver	1,414	45	-122	3.10	-3
San Francisco-Oakland-San Jose	6,042	37	-122	4.00	-3
Sacramento	1,385	38	-121	3.30	-3
Los Angeles-Anaheim-Riverside	13,770	34	-118	4.50	-3
San Diego	2,370	32	-117	3.30	-3
Phoenix	2,030	33	-112	3.30	-2
Salt Lake City-Ogden	1,065	40	-111	3.10	-2
Denver-Boulder	1,858	39	-103	3.10	-2
Houston-Galveston	3,641	32	-100	3.40	-1
San Antonio	1,323	30	-98	3.10	-1
Oklahoma City	964	35	-97	3.20	-1
Dallas-Fort Worth	3,766	32	-97	3.40	-1
Kansas City	1,575	39	-94	3.10	-1
Minneapolis-St. Paul	2,388	44	-93	3.30	-1
St. Louis	2,467	38	-90	3.20	-1
Memphis	979	35	-90	3.10	-1
New Orleans	1,307	29	-90	3.10	-1
Milwaukee-Racine	1,572	42	-87	3.10	-1
Chicago-Gary Lake County	8,181	41	-87	3.90	0
Indianapolis	1,237	39	-86	3.10	0
Nashville	972	36	-86	3.10	-1
Birmingham	923	33	-86	3.10	-1
Louisville	967	38	-85	3.10	0
Cincinnati-Hamilton	1,728	39	-84	3.20	0
Dayton-Sprigfield	948	39	-84	3.20	0
Atlanta	2,737	33	-84	3.20	0
Detroit-Ann Arbor	4,620	42	-83	3.30	0
Columbus	1,344	39	-83	3.10	0
Tampa-St. Petersburg-Clearwater	1,995	27	-82	3.20	0
Cleveland-Akron-Lorain	2,769	41	-81	3.30	0
Jacksonville	898	30	-81	3.10	0
Orlando	971	28	-81	3.20	0
Pittsburgh-Beaver Valley	2,284	40	-80	3.20	0
Charlotte-Gastonia-Rocky Hill	1,112	35	-80	3.10	0
Miami-Fort-Lauderdale	3,001	25	-80	3.30	0
Greensboro-Winston-Salem-High	925	36	-79	3.10	0
Buffalo-Niagara Falls	1,176	42	-78	3.20	0
Rochester	980	43	-77	3.20	0
Washington	3,734	38	-77	3.30	0
Richmond-Petersburg	844	37	-77	3.20	0
Baltimore	2,342	39	-76	3.20	0
Philadelphia-Winington-Trenton	5,963	39	-75	3.80	0
Norfolk-Virginia Beach-Newport News	1,380	36	-74	3.20	0
Hartford-New Britain-Middleton	1,068	42	-73	3.00	0
Albany-Schenectady-Troy	851	42	-73	3.20	0
New York-New Jersey-Long Island	18,120	40	-73	5.00	0
Boston-Lawrence-Salem	4,110	42	-71	3.30	0
Providence-Pawtucket-Fall River	1,125	41	-71	3.00	0
San Juan-Caguas-Ponce, PR	550	18	-66	3.20	1
52 Count				5.00 Max	
				3.29 Avg	
				3.00 Min	

NASA/SCAR Traffic Model



8 T001 SCA DAT CUDB91JN.WK3 July 2, 1991

ISDN User vs Industry

SCAR Database 2.

Industry	*ISDN %*
BROADCAST	4.0
COMMUNICATION	10.0
CONSTRUCTION	2.0
DATA PROCESSING	2.0
EDUCATION	6.0
ENERGY	2.0
FINANCIAL	8.0
FOOD SERVVICE	2.0
GOVERNMENT	8.0
LEGAL	6.0
LODGING	4.0
MANUFACTURING	6.0
MEDICAL	6.0
MILITARY	10.0
PUBLISHING	4.0
RECREATION	4.0
RESIDENTIAL	2.0
RETAIL	4.0
TRANSPORT	6.0
UTILITY	2.0
WHOLESALE	2.0
---	-- Check
21 Count	100.0 Normalization

Application vs Industry Database

SCAR Database 3.

APPLICATION	Total 21 BROADCAST	COMMUNICATION CONSTRUCTION	DATAPROCESSING EDUCATION	ENERGY FINANCIAL	FOODSERVICE GOVERNMENT	LEGAL LODGING	MANUFACTURING MEDICAL	MILITARY PUBLISHING	RECREATION RESIDENTIAL	RETAIL TRANSPORT	UTILITY WHOLESAL	Check Normalization
	%	% %	% %	% %	% %	% %	% %	% %	% %	% %	% %	%
Voice(interactive)	3.0	6.0 3.0	2.0 5.0	3.0 7.0	4.0 4.0	8.0 5.0	5.0 5.0	5.0 5.0	3.0 6.0	5.0 8.0	2.0 6.0	100.0
Voice(message)	0.5	5.0 2.5	1.0 5.0	3.0 10.0	2.5 7.5	10.0 5.0	5.0 5.0	3.0 5.0	2.5 10.0	5.0 5.0	2.5 5.0	100.0
Facsimile	1.0	10.0 5.0	1.0 5.0	2.5 11.0	5.0 11.5	11.0 0.5	5.0 7.0	4.0 10.0	0.5 1.5	1.0 2.5	2.5 2.5	100.0
FileTransfer	0.5	11.0 2.5	11.0 5.0	5.0 9.0	2.5 9.0	5.0 2.5	2.5 3.0	9.0 7.0	1.0 1.0	3.0 4.5	3.0 3.0	100.0
VideoBroadcasting	10.0	8.0 0.5	5.0 8.0	1.0 3.0	1.0 9.0	1.0 6.0	3.0 8.0	10.0 11.0	3.0 3.0	1.0 5.0	1.0 2.5	100.0
VideoConference	6.0	12.0 1.0	1.0 10.0	3.0 10.0	1.0 10.0	7.0 4.0	4.0 6.0	10.0 7.0	1.0 1.0	1.0 3.0	1.0 1.0	100.0
InteractiveData	2.0	15.0 1.0	10.0 10.0	3.0 10.0	2.0 8.0	5.0 1.0	5.0 3.0	10.0 5.0	1.0 3.0	2.0 1.0	1.0 2.0	100.0
Transaction	2.0	8.0 1.0	4.0 2.0	2.0 15.0	2.0 12.0	4.0 5.0	4.0 2.0	8.0 4.0	4.0 1.0	9.0 4.0	1.0 6.0	100.0
Teletex	3.0	10.0 1.0	3.0 3.0	3.0 15.0	3.0 7.0	3.0 5.0	3.0 3.0	7.0 8.0	1.0 1.0	5.0 5.0	1.0 10.0	100.0
Communications Check Sum:	28.0	85.0 17.5	38.0 53.0	25.5 90.0	23.0 78.0	54.0 34.0	36.5 42.0	66.0 62.0	17.0 27.5	32.0 38.0	15.0 38.0	900.0
												900.0

Application vs Time Database

SCAR Darabase 4

APPLICATION	*0001-0800 mid/8am 8 hours TIMENO1* %	*0801-1200 8am/noon 4 hours TIMENO2* %	*1201-1800 noon/6pm 6 hours TIMENO3* %	*1801-2400 6pm/mid 6 hours TIMENO4* %	*Check Normaization* %
Voice(interactive)	2.5	32.0	51.0	14.5	100.0
Voice(message)	2.5	32.0	51.0	14.5	100.0
Facsimile	2.5	32.0	51.0	14.5	100.0
FileTransfer	52.0	3.0	5.0	40.0	100.0
VideoBroadcasting	10.0	25.0	30.0	35.0	100.0
VideoConference	2.5	32.0	51.0	14.5	100.0
InteractiveData	2.5	32.0	51.0	14.5	100.0
Transaction	2.5	32.0	51.0	14.5	100.0
Teletex	2.5	32.0	51.0	14.5	100.0
Communications Check Sum:	79.5	252.0	392.0	176.5	900.0
					900.0

Application vs ISDN Bearer Service, Message Length Database

SCAR Database 5.

APPLICATION	*CS64KBPS* %	*CS128KBPS* %	*DX25* %	*BFRAMERELY* %	*TELEMETRY* %	*Check Normalization* %	*Messsage HOLDTIME* *min*	*Message Length* *kbytes*
Voice(interactive)	100.0	0.0	0.0	0.0	0.0	100.0	3.0	0
Voice(message)	100.0	0.0	0.0	0.0	0.0	100.0	1.5	0
Facsimile	80.0	15.0	2.0	3.0	0.0	100.0	0.0	160
FileTransfer	30.0	20.0	30.0	15.0	5.0	100.0	0.0	216
VideoBroad	25.0	40.0	0.0	35.0	0.0	100.0	0.0	9600
VideoConfe	30.0	40.0	0.0	30.0	0.0	100.0	0.0	57600
Interactivedata	20.0	10.0	40.0	10.0	20.0	100.0	0.0	27
Transaction	20.0	20.0	40.0	10.0	10.0	100.0	0.0	27
Teletex	10.0	10.0	40.0	20.0	20.0	100.0	0.0	75
Communications Check Sum:	415.0	155.0	152.0	123.0	55.0	900.0		
						900.0		

APPENDIX D

Q.931 PROTOCOL SIMULATION

The Q931 process provides procedures for establishing, maintaining, and clearing network connections at the ISDN user-network interface. Messages are exchanged over the D-channel. The CCITT Recommendation Q.931, ISDN User-Network Interface Layer 3 Specification for Basic Call Control provide a description of the procedures and functions.

This protocol like all other protocols will be simulated at the message element level. All aspects of the protocol necessary set-up and tear-down specific ISDN services will implemented. The protocols depicted by the Specification Design Language (SDL) diagrams are converted to initial state in ProcAr matrix. Intervening Q931 protocol messages change those states until all are activate and the requested ISDN service is provided. .

The principal operations of this ISDN communications satellite model and simulation revolves around the timely processing Q931 protocols as described in the CCITT "Blue Book". Figure 4.3-1, "FSIS Network Model Communication Components" and Figure 4.3-4, "ISIS Network Model Communication Components" show the overall structure and interaction between each communication process for the FSIS and ISIS simulation implementation. This section focuses on the Q931 processes: Q931U and Q931N, the origination, ISDNO, and destination, ISDND points, and the on board processor, FSISP.

Figure 8.1, "Q931 Protocol Connection SDL Interaction Diagram" and Figure 8.2, "Q931 Protocol Disconnection SDL Interaction Diagram" , in this appendix, can be traced directly to the CCITT "Blue Book". The origination and destination areas are each represented by two OSI, Layer 3, Q931 protocol entities - Q931U on the user side and Q931N on the network side. This results in four site for Q931 protocol states that must be transition for states U0 and N0 to U10 and N10 for call connection and back to U0 and N0 for call disconnects. The exchange of timely protocol Q931 protocol messages accomplish this action.

For call connection, Figure 8.1 shows an "Off Hook" condition shown as ProtoMsg=1 being converted by Q931U into "SetU Msg" and subsequently being transmitted to the Q931Ns and FSISP on board the ISDN satellite and ultimately received by the Q931U and ISDN destination processes. Since, for simulation purposes, the destination always available, the ISDND responds with a timely sequence of "CalP Msg", "Alrt Msg" and "Conn Msg" which follow their return paths through the satellite to the originator. If resources are not available on-board the satellite when it receives the "Conn Msg", the call is blocked and the prior protocol messages run their course and are eventually not propagated due time-outs or non-response. When resources are available on the satellite "Conn Msg" are converted to "ConA Msg" and the requested communication path is established and dedicated until it is terminated other actions.

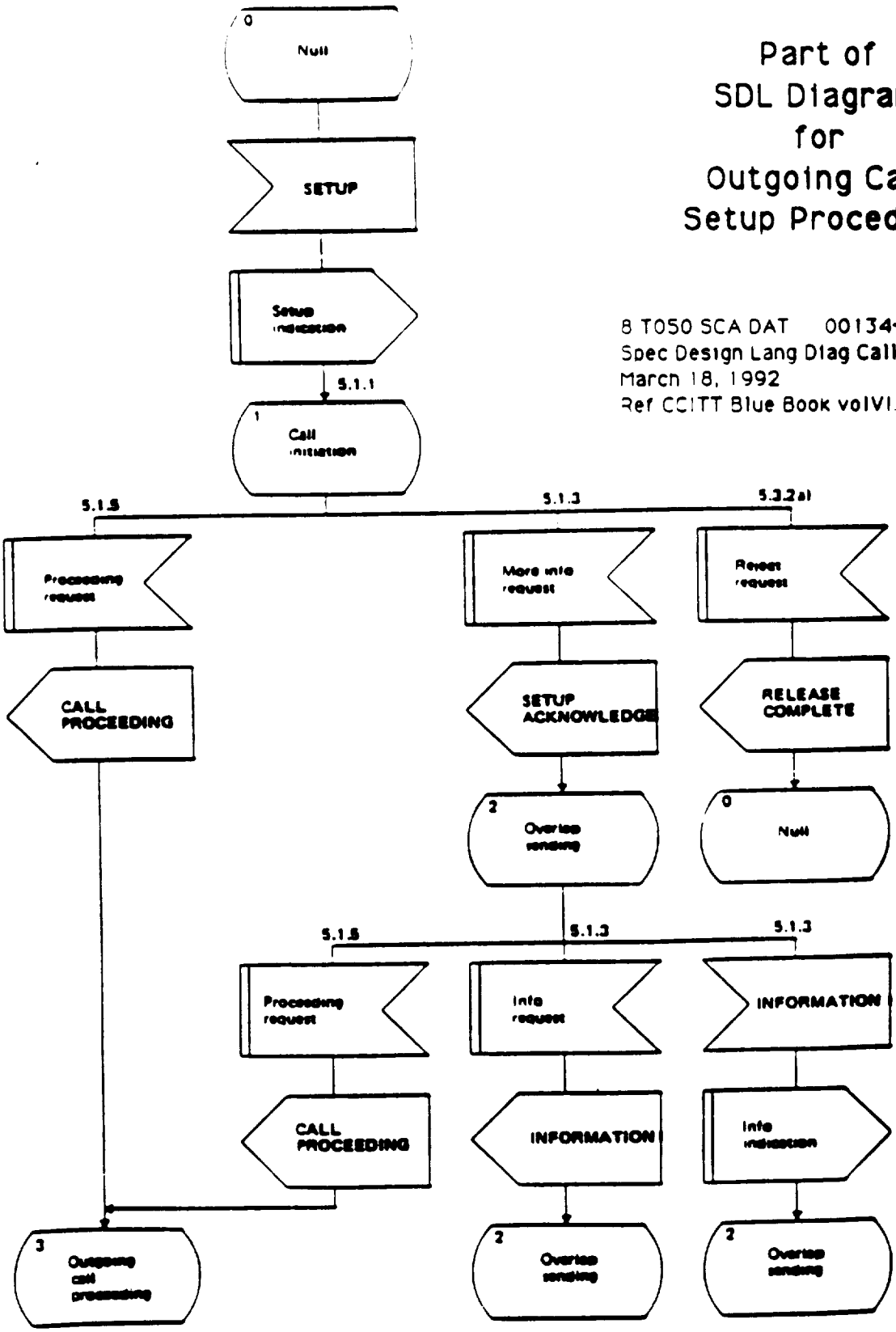
For call disconnection, Figure 8.2 shows an "On Hook" condition shown as ProtoMsg=2 being converted by Q931U into "DConn Msg" and subsequently being transmitted to the Q931Ns and FSISP on-board the ISDN satellite and ultimately received by the Q931U and ISDN destination processes. Resources are disconnected at the satellite upon receipt of the "DConn Msg" but Q931 protocol exchanges continues on both the origination and destination sides before the D-Channels can be released.

