PCSAT also will launch an in-orbit spare, co-located with the operational satellite, to serve as a backup in case of catastrophic satellite failure. An in-orbit spare prevents extended service disruptions that would occur if the replacement satellite were kept on the ground.

2. Satellite Design

The overall configuration of the satellites is illustrated in Figure 1. The satellites will be body-stabilized similar to the Hughes 601 design. The satellites will deliver a minimum of 740 watts of useable power to the service link antenna to support multiple services and allow independent access to the satellite from multiple earth stations. The satellites will amplify and retransmit the signals sent between the feederlink earth station and the mobile terminals. Table 1 lists the principal satellite system characteristics.

3. Communication Payload

a. Frequency Plan and Polarization

PCSAT proposes to use the 1970-1990 MHz band for the Earth-to-space service link and the 2160-2180 MHz band for the space-to-Earth service link. Polarization will be right hand circular for both bands. PCSAT proposes to use the 12,751-12,901 MHz band for feederlinks in the Earth-to-space direction and the 11,202-11,352 MHz band for feederlinks in the space-to-Earth direction.[3/] Polarization