GTE Government Systems

NASA - SCAR

Part of SDL Diagram for Outgoing Call Setup Procedure

8 T050 SCA DAT 00134-00
Spec Design Lang Diag Call Setup Proc
March 18, 1992
Ref CCITT Blue Book volVI.II Rec Q.931



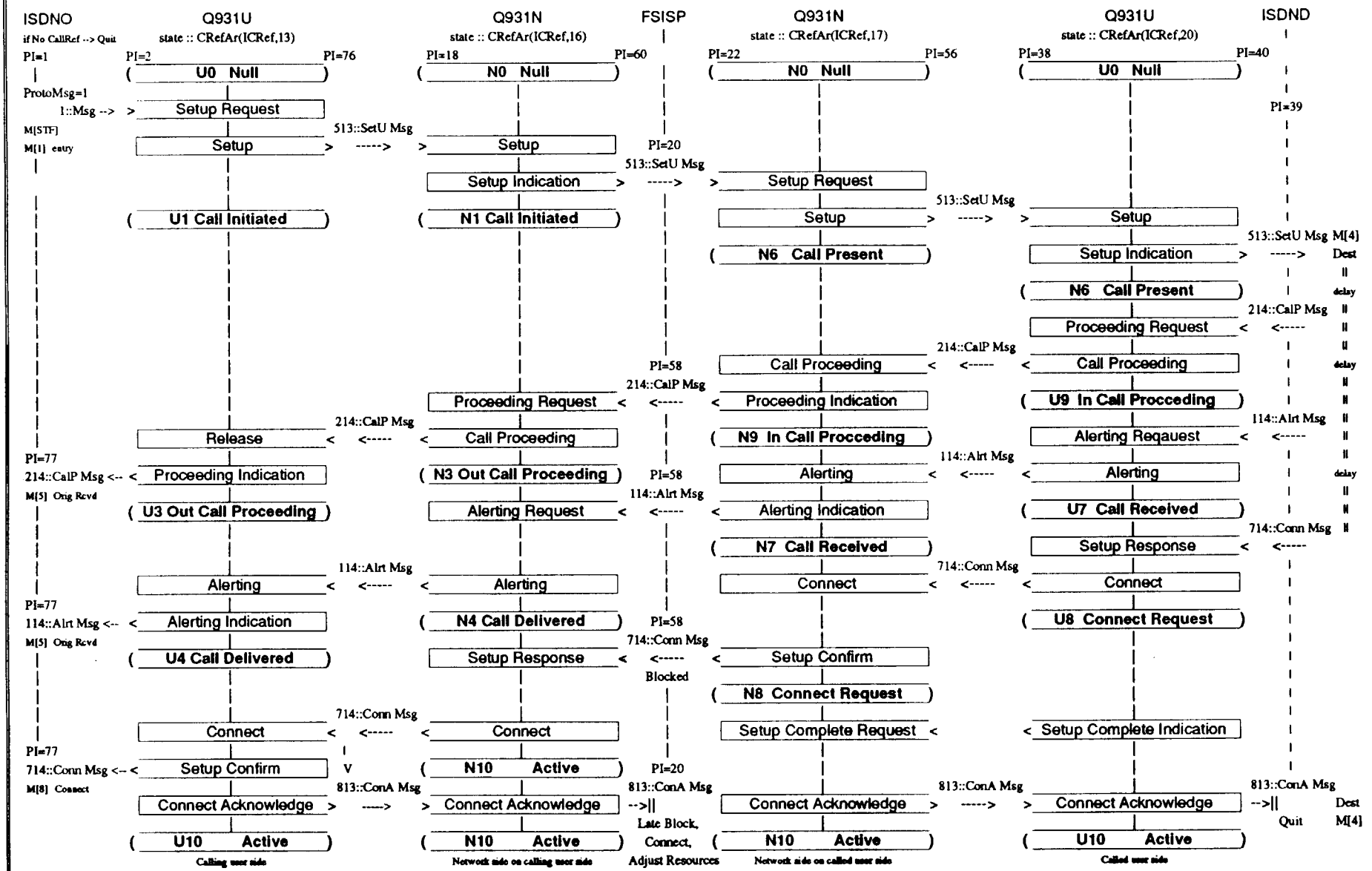


Figure 8.1 Q931 Protocol Connection SDL Interaction Diagram

Q931 Protocol adapted from CCITT BLue Book, vol. VI.11, 1988

The ISDN destination responds to the "DConn Msg" with a "Rel Msg" that eventually results in a "RelC Msg" to both Q931 entities on the destination side. Similarly on the origination side converts the "DConn Msg" into a "RelC Msg" that clears all the circuits including the D-Channel signalling access.

Figure 8.3. "Major ISDN Satellite Transition Points", in this appendix, shows the major resource allocations in terms of D and B channel activities and corresponding simulation status numbers (#). At an initial Rqst a signalling D-Channel is allocated and status is (1). This assumes one is available, no contention algorithm has been implemented. If the call is blocked (7) the D-Channel is released (11). Otherwise it remains active for the duration of call. When a call is connected its status is changed to (8). The initiation of a Term does not itself affect the connectivity until a the "DConn Msg" reaches the satellite. Then the allocated resources are disconnected (9) and when all affected circuits are cleared the D-Channels are released (11).

These ISDN communication satellite simulation break points are contrived for the present simulation and will be refined as necessary to fit the real-world.

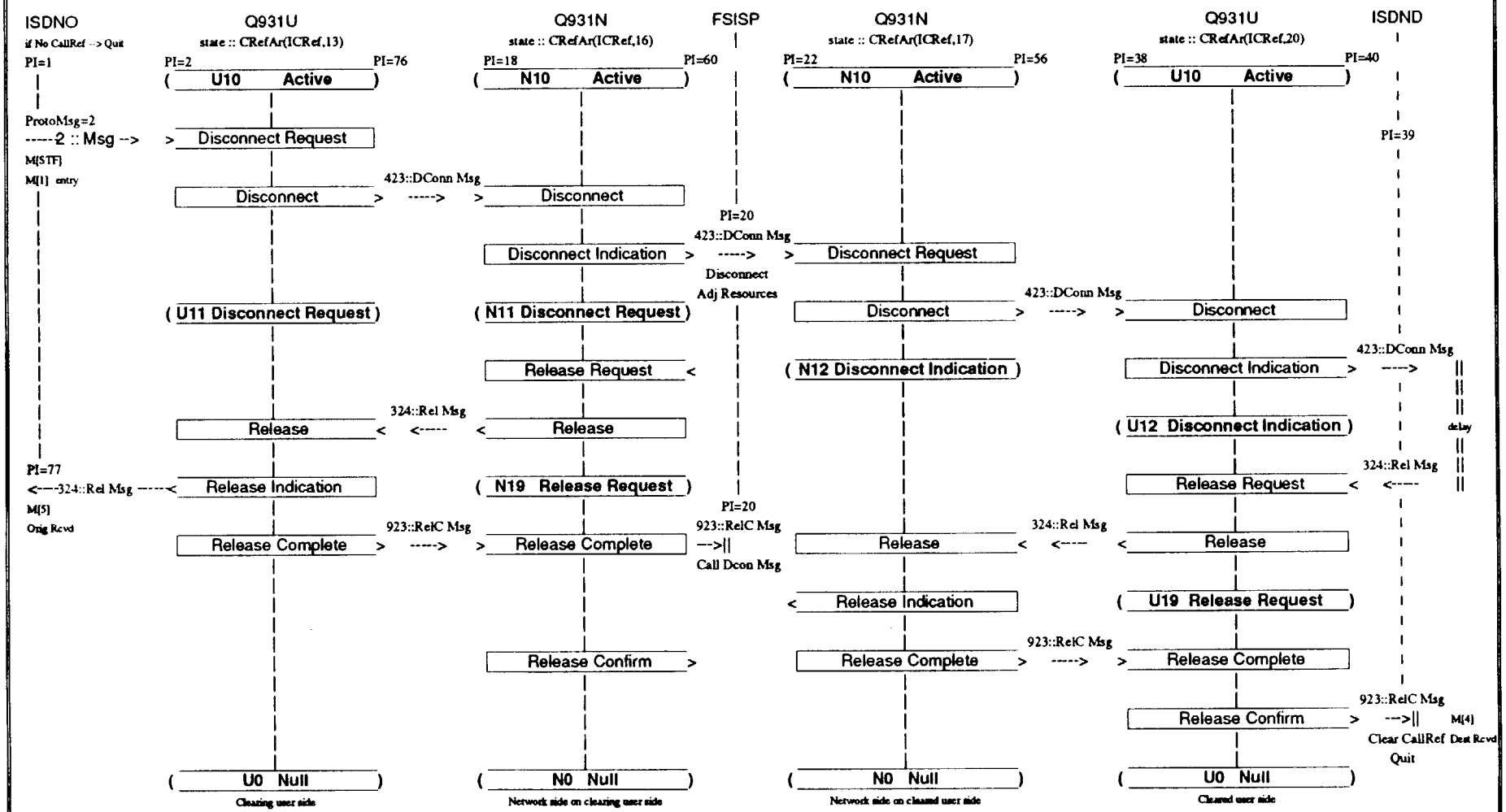


Figure 8.2 Q931 Protocol Disconnection SDL Interaction Diagram

Q931 Protocol adapted from CCITT BLue Book, vol. VI.11, 1988

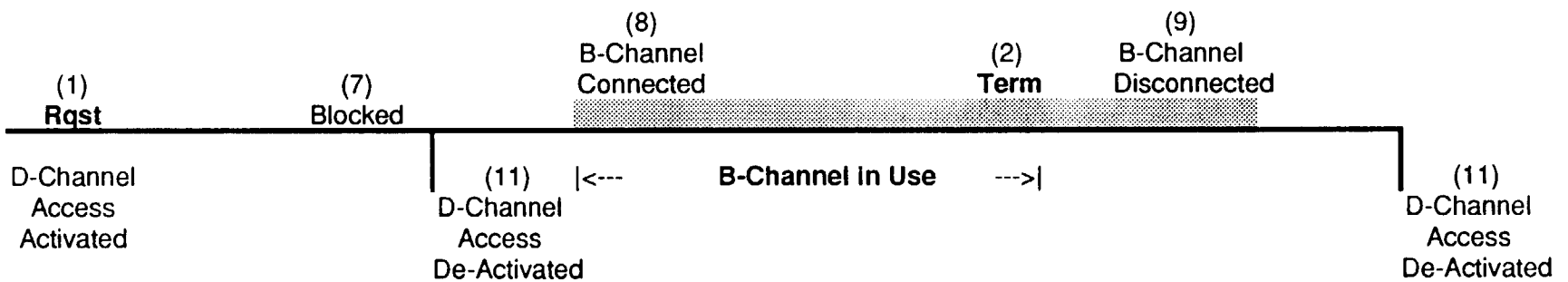


Figure 8.3 Major ISDN Satellite Transition Points

APPENDIX E

Measurement Save (MSave) File Structure

Three MSave files generated by the FSIS Build 3 are provided in this appendix -- "MSaveInt.DAT" and "MSaveInt.DAT"(STF01.DAT), "MSaveInt"(full CRef #7), and "MSaveInt"(STF06.DAT).

These Measurement Save (MSave) files contain the time sequenced data generated by the SimRun simulation program. Every time a communication process is activated an entry is made in MSave. Also, all significant events, such as protocol entity state changes, call connections, disconnections and blocking are saved in MSave. Periodically the internal MSave array is saved to disk as MSAVE##.DAT. Where ## represents a sequential digit starting with 1. These MSave files are the principal data sources for post simulation analyses. The contain all the data can be obtained from a particular simulation.

The MSave contains all data that is relevant to call processing in an ISDN era. The data within MSave can be used to calculate throughput, response time, blocking probability, and robustness. By using these performance measures an advanced ISDN satellite can be postulated and tested using these simulation techniques.

For MSaveInt.DAT, the MSave record consists of five fields: the simulation time, the call reference number, the PI, the protocol msg, and a state/status indicator.

For example the **first field is the simulation time** for the record of the MSave file in the appendix shows the simulation time in milliseconds-of-day:

11111010 milliseconds after midnight

The **second field is call reference** number associated with this call:

1 is the Call Reference Number

The **third field identifies** the number of the PI concatenated with the bearer service:

-11 is decoded as:

(-), the negative sign is a flag indicating that this record is a STF record.

1 indicates that this for PI=1

1 indicates that the CS64 Bearer service.

N.B. A positive number in this position indicates that the event is an internal event and represents the PI number.

The **forth field contains** the concatenated indexes for the origination and destination cities, if this is a STF record

2452

25 :: Los Angeles CA

52 :: Washington DC

or otherwise

contains the protocol message being transmitted at that time. The protocol messages were derived in part for the CCITT Q931 protocol messages, p72 Fascicle VI.11-Rec. Q931:

Bit position	87654321	#	Protocol Msg (use #)
	00000001	1	Alerting
	00000010	2	Call Processing
	00000111	7	Connect
	00001111	15	Connect Acknowledge (use 8)
	00000011	3	Progress
	00000101	5	Setup
	00001101	13	Set Acknowledge (use 6)
	01000101	37	Disconnect (use 4)
	01001101	45	Release (use 7)
	01011010	58	Release Complete (use 9)

This digit was used as the most significant digit of a three digit number indicating the Layer 3 protocol message. The center digit is set to "1" indicating messages used in the setup procedure. Whereas, this digit is set to 2 for call termination protocol messages. The least significant digit of the three digit number was set to either 3 or 4 depending on the Layer 1 flow of the protocol message. Protocol messages for FSIS Build 3 include:\

114	Alrt Alerting
214	CalP Call Processing
513	SetU Setup
614	SetC Setup Complete
714	Conn Connect
813	ConA Connect Acknowledge
324	Rel Release
423	DCon Disconnect
923	RelC Release Complete

The **fifth field** represents the Term time in seconds, if this a STF record:

11159 indicates that the call will terminated at
11159 seconds after midnight,.

or otherwise

represents the status or state of the PI. For FSIS Build 3 negative numbers represent states of various protocol entities such F1...F7, G1...G3, U0...U10, and N0...N10. The active states for these protocol entities are F7, G3, U10, and N10. Whereas, positive values indicate program status such as entry, exit, not in case, timer overflow, etc.

For MSaveTxt.DAT, the MSave record consists of the same five fields: the simulation time, the call reference number, the PI, the protocol msg, and a status indicator with the integer values replaced by text abbreviation to be more mnemonically pleasing.

MSaveInt.DAT from STF01.DAT
3-4 hours >> 11111/010 ms.day -- 14506/506 ms.day

The following MSave file data was generated using the STF01.DAT scenario traffic file with the ISDN Satellite Simulation of the FSIS Model. STF01.DAT requests only single B-Channels between Washington DC and Los Angeles CA using the data from Traffic Model previously generated as part of this NASA SCAR effort.

For that simulation run, SimRun, the STF01.DAT was started a 3 hours and ended at 4 hours. Only the MSave option was selected - NOT the Full option. The MSave data consisting of the nearly 200 data records shown here were generated. Using this partial MSave option only a minimal amount of data is saved. These data deal with the request, termination, connection, and blocking of calls.

This particular section of MSave data was selected using the Product Generation, ProGen, program by employing the <M>Save input data menu option. Under that <M>Save input data option, <R>ead was selected; no was responded to the "Find number of MSave files (yes)?" question; the value 24 was entered for MSaveFnNuMn; and the value 33 for MSaveFnNuMx.

The data selected spans the simulation time from 11111/010 msecs of day to 14506/506 msecs of day (ms.day) and includes Call Refence Number (CRef#) 7. CRef #7, using D-Channel access, first requested a B-Channel at 12971/010 ms.day but was blocked at 12971/614 ms.day and the D-Channel access is released A retry was generated for a minute later at 13031/624 ms.day and was connected to a B-Channel at 13032/578 ms.day. After a 3 minute telephone call, CRef #7 hung up at 13213/010 ms.day, was disconnected from the B-Channel at 13213/95 ms.day, and all circuits cleared at 13213/506 ms.day and the D-Channel released.

ISDN Satellite Call Data, Response Time, and Throughput Products were generated from these MSave data are presented in Appendices F, G, and H, respectively.

11111010	1	-11	2452	11159
11111193	1	20	513	1
11111564	1	58	214	1
11111569	1	58	114	1
11111604	1	58	714	1
11111954	1	20	813	1
11111964	1	20	813	8
11111964	1	20	-1	111
11159010	1	-21	2452	11159
11159185	1	20	423	1
11159195	1	20	423	9
11159195	1	20	-1	-111
11159496	1	20	923	1
11159506	1	20	923	11
11201010	100	-11	5224	11429
11201193	100	20	513	1
11201564	100	58	214	1
11201569	100	58	114	1
11201604	100	58	714	1
11201954	100	20	813	1
11201964	100	20	813	8
11201964	100	20	-1	111
11421010	2	-11	2424	11642
11421193	2	20	513	1
11421564	2	58	214	1
11421569	2	58	114	1
11421604	2	58	714	1
11421954	2	20	813	1
11421964	2	20	813	8
11421964	2	20	-1	111
11429010	100	-21	5224	11429
11429185	100	20	423	1
11429195	100	20	423	9
11429195	100	20	-1	-111
11429496	100	20	923	1
11429506	100	20	923	11
11642010	2	-21	2424	11642
11642185	2	20	423	1
11642195	2	20	423	9
11642195	2	20	-1	-111
11642496	2	20	923	1
11642506	2	20	923	11
11731010	3	-11	2452	11880
11731193	3	20	513	1
11731564	3	58	214	1
11731569	3	58	114	1
11731604	3	58	714	1
11731954	3	20	813	1
11731964	3	20	813	8
11731964	3	20	-1	111

11880010	3	-21	2452	11880
11880185	3	20	423	1
11880195	3	20	423	9
11880195	3	20	-1	-111
11880496	3	20	923	1
11880506	3	20	923	11
12041010	4	-11	2424	12178
12041193	4	20	513	1
12041564	4	58	214	1
12041569	4	58	114	1
12041604	4	58	714	1
12041954	4	20	813	1
12041964	4	20	813	8
12041964	4	20	-1	111
12178010	4	-21	2424	12178
12178185	4	20	423	1
12178195	4	20	423	9
12178195	4	20	-1	-111
12178496	4	20	923	1
12178506	4	20	923	11
12351010	5	-11	2452	12627
12351193	5	20	513	1
12351564	5	58	214	1
12351569	5	58	114	1
12351604	5	58	714	1
12351954	5	20	813	1
12351964	5	20	813	8
12351964	5	20	-1	111
12627010	5	-21	2452	12627
12627185	5	20	423	1
12627195	5	20	423	9
12627195	5	20	-1	-111
12627496	5	20	923	1
12627506	5	20	923	11
12661010	6	-11	2424	13026
12661193	6	20	513	1
12661564	6	58	214	1
12661569	6	58	114	1
12661604	6	58	714	1
12661954	6	20	813	1
12661964	6	20	813	8
12661964	6	20	-1	111
12801010	101	-11	5252	12979
12801193	101	20	513	1
12801564	101	58	214	1
12801569	101	58	114	1
12801604	101	58	714	1
12801954	101	20	813	1
12801964	101	20	813	8
12801964	101	20	-1	111
12971010	7	-11	2452	13152
12971193	7	20	513	1
12971564	7	58	214	1
12971569	7	58	114	1

12971604	7	58	714	1
12971614	7	58	714	7
12971614	7	58	714	11
12979010	101	-21	5252	12979
12979185	101	20	423	1
12979195	101	20	423	9
12979195	101	20	-1	-111
12979496	101	20	923	1
12979506	101	20	923	11
13026010	6	-21	2424	13026
13026185	6	20	423	1
13026195	6	20	423	9
13026195	6	20	-1	-111
13026496	6	20	923	1
13026506	6	20	923	11
13031624	7	-11	2452	13213
13031807	7	20	513	1
13032178	7	58	214	1
13032183	7	58	114	1
13032218	7	58	714	1
13032568	7	20	813	1
13032578	7	20	813	8
13032578	7	20	-1	111
13213010	7	-21	2452	13213
13213185	7	20	423	1
13213195	7	20	423	9
13213195	7	20	-1	-111
13213496	7	20	923	1
13213506	7	20	923	11
13281010	8	-11	2424	13504
13281193	8	20	513	1
13281564	8	58	214	1
13281569	8	58	114	1
13281604	8	58	714	1
13281954	8	20	813	1
13281964	8	20	813	8
13281964	8	20	-1	111
13504010	8	-21	2424	13504
13504185	8	20	423	1
13504195	8	20	423	9
13504195	8	20	-1	-111
13504496	8	20	923	1
13504506	8	20	923	11
13591010	9	-11	2452	13832
13591193	9	20	513	1
13591564	9	58	214	1
13591569	9	58	114	1
13591604	9	58	714	1
13591954	9	20	813	1
13591964	9	20	813	8
13591964	9	20	-1	111
13832010	9	-21	2452	13832
13832185	9	20	423	1
13832195	9	20	423	9

13832195	9	20	-1	-111
13832496	9	20	923	1
13832506	9	20	923	11
13901010	10	-11	2424	14102
13901193	10	20	513	1
13901564	10	58	214	1
13901569	10	58	114	1
13901604	10	58	714	1
13901954	10	20	813	1
13901964	10	20	813	8
13901964	10	20	-1	111
14102010	10	-21	2424	14102
14102185	10	20	423	1
14102195	10	20	423	9
14102195	10	20	-1	-111
14102496	10	20	923	1
14102506	10	20	923	11
14211010	11	-11	2452	14506
14211193	11	20	513	1
14211564	11	58	214	1
14211569	11	58	114	1
14211604	11	58	714	1
14211954	11	20	813	1
14211964	11	20	813	8
14211964	11	20	-1	111
14506010	11	-21	2452	14506
14506185	11	20	423	1
14506195	11	20	423	9
14506195	11	20	-1	-111
14506496	11	20	923	1
14506506	11	20	923	11
0	6	20	813	1

MSaveInt.DAT from STF01.DAT
3-4 hours >> 11111/010 ms.day -- 14506/506 ms.day
/// Call Reference #7 Only ///

The following MSave file data was generated using the STF01.DAT scenario traffic file with the ISDN Satellite Simulation of the FSIS Model. STF01.DAT requests only single B-Channels between Washington DC and Los Angeles CA using the data from Traffic Model previously generated as part of this NASA SCAR effort.

For that simulation run, SimRun, the STF01.DAT was started a 3 hours and ended at 4 hours. The MSave option was selected, both MSave and Full were checked on the input graphic. The MSave data consisting of the 4500 data records were generated. Using this full MSave option all the data that can be save during the SimRun is saved. These data deal with every process in the simulation and account of such things as delay, transmitted/received power, thresholds, timers, time-outs, etc. During this SimRun 14 calls requesting a B-Channel were made. Each call lasted approximated 3 minutes and one call was blocked, Call Reference #7, resulting in a blocking factor of 7.14%..

This particular section of MSave data was edited, using the Word Perfect® 5.1 word processor, to retain only the data related to Call Reference #7, CRef #7. CRef #7 first requested a B-Channel at 12971/010 ms.day but was blocked at 12971/614 ms.day. A retry was generated for a minute later at 13031/624 ms.day and was connected at 13032/578 ms.day. After a 3 minute telephone call, CRef #7 hung up at 13213/010 ms.day, was disconnected from the B-Channel at 13213/195 ms.day, and all circuits cleared at 13213/711 ms.day.

Every protocol message exchange is shown. Every propagation element is modeled. And, all call processing aspects are presented. About 125 processes are encounter before a call is determined blocked. More than 200 processes are traversed before a call is connected, and at least 50 protocol exchanges are needed to disconnect the B-Channels with a 100 exchanges before all the circuit connections are cleared. ISDN Satellite Call Data, Response Time, and Throughput Products were generated from these MSave data are presented in Appendices F, G, and H, respectively.

12971378	7	38	513	0
12971378	7	39	513	1
12971398	7	40	214	-600
12971398	7	41	214	1
12971400	7	42	214	-7
12971400	7	43	214	1
12971401	7	44	214	-3
12971402	7	45	214	1
12971403	7	46	214	1
12971403	7	40	114	-900
12971403	7	41	114	1
12971404	7	47	214	1
12971405	7	42	114	-7
12971405	7	43	114	1
12971405	7	48	214	1
12971406	7	44	114	-3
12971407	7	45	114	1
12971407	7	49	214	1
12971408	7	46	114	1
12971408	7	50	214	1
12971409	7	51	214	1
12971409	7	47	114	1
12971410	7	48	114	1
12971412	7	49	114	1
12971413	7	50	114	1
12971414	7	51	114	1
12971438	7	40	714	-700
12971438	7	41	714	1
12971440	7	42	714	-7
12971440	7	43	714	1
12971441	7	44	714	-3
12971442	7	45	714	1
12971443	7	46	714	1
12971444	7	47	714	1
12971445	7	48	714	1
12971447	7	49	714	1
12971448	7	50	714	1
12971449	7	51	714	1
12971536	7	52	214	1
12971537	7	53	214	1
12971538	7	54	214	1
12971541	7	52	114	1
12971542	7	53	114	1
12971543	7	55	214	1
12971543	7	54	114	1
12971548	7	55	114	1
12971554	7	56	214	-600
12971554	7	56	-331	303
12971554	7	57	214	1
12971559	7	56	114	-900
12971559	7	56	-5	310
12971559	7	57	114	1
12971564	7	58	214	1
12971569	7	58	114	1

12971574	7	59	214	1	
12971576	7	52	714	1	
12971577	7	53	714	1	
12971578	7	54	714	1	
12971579	7	59	114	1	
12971583	7	55	714	1	
12971594	7	60	214	-100	
12971594	7	61	214	1	
12971594	7	56	714	-700	
12971594	7	56	813	-800	
12971594	7	56	813	-1000	
12971594	7	57	714	1	
12971594	7	23	813	1	
12971595	7	62	214	1	
12971595	7	24	813	1	
12971599	7	60	114	-300	
12971599	7	61	114	1	
12971600	7	63	214	1	
12971600	7	25	813	1	
12971600	7	62	114	1	
12971601	7	64	214	1	
12971601	7	26	813	1	
12971602	7	65	214	1	
12971602	7	27	813	1	
12971604	7	58	714	1	
12971605	7	63	114	1	
12971606	7	64	114	1	
12971607	7	65	114	1	
12971614	7	58	714	7	<-- Call Blocked
12971614	7	58	714	11	
12971728	7	66	214	1	
12971728	7	28	813	1	
12971729	7	67	214	1	
12971729	7	29	813	1	
12971730	7	68	214	1	
12971730	7	30	813	1	
12971732	7	69	214	1	
12971732	7	31	813	1	
12971733	7	70	214	1	
12971733	7	32	813	1	
12971733	7	66	114	1	
12971734	7	67	114	1	
12971734	7	71	214	1	
12971734	7	33	813	1	
12971735	7	68	114	1	
12971737	7	69	114	1	
12971738	7	70	114	1	
12971739	7	71	114	1	
13031614	7	1	1	1	
13031624	7	-11	2452	13213	<-- initiate RQST
13031634	7	2	1	0	
13031634	7	3	513	1	

13031636	7	4	1	-4
13031636	7	5	1	1
13031638	7	6	2	-2
13031638	7	73	2	1
13031640	7	4	3	-6
13031640	7	5	3	1
13031642	7	6	-4	1
13031642	7	6	4	-3
13031642	7	73	4	1
13031644	7	74	-8	3
13031644	7	4	513	-7
13031644	7	5	513	1
13031645	7	6	513	-3
13031646	7	7	513	1
13031647	7	8	513	1
13031648	7	9	513	1
13031649	7	10	513	1
13031651	7	11	513	1
13031652	7	12	513	1
13031653	7	13	513	1
13031779	7	14	513	1
13031780	7	15	513	1
13031781	7	16	513	1
13031786	7	17	513	1
13031797	7	18	513	0
13031797	7	19	513	1
13031807	7	20	513	1
13031817	7	21	513	1
13031837	7	22	513	0
13031837	7	23	513	1
13031838	7	24	513	1
13031843	7	25	513	1
13031844	7	26	513	1
13031845	7	27	513	1
13031971	7	28	513	1
13031972	7	29	513	1
13031973	7	30	513	1
13031975	7	31	513	1
13031976	7	32	513	1
13031977	7	33	513	1
13031978	7	34	513	-3
13031979	7	35	513	1
13031981	7	36	513	-7
13031981	7	37	513	1
13031992	7	38	513	0
13031992	7	39	513	1
13032012	7	40	214	-600
13032012	7	41	214	1
13032014	7	42	214	-7
13032014	7	43	214	1
13032015	7	44	214	-3
13032016	7	45	214	1
13032017	7	46	214	1
13032017	7	40	114	-900

13032017	7	41	114	1
13032018	7	47	214	1
13032019	7	42	114	-7
13032019	7	43	114	1
13032019	7	48	214	1
13032020	7	44	114	-3
13032021	7	45	114	1
13032021	7	49	214	1
13032022	7	46	114	1
13032022	7	50	214	1
13032023	7	51	214	1
13032023	7	47	114	1
13032024	7	48	114	1
13032026	7	49	114	1
13032027	7	50	114	1
13032028	7	51	114	1
13032052	7	40	714	-700
13032052	7	41	714	1
13032054	7	42	714	-7
13032054	7	43	714	1
13032055	7	44	714	-3
13032056	7	45	714	1
13032057	7	46	714	1
13032058	7	47	714	1
13032059	7	48	714	1
13032061	7	49	714	1
13032062	7	50	714	1
13032063	7	51	714	1
13032150	7	52	214	1
13032151	7	53	214	1
13032152	7	54	214	1
13032155	7	52	114	1
13032156	7	53	114	1
13032157	7	55	214	1
13032157	7	54	114	1
13032162	7	55	114	1
13032168	7	56	214	-600
13032168	7	56	-331	303
13032168	7	57	214	1
13032173	7	56	114	-900
13032173	7	56	-5	310
13032173	7	57	114	1
13032178	7	58	214	1
13032183	7	58	114	1
13032188	7	59	214	1
13032190	7	52	714	1
13032191	7	53	714	1
13032192	7	54	714	1
13032193	7	59	114	1
13032197	7	55	714	1
13032208	7	60	214	-100
13032208	7	61	214	1
13032208	7	56	714	-700
13032208	7	56	813	-800

13032208	7	56	813	-1000
13032208	7	57	714	1
13032208	7	23	813	1
13032209	7	62	214	1
13032209	7	24	813	1
13032213	7	60	114	-300
13032213	7	61	114	1
13032214	7	63	214	1
13032214	7	25	813	1
13032214	7	62	114	1
13032215	7	64	214	1
13032215	7	26	813	1
13032216	7	65	214	1
13032216	7	27	813	1
13032218	7	58	714	1
13032219	7	63	114	1
13032220	7	64	114	1
13032221	7	65	114	1
13032228	7	59	714	1
13032248	7	60	714	-400
13032248	7	61	714	1
13032249	7	62	714	1
13032254	7	63	714	1
13032255	7	64	714	1
13032256	7	65	714	1
13032342	7	66	214	1
13032342	7	28	813	1
13032343	7	67	214	1
13032343	7	29	813	1
13032344	7	68	214	1
13032344	7	30	813	1
13032346	7	69	214	1
13032346	7	31	813	1
13032347	7	70	214	1
13032347	7	32	813	1
13032347	7	66	114	1
13032348	7	67	114	1
13032348	7	71	214	1
13032348	7	33	813	1
13032349	7	72	214	-3
13032349	7	34	813	-3
13032349	7	68	114	1
13032350	7	73	214	1
13032350	7	35	813	1
13032351	7	69	114	1
13032352	7	74	214	-7
13032352	7	75	214	1
13032352	7	36	813	-7
13032352	7	37	813	1
13032352	7	70	114	1
13032353	7	71	114	1
13032354	7	72	114	-3
13032355	7	73	114	1
13032357	7	74	114	-7

13032357	7	75	114	1	
13032363	7	76	214	-100	
13032363	7	76	-729	303	
13032363	7	77	1	1	
13032363	7	38	813	-800	
13032363	7	38	-311	313	
13032363	7	38	813	-1000	
13032363	7	39	813	1	
13032368	7	76	114	-300	
13032368	7	76	-5	310	
13032368	7	77	1	1	
13032373	7	39	813	4	
13032373	7	77	214	5	
13032378	7	77	114	5	
13032382	7	66	714	1	
13032383	7	67	714	1	
13032384	7	68	714	1	
13032386	7	69	714	1	
13032387	7	70	714	1	
13032388	7	71	714	1	
13032389	7	72	714	-3	
13032390	7	73	714	1	
13032392	7	74	714	-7	
13032392	7	75	714	1	
13032403	7	76	714	-400	
13032403	7	76	813	-1000	
13032403	7	77	1	1	
13032403	7	3	813	1	
13032405	7	4	813	-7	
13032405	7	5	813	1	
13032406	7	6	813	-3	
13032407	7	7	813	1	
13032408	7	8	813	1	
13032409	7	9	813	1	
13032410	7	10	813	1	
13032412	7	11	813	1	
13032413	7	77	714	8	
13032413	7	12	813	1	
13032414	7	13	813	1	
13032540	7	14	813	1	
13032541	7	15	813	1	
13032542	7	16	813	1	
13032547	7	17	813	1	
13032558	7	18	813	-1000	
13032558	7	19	813	1	
13032568	7	20	813	1	
13032578	7	20	813	8	<-- Call Connected
13032578	7	20	-1	111	
13213000	7	1	1	1	
13213010	7	-21	2452	13213	<-- initiate TERM
13213020	7	2	2	-1000	
13213020	7	3	423	1	

13213022	7	4	423	-7	
13213022	7	5	423	1	
13213023	7	6	423	-3	
13213024	7	7	423	1	
13213025	7	8	423	1	
13213026	7	9	423	1	
13213027	7	10	423	1	
13213029	7	11	423	1	
13213030	7	12	423	1	
13213031	7	13	423	1	
13213157	7	14	423	1	
13213158	7	15	423	1	
13213159	7	16	423	1	
13213164	7	17	423	1	
13213175	7	18	423	-1000	
13213175	7	19	423	1	
13213175	7	61	324	1	
13213176	7	62	324	1	
13213181	7	63	324	1	
13213182	7	64	324	1	
13213183	7	65	324	1	
13213185	7	20	423	1	
13213195	7	20	423	9	<-- Call Disconnected
13213195	7	20	-1	-111	
13213195	7	21	423	1	
13213215	7	22	423	-1000	
13213215	7	23	423	1	
13213216	7	24	423	1	
13213221	7	25	423	1	
13213222	7	26	423	1	
13213223	7	27	423	1	
13213309	7	66	324	1	
13213310	7	67	324	1	
13213311	7	68	324	1	
13213313	7	69	324	1	
13213314	7	70	324	1	
13213315	7	71	324	1	
13213316	7	72	324	-3	
13213317	7	73	324	1	
13213319	7	74	324	-7	
13213319	7	75	324	1	
13213330	7	76	324	-1100	
13213330	7	76	923	0	
13213330	7	77	1	1	
13213330	7	3	923	1	
13213332	7	4	923	-7	
13213332	7	5	923	1	
13213333	7	6	923	-3	
13213334	7	7	923	1	
13213335	7	8	923	1	
13213336	7	9	923	1	
13213337	7	10	923	1	
13213339	7	11	923	1	
13213340	7	77	324	5	

13213340	7	12	923	1
13213341	7	13	923	1
13213349	7	28	423	1
13213350	7	29	423	1
13213351	7	30	423	1
13213353	7	31	423	1
13213354	7	32	423	1
13213355	7	33	423	1
13213356	7	34	423	-3
13213357	7	35	423	1
13213359	7	36	423	-7
13213359	7	37	423	1
13213370	7	38	423	-1000
13213370	7	39	423	1
13213390	7	40	324	-1200
13213390	7	41	324	1
13213392	7	42	324	-7
13213392	7	43	324	1
13213393	7	44	324	-3
13213394	7	45	324	1
13213395	7	46	324	1
13213396	7	47	324	1
13213397	7	48	324	1
13213399	7	49	324	1
13213400	7	50	324	1
13213401	7	51	324	1
13213468	7	14	923	1
13213469	7	15	923	1
13213470	7	16	923	1
13213475	7	17	923	1
13213486	7	18	923	-1900
13213486	7	18	923	0
13213486	7	19	923	1
13213496	7	20	923	1
13213506	7	20	923	11
13213528	7	52	324	1
13213529	7	53	324	1
13213530	7	54	324	1
13213535	7	55	324	1
13213546	7	56	324	-1200
13213546	7	56	923	0
13213546	7	23	923	1
13213547	7	24	923	1
13213552	7	25	923	1
13213553	7	26	923	1
13213554	7	27	923	1
13213680	7	28	923	1
13213681	7	29	923	1
13213682	7	30	923	1
13213684	7	31	923	1
13213685	7	32	923	1
13213686	7	33	923	1
13213687	7	34	923	-3
13213688	7	35	923	1

13213690	7	36	923	-7
13213690	7	37	923	1
13213701	7	38	923	-1900
13213701	7	38	923	0
13213701	7	39	923	1
13213711	7	39	923	4

MSaveInt.DAT from STF06.DAT
8-9 hours >> 28800/010 ms.day -- 29782/505 ms.day

The following MSave file data was generated using the STF01.DAT scenario traffic file with the ISDN Satellite Simulation of the FSIS Model. STF01.DAT requests all possible bearer services permitted: CS64, CS128, DX25, BFR and TLM between Washington DC and Denver CO using the data from Traffic Model previously generated as part of this NASA SCAR effort.

For that simulation run, SimRun, the STF06.DAT was started a 8 hours and ended at 9 hours. Only the MSave option was selected - NOT the Full option. The MSave data consisting of the 350 data records shown here were generated. Using this partial MSave option only a minimal amount of data is saved. These data deal with the request, termination, connection, and blocking of calls.

This particular section of MSave data was selected using the Product Generation, ProGen, program by employing the <M>Save input data menu option. Under that <M>Save input data option, <R>ead was selected; no was responded to the "Find number of MSave files (yes)?" question; the value 1 was entered for MSaveFnNuMn; and the value 4 for MSaveFnNuMx.

The data selected spans the simulation time from 28800/010 msecs of day to 29782/505 msecs of day (ms.day). This simulation run included 30 call covering all the five bearer services of the Traffic Model. Each call lasted from seconds to minutes. There were ten blocked calls that were retried a minute later.

ISDN Satellite Call Data, Response Time, and Throughput Products were generated from these MSave data are presented in Appendices F, G, and H, respectively.

28800010	401	-13	5252	28814
28800010	402	-14	5215	28814
28800193	401	20	513	1
28800193	402	20	513	1
28800563	402	58	214	1
28800564	401	58	214	1
28800568	402	58	114	1
28800569	401	58	114	1
28800603	402	58	714	1
28800604	401	58	714	1
28800954	402	20	813	1
28800954	401	20	813	1
28800964	402	20	813	8
28800964	402	20	-4	111
28800964	401	20	813	8
28800964	401	20	-3	111
28801010	18	-11	1515	28828
28801010	348	-15	1515	28858
28801010	370	-11	5215	29043
28801010	395	-11	5252	28823
28801010	400	-12	5215	28818
28801193	18	20	513	1
28801193	348	20	513	1
28801193	370	20	513	1
28801193	395	20	513	1
28801193	400	20	513	1
28801563	18	58	214	1
28801563	348	58	214	1
28801563	370	58	214	1
28801563	400	58	214	1
28801564	395	58	214	1
28801568	18	58	114	1
28801568	348	58	114	1
28801568	370	58	114	1
28801568	400	58	114	1
28801569	395	58	114	1
28801603	18	58	714	1
28801603	348	58	714	1
28801603	370	58	714	1
28801603	400	58	714	1
28801604	395	58	714	1
28801613	18	58	714	7
28801613	18	58	714	11
28801613	370	58	714	7
28801613	370	58	714	11
28801613	400	58	714	7
28801613	400	58	714	11
28801614	395	58	714	7
28801614	395	58	714	11
28801954	348	20	813	1
28801964	348	20	813	8
28801964	348	20	-5	111
28806010	1106	-15	5215	28834
28806193	1106	20	513	1

28806563	1106	58	214	1
28806568	1106	58	114	1
28806603	1106	58	714	1
28806954	1106	20	813	1
28806964	1106	20	813	8
28806964	1106	20	-5	111
28814010	402	-24	5215	28814
28814185	402	20	423	1
28814195	402	20	423	9
28814195	402	20	-4	-111
28814496	402	20	923	1
28814506	402	20	923	11
28833010	1071	-14	5252	28851
28833193	1071	20	513	1
28833564	1071	58	214	1
28833569	1071	58	114	1
28833604	1071	58	714	1
28833954	1071	20	813	1
28833964	1071	20	813	8
28833964	1071	20	-4	111
28851010	1071	-24	5252	28851
28851185	1071	20	423	1
28851195	1071	20	423	9
28851195	1071	20	-4	-111
28851496	1071	20	923	1
28851506	1071	20	923	11
28856010	401	-23	5252	28856
28856185	401	20	423	1
28856195	401	20	423	9
28856195	401	20	-3	-111
28856496	401	20	923	1
28856506	401	20	923	11
28861623	18	-11	1515	28889
28861623	370	-11	5215	29104
28861623	400	-12	5215	28879
28861624	395	-11	5252	28884
28861806	18	20	513	1
28861806	370	20	513	1
28861806	400	20	513	1
28861807	395	20	513	1
28862176	18	58	214	1
28862176	370	58	214	1
28862176	400	58	214	1
28862178	395	58	214	1
28862181	18	58	114	1
28862181	370	58	114	1
28862181	400	58	114	1
28862183	395	58	114	1
28862216	18	58	714	1
28862216	370	58	714	1
28862216	400	58	714	1
28862218	395	58	714	1
28862567	18	20	813	1
28862567	370	20	813	1

28862567	400	20	813	1
28862568	395	20	813	1
28862577	18	20	813	8
28862577	18	20	-1	111
28862577	370	20	813	8
28862577	370	20	-1	111
28862577	400	20	813	7
28862577	400	20	813	11
28862578	395	20	813	7
28862578	395	20	813	11
28889010	18	-21	1515	28889
28889185	18	20	423	1
28889195	18	20	423	9
28889195	18	20	-1	-111
28889495	18	20	923	1
28889505	18	20	923	11
28918010	1106	-25	5215	28918
28918185	1106	20	423	1
28918195	1106	20	423	9
28918195	1106	20	-5	-111
28918496	1106	20	923	1
28918506	1106	20	923	11
28922587	400	-12	5215	28940
28922588	395	-11	5252	28945
28922770	400	20	513	1
28922771	395	20	513	1
28923140	400	58	214	1
28923142	395	58	214	1
28923145	400	58	114	1
28923147	395	58	114	1
28923180	400	58	714	1
28923182	395	58	714	1
28923190	400	58	714	7
28923190	400	58	714	11
28923532	395	20	813	1
28923542	395	20	813	8
28923542	395	20	-1	111
28945010	395	-21	5252	28945
28945185	395	20	423	1
28945195	395	20	423	9
28945195	395	20	-1	-111
28945496	395	20	923	1
28945506	395	20	923	11
28957010	324	-14	1515	29000
28957193	324	20	513	1
28957563	324	58	214	1
28957568	324	58	114	1
28957603	324	58	714	1
28957613	324	58	714	7
28957613	324	58	714	11
28983200	400	-12	5215	29001
28983383	400	20	513	1
28983753	400	58	214	1
28983758	400	58	114	1

28983793	400	58	714	1
28983803	400	58	714	7
28983803	400	58	714	11
29001010	172	-12	1515	29036
29001193	172	20	513	1
29001563	172	58	214	1
29001568	172	58	114	1
29001603	172	58	714	1
29001613	172	58	714	7
29001613	172	58	714	11
29017623	324	-14	1515	29061
29017806	324	20	513	1
29018176	324	58	214	1
29018181	324	58	114	1
29018216	324	58	714	1
29018226	324	58	714	7
29018226	324	58	714	11
29026010	98	-11	1515	29047
29026010	263	-13	1552	29047
29026193	98	20	513	1
29026193	263	20	513	1
29026563	98	58	214	1
29026564	263	58	214	1
29026568	98	58	114	1
29026569	263	58	114	1
29026603	98	58	714	1
29026604	263	58	714	1
29026954	98	20	813	1
29026954	263	20	813	1
29026964	98	20	813	8
29026964	98	20	-1	111
29026964	263	20	813	8
29026964	263	20	-3	111
29029010	348	-25	1515	29029
29029185	348	20	423	1
29029195	348	20	423	9
29029195	348	20	-5	-111
29029495	348	20	923	1
29029505	348	20	923	11
29043813	400	-12	5215	29062
29043996	400	20	513	1
29044366	400	58	214	1
29044371	400	58	114	1
29044406	400	58	714	1
29044416	400	58	714	7
29044416	400	58	714	11
29047010	98	-21	1515	29047
29047185	98	20	423	1
29047195	98	20	423	9
29047195	98	20	-1	-111
29047495	98	20	923	1
29047505	98	20	923	11
29061623	172	-12	1515	29097
29061806	172	20	513	1

29062176	172	58	214	1
29062181	172	58	114	1
29062216	172	58	714	1
29062226	172	58	714	7
29062226	172	58	714	11
29078236	324	-14	1515	29122
29078419	324	20	513	1
29078789	324	58	214	1
29078794	324	58	114	1
29078829	324	58	714	1
29078839	324	58	714	7
29078839	324	58	714	11
29104010	370	-21	5215	29104
29104185	370	20	423	1
29104195	370	20	423	9
29104195	370	20	-1	-111
29104426	400	-12	5215	29123
29104496	370	20	923	1
29104506	370	20	923	11
29104609	400	20	513	1
29104979	400	58	214	1
29104984	400	58	114	1
29105019	400	58	714	1
29105370	400	20	813	1
29105380	400	20	813	8
29105380	400	20	-2	111
29110010	263	-23	1552	29110
29110185	263	20	423	1
29110195	263	20	423	9
29110195	263	20	-3	-111
29110495	263	20	923	1
29110505	263	20	923	11
29122236	172	-12	1515	29158
29122419	172	20	513	1
29122789	172	58	214	1
29122794	172	58	114	1
29122829	172	58	714	1
29122839	172	58	714	7
29122839	172	58	714	11
29123010	400	-22	5215	29123
29123185	400	20	423	1
29123195	400	20	423	9
29123195	400	20	-2	-111
29123496	400	20	923	1
29123506	400	20	923	11
29138849	324	-14	1515	29183
29139032	324	20	513	1
29139402	324	58	214	1
29139407	324	58	114	1
29139442	324	58	714	1
29139793	324	20	813	1
29139803	324	20	813	8
29139803	324	20	-4	111
29182849	172	-12	1515	29219

29183010	324	-24	1515	29183
29183032	172	20	513	1
29183185	324	20	423	1
29183195	324	20	423	9
29183195	324	20	-4	-111
29183402	172	58	214	1
29183407	172	58	114	1
29183442	172	58	714	1
29183495	324	20	923	1
29183505	324	20	923	11
29183793	172	20	813	1
29183803	172	20	813	8
29183803	172	20	-2	111
29219010	172	-22	1515	29219
29219185	172	20	423	1
29219195	172	20	423	9
29219195	172	20	-2	-111
29219495	172	20	923	1
29219505	172	20	923	11
29317010	99	-11	1552	29341
29317010	264	-13	1515	29362
29317193	99	20	513	1
29317193	264	20	513	1
29317563	264	58	214	1
29317564	99	58	214	1
29317568	264	58	114	1
29317569	99	58	114	1
29317603	264	58	714	1
29317604	99	58	714	1
29317954	264	20	813	1
29317954	99	20	813	1
29317964	264	20	813	8
29317964	264	20	-3	111
29317964	99	20	813	8
29317964	99	20	-1	111
29341010	99	-21	1552	29341
29341185	99	20	423	1
29341195	99	20	423	9
29341195	99	20	-1	-111
29341495	99	20	923	1
29341505	99	20	923	11
29437010	173	-12	1552	29468
29437193	173	20	513	1
29437564	173	58	214	1
29437569	173	58	114	1
29437604	173	58	714	1
29437954	173	20	813	1
29437964	173	20	813	8
29437964	173	20	-2	111
29468010	173	-22	1552	29468
29468185	173	20	423	1
29468195	173	20	423	9
29468195	173	20	-2	-111
29468495	173	20	923	1

29468505	173	20	923	11
29497010	264	-23	1515	29497
29497185	264	20	423	1
29497195	264	20	423	9
29497195	264	20	-3	-111
29497495	264	20	923	1
29497505	264	20	923	11
29545010	325	-14	1552	29559
29545193	325	20	513	1
29545564	325	58	214	1
29545569	325	58	114	1
29545604	325	58	714	1
29545954	325	20	813	1
29545964	325	20	813	8
29545964	325	20	-4	111
29559010	325	-24	1552	29559
29559185	325	20	423	1
29559195	325	20	423	9
29559195	325	20	-4	-111
29559495	325	20	923	1
29559505	325	20	923	11
29601010	7	-11	1552	29782
29601193	7	20	513	1
29601564	7	58	214	1
29601569	7	58	114	1
29601604	7	58	714	1
29601954	7	20	813	1
29601964	7	20	813	8
29601964	7	20	-1	111
29608010	100	-11	1515	29642
29608010	265	-13	1552	29653
29608193	100	20	513	1
29608193	265	20	513	1
29608563	100	58	214	1
29608564	265	58	214	1
29608568	100	58	114	1
29608569	265	58	114	1
29608603	100	58	714	1
29608604	265	58	714	1
29608954	100	20	813	1
29608954	265	20	813	1
29608964	100	20	813	8
29608964	100	20	-1	111
29608964	265	20	813	8
29608964	265	20	-3	111
29642010	100	-21	1515	29642
29642185	100	20	423	1
29642195	100	20	423	9
29642195	100	20	-1	-111
29642495	100	20	923	1
29642505	100	20	923	11
29782010	7	-21	1552	29782
29782185	7	20	423	1
29782195	7	20	423	9

29782195	7	20	-1	-111
29782495	7	20	923	1
29782505	7	20	923	11
29788010	265	-23	1552	29788
29788185	265	20	423	1
29788195	265	20	423	9
29788195	265	20	-3	-111
29788495	265	20	923	1
29788505	265	20	923	11
0	172	20	923	1

Appendix F

Basic ISDN Satellite Call Data Product

This appendix presents the Call Data Product relatable to both the ISIS and FSIS simulation models using a scenario traffic file generated from the Traffic model. These models were developed earlier in this SCAR Program and were subjects of other reports.

The Call Data Product is generated by the Product Generation (ProGen) software written in Simscript II.5. ProGen uses the MSave file data presented in Appendix E. To generate the Call Data Product from these MSave data ProGen is executed using the FSIS Build 3.

Before ProGen can generate the Call Data Product a suitable MSaveInt.DAT file must be available as a disk file. The <M>Save main menu option of ProGen allows the selection of MSave data to analyzed. Once selected with the <R>ead option, these data can be reviewed using the <D>isplay option and saved using the <S>ave option.

Selecting the main menu <C>all Data Generation option displays the 'Analyzing Data' while reading and processing the data stored in the MSaveInt.DAT file. The Call Data Product generation is automatic. The results are shown for STF01.DAT and STF06.DAT scenario presented in Appendix A.

The Call Data Product can be saved on request. The specific outputs were generated using the Word Perfect® 5.1 word processor software.

The Call Data Product consists of a tabular representation on a call by call basis. The Call Reference Number, Request Time, Blocked Time, Connection Time, Disconnect Request Time, Disconnect Time and Bearer Service are read from the MSave data. The Call Duration is calculated from the Call Connect Time and Call Disconnect Time in seconds.

This Call Data Product provides a quick view of the simulation results. It provides a sanity check of the scenario; a quick estimate of the traffic duration; and a view of the blocked traffic and its recovery.

The CallRT01.DAT Call Data Product summarizes the FSIS simulation using the STF01.DAT scenario traffic file. It shows that only CS64 bearer services were requested and used for an average of 3 minutes, as dictated by the Traffic Model. The single blocked call was retired on minute later and was successful. The Response Time portion of this page will be discussed later in the Response Time Product, Appendix G.

The CallData.DAT Call Data Product summarizes the FSIS simulation using the STF06.DAT scenario traffic file. It shows that all five permitted bearer services were requested and used for times ranging from tens to hundreds of seconds. No attempt is being made here to account for the wisdom or economics a call lasting tens of seconds. That rationale will be left for later studies using the ISDN satellite simulation. The data were derived from the Traffic Model. That model may need refinement when new ISDN traffic data becomes available. There were 15 blocked call situations. CRef #395 was blocked twice and CRef #400 was blocked five times before being successful. All calls were retired one minute after being blocked.

[GTE] Program ProGen -- Product Generation (NASA/SCAR)

Basic ISDN Call Data

CallRef ####	RqstTime (ms.day)	BlkdTime (ms.day)	ConnTime (ms.day)	DConnRTime (ms.day)	DConnTime (ms.day)	Duration (secs)	BearerSvcs (text)
1	11111010	0	11111964	11159010	11159195	48	CS64
100	11201010	0	11201964	11429010	11429195	228	CS64
2	11421010	0	11421964	11642010	11642195	221	CS64
3	11731010	0	11731964	11880010	11880195	149	CS64
4	12041010	0	12041964	12178010	12178195	137	CS64
5	12351010	0	12351964	12627010	12627195	276	CS64
6	12661010	0	12661964	13026010	13026195	365	CS64
101	12801010	0	12801964	12979010	12979195	178	CS64
7	12971010	12971614	0	0	0	0	CS64
7	13031624	0	13032578	13213010	13213195	182	CS64
8	13281010	0	13281964	13504010	13504195	223	CS64
9	13591010	0	13591964	13832010	13832195	241	CS64
10	13901010	0	13901964	14102010	14102195	201	CS64
11	14211010	0	14211964	14506010	14506195	295	CS64

[GTE] Program ProGen -- Product Generation (NASA/SCAR)

Response Time Call Data

CallRef ####	RqstTime (ms.day)	BlkdTime (ms.day)	ConnTime (ms.day)	DConnRTime (ms.day)	DConnTime (ms.day)	Conn R/T (msecs)	DConn R/T (msecs)
1	11111010	0	11111964	11159010	11159195	954	185
100	11201010	0	11201964	11429010	11429195	954	185
2	11421010	0	11421964	11642010	11642195	954	185
3	11731010	0	11731964	11880010	11880195	954	185
4	12041010	0	12041964	12178010	12178195	954	185
5	12351010	0	12351964	12627010	12627195	954	185
6	12661010	0	12661964	13026010	13026195	954	185
101	12801010	0	12801964	12979010	12979195	954	185
7	12971010	12971614	0	0	0	0	0
7	13031624	0	13032578	13213010	13213195	954	185
8	13281010	0	13281964	13504010	13504195	954	185
9	13591010	0	13591964	13832010	13832195	954	185
10	13901010	0	13901964	14102010	14102195	954	185
11	14211010	0	14211964	14506010	14506195	954	185

[GTE] Program ProGen -- Product Generation (NASA/SCAR)

Basic ISDN Call Data

CallRef ####	RqstTime (ms.day)	BlkdTime (ms.day)	ConnTime (ms.day)	DConnRTime (ms.day)	DConnTime (ms.day)	Duration (secs)	BearerSvcs (text)
401	28800010	0	28800964	28856010	28856195	56	DX25
402	28800010	0	28800964	28814010	28814195	14	BRF
18	28801010	28801613	0	0	0	0	CS64
348	28801010	0	28801964	29029010	29029195	228	TLM
370	28801010	28801613	0	0	0	0	CS64
395	28801010	28801614	0	0	0	0	CS64
400	28801010	28801613	0	0	0	0	CS128
1106	28806010	0	28806964	28918010	28918195	112	TLM
1071	28833010	0	28833964	28851010	28851195	18	BRF
18	28861623	0	28862577	28889010	28889195	28	CS64
370	28861623	0	28862577	29104010	29104195	243	CS64
400	28861623	28862577	0	0	0	0	CS128
395	28861624	28862578	0	0	0	0	CS64
400	28922587	28923190	0	0	0	0	CS128
395	28922588	0	28923542	28945010	28945195	23	CS64
324	28957010	28957613	0	0	0	0	BRF
400	28983200	28983803	0	0	0	0	CS128
172	29001010	29001613	0	0	0	0	CS128
324	29017623	29018226	0	0	0	0	BRF
98	29026010	0	29026964	29047010	29047195	21	CS64
263	29026010	0	29026964	29110010	29110195	84	DX25
400	29043813	29044416	0	0	0	0	CS128
172	29061623	29062226	0	0	0	0	CS128
324	29078236	29078839	0	0	0	0	BRF
400	29104426	0	29105380	29123010	29123195	19	CS128
172	29122236	29122839	0	0	0	0	CS128
324	29138849	0	29139803	29183010	29183195	44	BRF
172	29182849	0	29183803	29219010	29219195	36	CS128
99	29317010	0	29317964	29341010	29341195	24	CS64
264	29317010	0	29317964	29497010	29497195	180	DX25
173	29437010	0	29437964	29468010	29468195	31	CS128
325	29545010	0	29545964	29559010	29559195	14	BRF
7	29601010	0	29601964	29782010	29782195	181	CS64
100	29608010	0	29608964	29642010	29642195	34	CS64
265	29608010	0	29608964	29788010	29788195	180	DX25

Appendix G

ISDN Satellite Response Time Product

This appendix presents the Response Time Product related to the simulation run of the FSIS model using a scenario traffic file generated from the Traffic model. Both models were developed earlier in this program and were subjects of other reports.

The Response Time Product is generated by the Product Generation (ProGen) software written in Simscript II.5. ProGen uses the MSave file data presented in Appendix E. To generate the Response Time Product from these MSave data ProGen is executed using the FSIS Build 3 MSave data.

Before ProGen can generate the Response Time Product a suitable MSaveInt.DAT file must be available as a disk file. The <M>Save main menu option of ProGen allows the selection of MSave data to analyzed. Once selected with the <R>ead option, these data can be reviewed using the <D>isplay option and saved using the <S>ave option.

Selecting the main menu <R>esponse Time Generation option displays the 'Analyzing Data' while reading and processing the data stored in the MSaveInt.DAT file. The Response Time Product generation is automatic. The results are shown for STF01.DAT and STF06.DAT scenario presented in Appendix A.

The Response Time Product can be saved on request. The specific outputs were generated using the Word Perfect® 5.1 word processor software.

The Response Time Product consists of a tabular representation on a call by call basis. The Call Reference Number, Request Time, Blocked Time, Connection Time, Disconnect Request Time, and Disconnect Time are read from the MSave data. The Connection Response Time and the Disconnection Time calculated from the Call Request Time and the Call Connect Time, and the Disconnect Request Time and Call Disconnect Time in milliseconds, respectively.

This Response Time Product provides a view of the both these response times on a call by call basis. For the present FSIS model the results are identical for all calls and all scenarios due to the fixed delays associated with each communication process being presently models. These times fall within each respective protocol timer and thereby provide the first order viability for ISDN satellites even in geosynchronous orbits.

When such things as non-stationary satellites, antenna hopping patterns, and uplink contention algorithms are added to the simulation these response will wary from call to call depending on the call origination, destination, and communication path.

The CallRT01.DAT Response Time Product summarizes the FSIS simulation using the STF01.DAT scenario traffic file. It shows that only CS64 bearer services were requested. In all cases the Connection Response Time was 954 msecs and the Disconnection Response Time was 185 msecs.

The RespTime.DAT Response Time Product summarizes the FSIS simulation using the STF06.DAT scenario traffic file. It shows that all five permitted bearer services were

requested. Again, In all cases the Connection Response Time was 954 msecs and the Disconnection Response Time was 185 msecs.

The Response Time Product is a useful to determine the amount of setup used to connect and disconnect calls. As modeling and simulation refinements occur, the Response Time Product will provide a primary tool for determining the envelope of engineering options for the ISDN communication satellite design.

[GTE] Program ProGen -- Product Generation (NASA/SCAR)

Basic ISDN Call Data

CallRef ####	RqstTime (ms.day)	BlkdTime (ms.day)	ConnTime (ms.day)	DConnRTime (ms.day)	DConnTime (ms.day)	Duration (secs)	BearerSvcs (text)
1	11111010	0	11111964	11159010	11159195	48	CS64
100	11201010	0	11201964	11429010	11429195	228	CS64
2	11421010	0	11421964	11642010	11642195	221	CS64
3	11731010	0	11731964	11880010	11880195	149	CS64
4	12041010	0	12041964	12178010	12178195	137	CS64
5	12351010	0	12351964	12627010	12627195	276	CS64
6	12661010	0	12661964	13026010	13026195	365	CS64
101	12801010	0	12801964	12979010	12979195	178	CS64
7	12971010	12971614	0	0	0	0	CS64
7	13031624	0	13032578	13213010	13213195	182	CS64
8	13281010	0	13281964	13504010	13504195	223	CS64
9	13591010	0	13591964	13832010	13832195	241	CS64
10	13901010	0	13901964	14102010	14102195	201	CS64
11	14211010	0	14211964	14506010	14506195	295	CS64

[GTE] Program ProGen -- Product Generation (NASA/SCAR)

Response Time Call Data

CallRef ####	RqstTime (ms.day)	BlkdTime (ms.day)	ConnTime (ms.day)	DConnRTime (ms.day)	DConnTime (ms.day)	Conn R/T (msecs)	DConn R/T (msecs)
1	11111010	0	11111964	11159010	11159195	954	185
100	11201010	0	11201964	11429010	11429195	954	185
2	11421010	0	11421964	11642010	11642195	954	185
3	11731010	0	11731964	11880010	11880195	954	185
4	12041010	0	12041964	12178010	12178195	954	185
5	12351010	0	12351964	12627010	12627195	954	185
6	12661010	0	12661964	13026010	13026195	954	185
101	12801010	0	12801964	12979010	12979195	954	185
7	12971010	12971614	0	0	0	0	0
7	13031624	0	13032578	13213010	13213195	954	185
8	13281010	0	13281964	13504010	13504195	954	185
9	13591010	0	13591964	13832010	13832195	954	185
10	13901010	0	13901964	14102010	14102195	954	185
11	14211010	0	14211964	14506010	14506195	954	185

[GTE] Program ProGen -- Product Generation (NASA/SCAR)

Response Time Call Data

CallRef ####	RqstTime (ms.day)	BlkdTime (ms.day)	ConnTime (ms.day)	DConnRTime (ms.day)	DConnTime (ms.day)	Conn R/T (msecs)	DConn R/T (msecs)
401	28800010	0	28800964	28856010	28856195	954	185
402	28800010	0	28800964	28814010	28814195	954	185
18	28801010	28801613	0	0	0	0	0
348	28801010	0	28801964	29029010	29029195	954	185
370	28801010	28801613	0	0	0	0	0
395	28801010	28801614	0	0	0	0	0
400	28801010	28801613	0	0	0	0	0
1106	28806010	0	28806964	28918010	28918195	954	185
1071	28833010	0	28833964	28851010	28851195	954	185
18	28861623	0	28862577	28889010	28889195	954	185
370	28861623	0	28862577	29104010	29104195	954	185
400	28861623	28862577	0	0	0	0	0
395	28861624	28862578	0	0	0	0	0
400	28922587	28923190	0	0	0	0	0
395	28922588	0	28923542	28945010	28945195	954	185
324	28957010	28957613	0	0	0	0	0
400	28983200	28983803	0	0	0	0	0
172	29001010	29001613	0	0	0	0	0
324	29017623	29018226	0	0	0	0	0
98	29026010	0	29026964	29047010	29047195	954	185
263	29026010	0	29026964	29110010	29110195	954	185
400	29043813	29044416	0	0	0	0	0
172	29061623	29062226	0	0	0	0	0
324	29078236	29078839	0	0	0	0	0
400	29104426	0	29105380	29123010	29123195	954	185
172	29122236	29122839	0	0	0	0	0
324	29138849	0	29139803	29183010	29183195	954	185
172	29182849	0	29183803	29219010	29219195	954	185
99	29317010	0	29317964	29341010	29341195	954	185
264	29317010	0	29317964	29497010	29497195	954	185
173	29437010	0	29437964	29468010	29468195	954	185
325	29545010	0	29545964	29559010	29559195	954	185
7	29601010	0	29601964	29782010	29782195	954	185
100	29608010	0	29608964	29642010	29642195	954	185
265	29608010	0	29608964	29788010	29788195	954	185

Appendix H

ISDN Satellite Throughput Product

This appendix presents the Throughput Product related to the simulation run of the FSIS model using a scenario traffic file generated from the Traffic model. Both models were developed earlier in this NASA SCAR program and were subjects of other reports.

The Throughput Product is generated by the Product Generation (ProGen) software written in Simscript II.5. ProGen uses the MSave file data presented in Appendix E. To generate the Throughput Product from these MSave data ProGen is executed using the FSIS Build 3, User Instructions presented in Appendix C.

Before ProGen can generate the Throughput Product a suitable MSaveInt.DAT file must be available as a disk file. The <M>Save main menu option of ProGen allows the selection of MSave data to analyzed. Once selected with the <R>ead option, these data can be reviewed using the <D>isplay option and saved using the <S>ave option.

Selecting the main menu <T>hroughput Generation option displays the 'Analyzing Data' while reading and processing the data stored in the MSaveInt.DAT file. The Throughput Product generation is automatic. The results are shown for STF01.DAT and STF06.DAT scenario presented in Appendix A.

The Throughput Product can be saved on request. The specific outputs were generated using the Word Perfect® 5.1 word processor software.

The Throughput Product consists of a tabular representation on a call event by call event basis. Each time a call is Requested, Connected, Terminated, Blocked, or the D-Channel, the ISDN Satellite Throughput is changed. The Throughput Product displays these event changes as a function of time and amount of ISDN Satellite bandwidth being used at that time.

The present algorithm for calculating throughput consists of:

1) Adding a D-Channel (16 Kbps) when any call is requested to support signalling.
2) Adding a B-Channel (64 Kbps) when a CS64 is connected, Conn.
3) Adding two B-Channels (128 Kbps) when CS128 or BFR services are connected.
4) Not adding any bandwidth for DX25 or TLM bearer services are connected.
   It is assumed that the signalling D-Channel is used to support these services.
5) Subtracting the bandwidth indicated for the bearer services above
   when they are disconnected, Dcon.
6) Subtracting a D-Channel at the end of all call clearing for each bearer service.
7) Subtracting a D-Channel when a call is blocked,

The Throughput bandwidth changes with each event cited, above. The Throughput product displays the resultant bandwidth as a function of event changes. The Throughput display consists of CallREf#, Simulation Time, Bearer Service, Action, Throughput (Kbps), Number of D-Channels in use, Number of B-Channels in use.

This Throughput Product provides a view of the simulation throughput results. It provides the ability to track the ISDN satellite throughput as a function of time; an estimate of the peak traffic; and a view of the satellite quiet periods.

The 11111/010 ms.day Throughput Product summarizes the FSIS simulation using the STF01.DAT scenario traffic file. It shows that only CS64 bearer services were requested. It shows the use and release of bandwidth in 16 Kbps and 64 Kbps values. The largest throughput was 176 Kbps with seven periods of zero throughput. An event time plot accompanies these data to provide a pictorial view of throughput as a function of events. As expected for the input data used there is a degree of periodicity to the throughput pattern.

The 28800/010 Throughput Product summarizes the FSIS simulation using the STF06.DAT scenario traffic file. It shows that all five permitted bearer services were requested and thereby provided multiple bandwidth steps in the throughput sum. With the use of DX25 and TLM more activity is seen in the D-Channels rather than the B-Channels. Restricting the present simulation to only two B-Channels did cause more blocking than normally expected.

The corresponding event graph of the throughput data shows its build-up and decay. The second graph shows these same data strictly as a function of time. The throughput minimum never drops below 48 Kbps during the steady state and reaches a maximum of 240 Kbps. More than likely, an increase in numbers of B-Channels would have increased the throughput capacity and would have reduced the blocking percentage.

The Throughput Product can be analyzed in many ways to determine averages, peak periods, and idle times. Like the Response Time Product, the Throughput Product will provide a basic tool for determining the envelope of engineering options for the ISDN communication satellite design..

[GTE] Program ProGen -- Product Generation (NASA/SCAR)

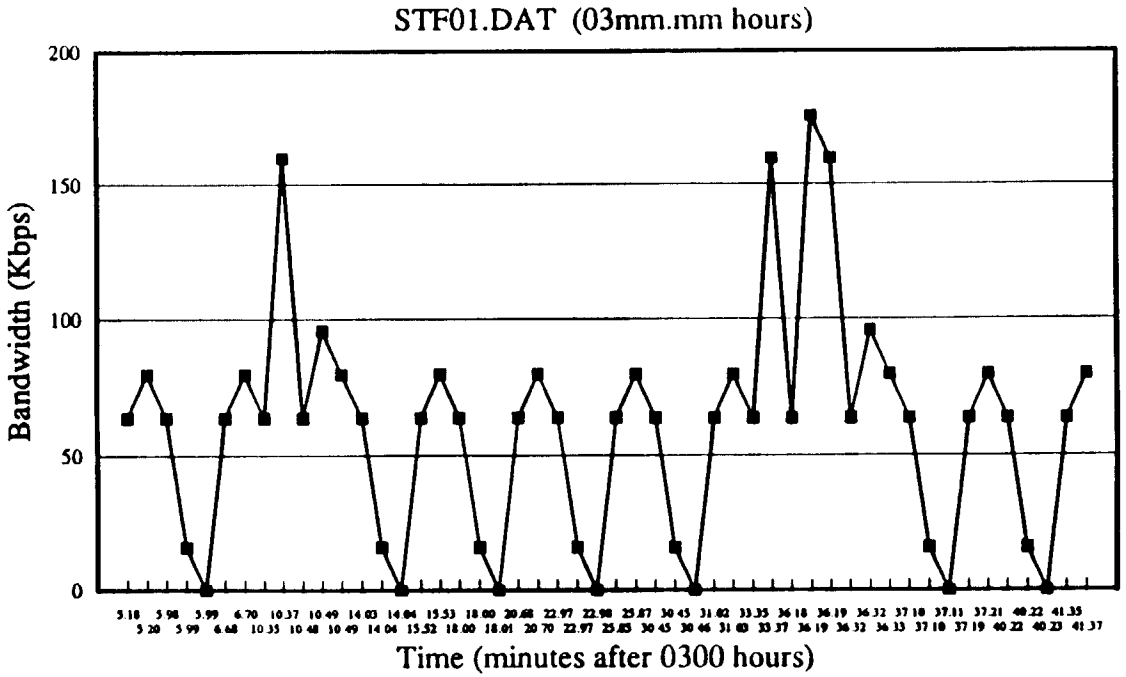
Throughput Call Data

CallRef# (####)	RqstTime (ms.day)	BearerSvc (text)	Action (text)	Throughput (Kbps)	D-Used (##)	B-Used (##)
1	11111010	CS64	Rqst	16	1	0
1	11111964		Conn	80	1	1
1	11159010	CS64	Term	80	1	1
1	11159195		Dcon	16	1	0
1	11159506		-D	0	0	0
100	11201010	CS64	Rqst	16	1	0
100	11201964		Conn	80	1	1
2	11421010	CS64	Rqst	96	2	1
2	11421964		Conn	160	2	2
100	11429010	CS64	Term	160	2	2
100	11429195		Dcon	96	2	1
100	11429506		-D	80	1	1
2	11642010	CS64	Term	80	1	1
2	11642195		Dcon	16	1	0
2	11642506		-D	0	0	0
3	11731010	CS64	Rqst	16	1	0
3	11731964		Conn	80	1	1
3	11880010	CS64	Term	80	1	1
3	11880195		Dcon	16	1	0
3	11880506		-D	0	0	0
4	12041010	CS64	Rqst	16	1	0
4	12041964		Conn	80	1	1
4	12178010	CS64	Term	80	1	1
4	12178195		Dcon	16	1	0
4	12178506		-D	0	0	0
5	12351010	CS64	Rqst	16	1	0
5	12351964		Conn	80	1	1
5	12627010	CS64	Term	80	1	1
5	12627195		Dcon	16	1	0
5	12627506		-D	0	0	0
6	12661010	CS64	Rqst	16	1	0
6	12661964		Conn	80	1	1
101	12801010	CS64	Rqst	96	2	1
101	12801964		Conn	160	2	2
7	12971010	CS64	Rqst	176	3	2
7	12971614		Blkd	176	3	2
7	12971614		-D	160	2	2
101	12979010	CS64	Term	160	2	2
101	12979195		Dcon	96	2	1
101	12979506		-D	80	1	1
6	13026010	CS64	Term	80	1	1
6	13026195		Dcon	16	1	0
6	13026506		-D	0	0	0
7	13031624	CS64	Rqst	16	1	0
7	13032578		Conn	80	1	1
7	13213010	CS64	Term	80	1	1
7	13213195		Dcon	16	1	0
7	13213506		-D	0	0	0
8	13281010	CS64	Rqst	16	1	0
8	13281964		Conn	80	1	1

GTE Government Systems

NASA - SCAR

ISDN Satellite Throughput



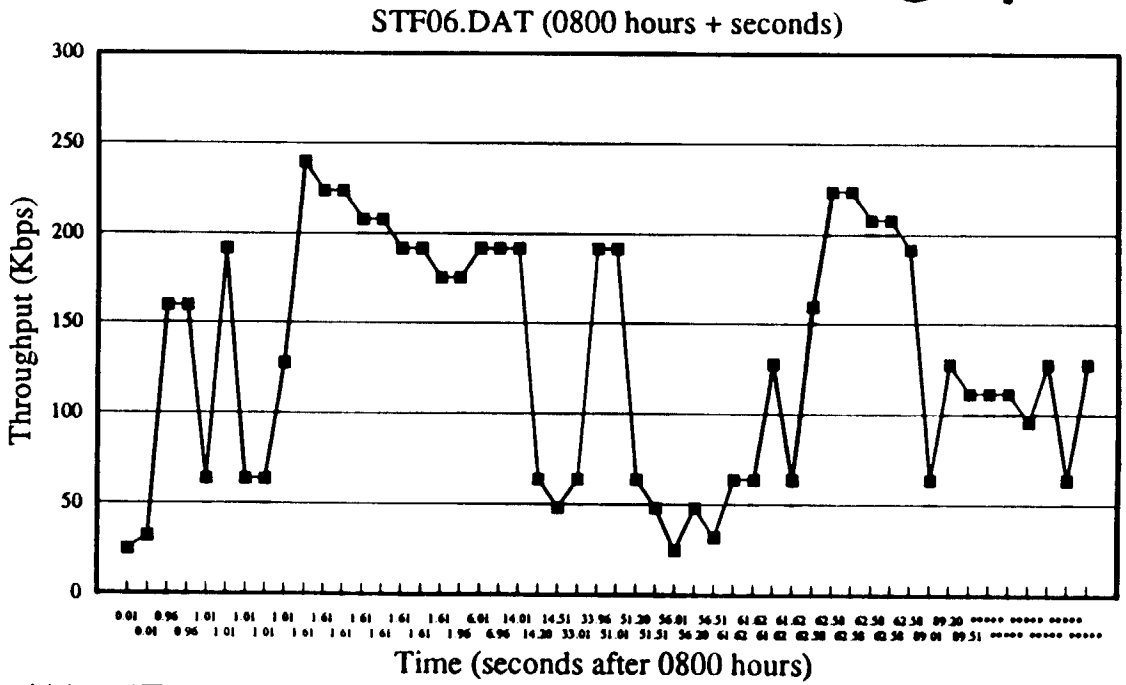
c:\sim\progen\TPPlot01.wk3
July 7, 1992

[GTE] Program ProGen -- Product Generation (NASA/SCAR)

Throughput Call Data

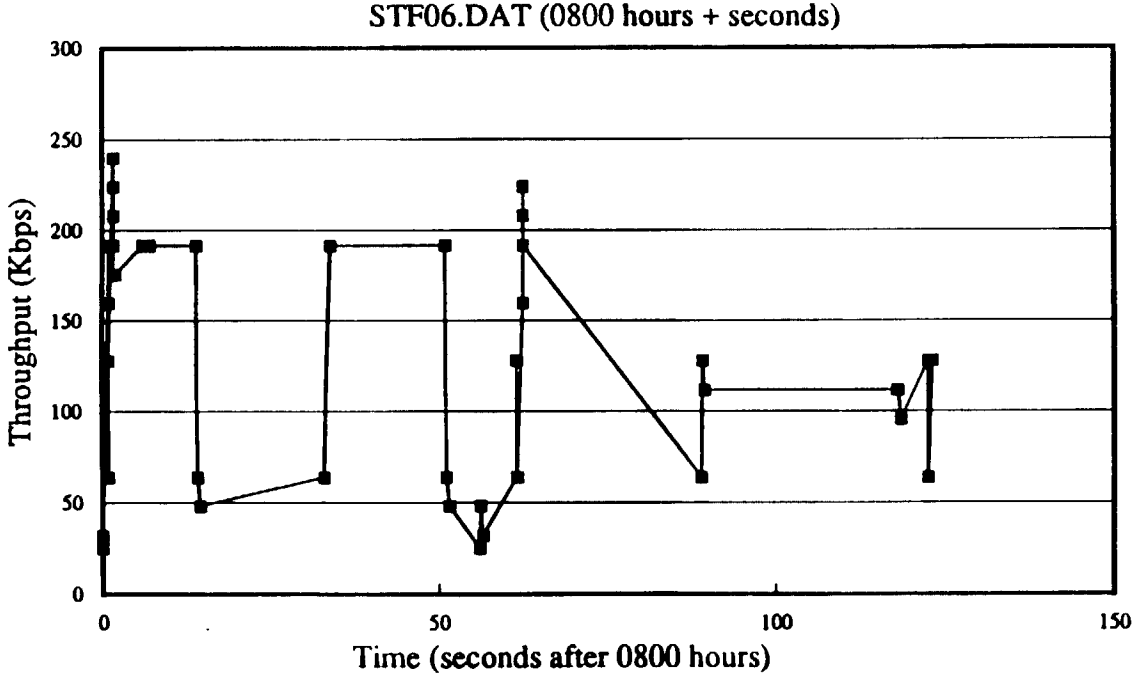
CallRef# (####)	RqstTime (ms.day)	BearerSvc (text)	Action (text)	Throughput (Kbps)	D-Used (##)	B-Used (##)
401	28800010	DX25	Rqst	16	1	0
402	28800010	BRF	Rqst	32	2	0
402	28800964		Conn	160	2	2
401	28800964		Conn	160	2	2
18	28801010	CS64	Rqst	176	3	2
348	28801010	TLM	Rqst	192	4	2
370	28801010	CS64	Rqst	208	5	2
395	28801010	CS64	Rqst	224	6	2
400	28801010	CS128	Rqst	240	7	2
18	28801613		Blkd	240	7	2
18	28801613		-D	224	6	2
370	28801613		Blkd	224	6	2
370	28801613		-D	208	5	2
400	28801613		Blkd	208	5	2
400	28801613		-D	192	4	2
395	28801614		Blkd	192	4	2
395	28801614		-D	176	3	2
348	28801964		Conn	176	3	2
1106	28806010	TLM	Rqst	192	4	2
1106	28806964		Conn	192	4	2
402	28814010	BRF	Term	192	4	2
402	28814195		Dcon	64	4	0
402	28814506		-D	48	3	0
1071	28833010	BRF	Rqst	64	4	0
1071	28833964		Conn	192	4	2
1071	28851010	BRF	Term	192	4	2
1071	28851195		Dcon	64	4	0
1071	28851506		-D	48	3	0
401	28856010	DX25	Term	48	3	0
401	28856195		Dcon	48	3	0
401	28856506		-D	32	2	0
18	28861623	CS64	Rqst	48	3	0
370	28861623	CS64	Rqst	64	4	0
400	28861623	CS128	Rqst	80	5	0
395	28861624	CS64	Rqst	96	6	0
18	28862577		Conn	160	6	1
370	28862577		Conn	224	6	2
400	28862577		Blkd	224	6	2
400	28862577		-D	208	5	2
395	28862578		Blkd	208	5	2
395	28862578		-D	192	4	2
18	28889010	CS64	Term	192	4	2
18	28889195		Dcon	128	4	1
18	28889505		-D	112	3	1
1106	28918010	TLM	Term	112	3	1
1106	28918195		Dcon	112	3	1
1106	28918506		-D	96	2	1
400	28922587	CS128	Rqst	112	3	1
395	28922588	CS64	Rqst	128	4	1
400	28923190		Blkd	128	4	1

ISDN Satellite Throughput



c:\sim\progen\TPxy06.DAT
July 8, 1992

ISDN Satellite Throughput



c:\sim\progen\TPxy06.DAT
July 8, 1992

Appendix I

Description of Z-Chart Trace

The Z-Chart Trace plots the output showing the migration of the "Rqst" and "Term" protocols through the various processes (process indexes :: PIs) for the setup and termination of a telephone call. Two types of Z-Chart outputs are generated in FSIS Build 3. One of them is generated during the SimRun execution and provides a *real-time Z-Chart* view of the protocol migrations. The other Z-Chart output is derived from the MSave data generated by SimRun, *MSave derived Z-Chart.*

The **real-time Z-Chart** is depicted by an ordinate representing the Process Index (PI) number associated with each communication function/process. The time elapsed with each communication function (PI) is plotted along the abscissa. The result is a time history trace of communication processes activated as a function of time it took for them to perform their respective functions.

In relation to the Z-Chart Trace the simulation progress from process to process is depicted as a time-line constantly edging towards increasing time. The longer times associated with propagation are plotted as long steps among more evenly spaced smaller steps. The call connection (Rqst) display is depicted as line segments connected by long steps representing the VSAT/ISDN satellite propagation links. The "Seconds of Day" window in the output graphic displays the exact time down to millisecond of the data being plotted on the Z-Chart Trace graphic.

The Z-Chart window was set 75 msecs wide in order to sufficiently resolve these milliseconds events. Therefore, it is extremely unlikely that both the call "Rqst" and the "Term" for the same call can be seen in the same window. Also, due to the discrete event aspects of the simulation the call set up and the call termination seem to appear on sequential windows. This is an illusion. For call ranging minutes in duration hundreds of blank windows are traversed between the "Rqst" and the "Term" but are not displayed on the Z-Chart Trace .

The **MSave derived Z-Chart** is generated by the Product Generation (ProGen) software that uses the MSave##.DAT files generated by the SimRun software. Several steps are necessary to generate the hard copy output provided in this appendix.

The "MSave input data" option of the main ProGen menu allows the generation of combined MSave files for both integer values "MSaveInt.DAT" and text versions "MSaveTxt.DAT". These MSave files, once generated and saved, can now be used to generate the Z-Chart data and files using the "Z-Chart: Generation" option of the ProGen main menu. For FSIS Build 3, the Z-Chart product is saved as "ZChart.DAT" and was read using Word Perfect® 5.1. The output was generated after reducing the text font to "Small".

The Z-Chart depicts the major protocol processes on the top abscissa and the time in seconds-of-day on the ordinate down the page. Text symbols are plotted in the matrix element that corresponds to time and process. For example the first element shows an ISDN Originator requesting "Rqst" service by going off hook "OffH". That fact is detected by the Q931U protocol process which is in state U0. The Q931U process sends a Info1 "I1" with the content of "setup" protocol message to the Q921U protocol process. For this simulation the Q921U is assumed to have received an error free protocol message that it

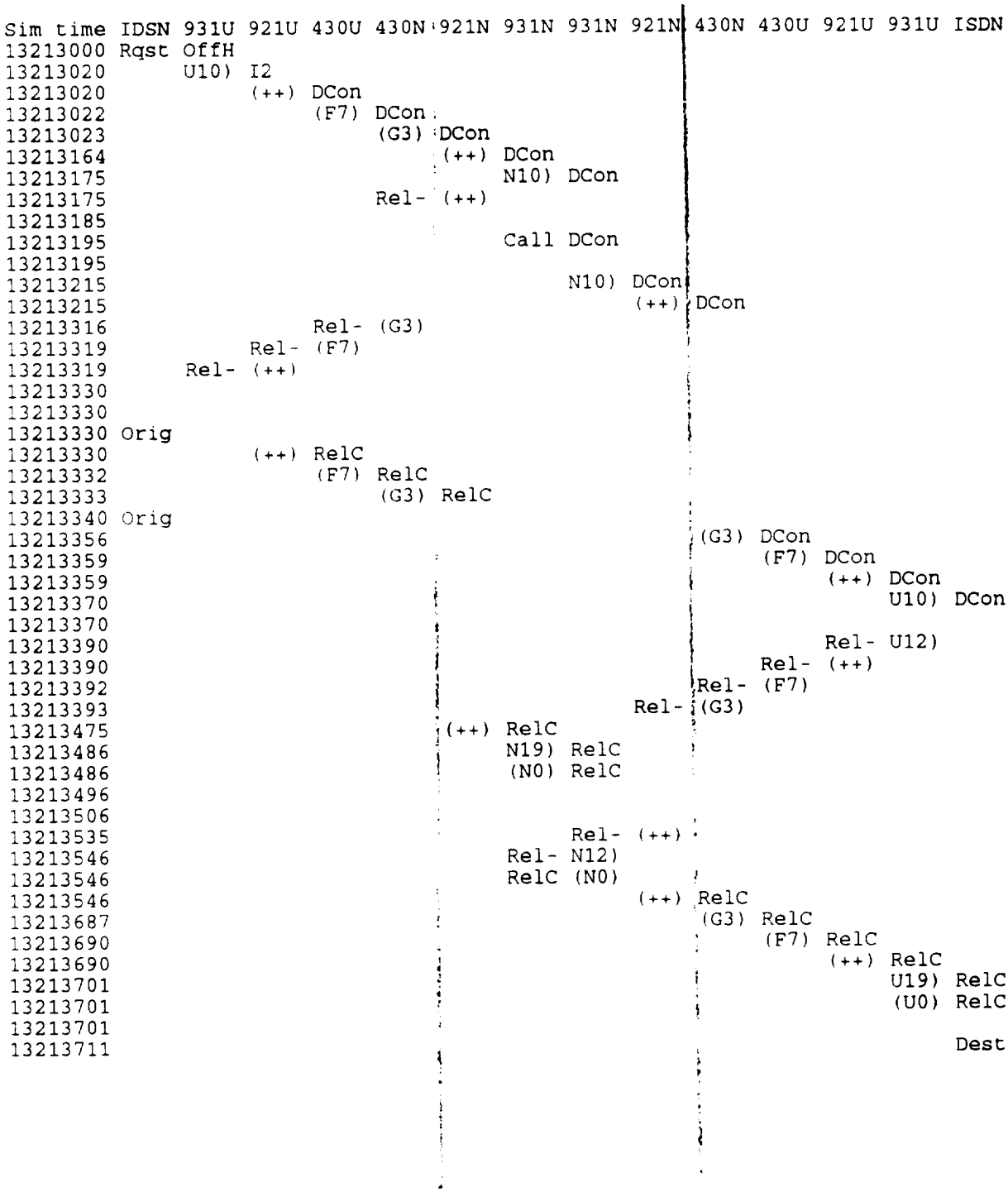
delivers to the I430U protocol process. Since this is the first protocol message received by the I430U interface it finds a deactivated interface and therefore goes through the Info1/Info2/Info3/Info4 protocol sequence to activate the interface. Q931 protocols: Setup, Call Proceeding, Alerting, Connect, Connect Acknowledge, etc. are progressed along each PIs until all the protocol entities are in the active state and a B-Channel is assigned. That B-Channel remains assigned to this call until released by a "Term" protocol message sequence.

For FSIS Build 3, the center bar of the Z-Chart represent on board the satellite. Q921N, Q931N, Q931N, and Q921N account for the protocol processing on the satellite. Z-Charts, generated by ProGen, are included for call blocked, call connected, and call disconnected situations.

Z-Chart for Call Reference Number 7 of STF01.DAT
The call is blocked; a minute later it is retried and successfully connected and subsequently disconnected.

Sim time	IDSN	931U	921U	430U	430N	921N	931N	931N	921N	430N	430U	921U	931U	ISDN
12971000	Rqst	OffH												
12971020		(U0)	I1											
12971020			(++)	SetU										
12971022				(F4)	I1									
12971024				I2	(G2)									
12971026				(F6)	I3									
12971028				I4	(G3)									
12971030				(F7)	SetU									
12971031					(G3)	SetU								
12971172						(++)	SetU							
12971183							(N0)	SetU						
12971193														
12971223								(N0)	SetU					
12971223									(++)	SetU				
12971364										(G3)	SetU			
12971367											(F7)	SetU		
12971367												(++)	SetU	
12971378													(U0)	SetU
12971378														
12971398													CalP	U06)
12971398												CalP	(++)	
12971400										CalP	(F7)			
12971401									CalP	(G3)				
12971403													Alrt	U09)
12971403												Alrt	(++)	
12971405										Alrt	(F7)			
12971406									Alrt	(G3)				
12971438													Conn	U07)
12971438												Conn	(++)	
12971440										Conn	(F7)			
12971441									Conn	(G3)				
12971543								CalP	(++)					
12971548								Alrt	(++)					
12971554							CalP	N06)						
12971559							Alrt	N09)						
12971564														
12971569														
12971583								Conn	(++)					
12971594						CalP	N01)							
12971594					CalP	(++)								
12971594							Conn	N07)						
12971594							ConA	N08)						
12971594							ConA	N10)						
12971594									(++)	ConA				
12971599						Alrt	N03)							
12971599					Alrt	(++)								
12971604														
12971614							Call	Blkd						
12971614														

```
Sim time IDSN 931U 921U 430U 430N 921N 931N 931N 921N 430N 430U 921U 931U ISDN
13031614 Rqst OffH
13031634      (U0) I1
13031634           (++) SetU
13031636                (F4) I1
13031638                I2   (G2)
13031640                (F6) I3
13031642                I4   (G3)
13031644                (F7) SetU
13031645                     (G3) SetU
13031786                          (++) SetU
13031797                               (N0) SetU
13031837                                    (N0) SetU
13031837                                         (++) SetU
13031978                                              (G3) SetU
13031981                                                   (F7) SetU
13031981                                                        (++) SetU
13031992                                                             (U0) SetU
13032012                                                        CalP U06)
13032012                                                   CalP (++)
13032014                                              CalP (F7)
13032015                                         CalP (G3)
13032017                                                        Alrt U09)
13032017                                                   Alrt (++)
13032019                                              Alrt (F7)
13032020                                         Alrt (G3)
13032052                                                        Conn U07)
13032052                                                   Conn (++)
13032054                                              Conn (F7)
13032055                                         Conn (G3)
13032157                                    CalP (++)
13032162                                    Alrt (++)
13032168                               CalP N06)
13032173                               Alrt N09)
13032197                                    Conn (++)
13032208                          CalP N01)
13032208                     CalP (++)
13032208                          Conn N07)
13032208                          ConA N08)
13032208                          ConA N10)
13032208                                         (++) ConA
13032213                          Alrt N03)
13032213                     Alrt (++)
13032248                          Conn N04)
13032248                     Conn (++)
13032349                CalP (G3)
13032349                                              (G3) ConA
13032352           CalP (F7)
13032352      CalP (++)
13032352                                                   (F7) ConA
13032352                                                        (++) ConA
13032354                CalP (G3)
13032357           Alrt (F7)
13032357      Alrt (++)
13032363 Orig                                                            U08) ConA
13032363                                                                 U10) ConA
13032373                                                                      Dest
13032389                Conn (G3)
13032392           Conn (F7)
13032392      Conn (++)
13032403 Orig
13032403           (++) ConA
13032405                (F7) ConA
13032406                     (G3) ConA
13032547                          (++) ConA
13032558                               N10) ConA
13032578                               Call Conn
```


Sim time IDSN 931U 921U 430U 430N 921N 931N 931N 921N 430N 430U 921U 931U ISDN
13213000 Rqst OffH
13213020 U10) I2
13213020 (++) DCon
13213022 (F7) DCon
13213023 (G3) DCon
13213164 (++) DCon
13213175 N10) DCon
13213175 Rel- (++)
13213185
13213195 Call DCon
13213195
13213215 N10) DCon
13213215 (++) DCon
13213316 Rel- (G3)
13213319 Rel- (F7)
13213319 Rel- (++)
13213330
13213330
13213330 Orig
13213330 (++) RelC
13213332 (F7) RelC
13213333 (G3) RelC
13213340 Orig
13213356 (G3) DCon
13213359 (F7) DCon
13213359 (++) DCon
13213370 U10) DCon
13213370
13213390 Rel- U12)
13213390 Rel- (++)
13213392 Rel- (F7)
13213393 Rel- (G3)
13213475 (++) RelC
13213486 N19) RelC
13213486 (N0) RelC
13213496
13213506
13213535 Rel- (++)
13213546 Rel- N12)
13213546 RelC (N0)
13213546 (++) RelC
13213687 (G3) RelC
13213690 (F7) RelC
13213690 (++) RelC
13213701 U19) RelC
13213701 (U0) RelC
13213701
13213711 Dest

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16. Abstract

This Simulation Development Task Completion Report documents the simulation development associated with the network models of both the Interim Service ISDN Satellite (ISIS) and the Full Service ISDN Satellite (FSIS) architectures. The ISIS Network Model design represents satellite systems like the Advanced Communications Technology Satellite (ACTS) orbiting switch.

The FSIS architecture, the ultimate aim of this element of the SCAR Program, moves all control and switching functions on-board the next generation ISDN communications satellite. The technical and operational parameters for the advanced ISDN communications satellite design will be obtained from the simulation of ISIS and FSIS engineering software models for their major subsystems. Discrete event simulation experiments will be performed with these models using various traffic scenarios, design parameters, and operational procedures. The data from these simulations will be used to determine the engineering parameters for the advanced ISDN communications satellite.

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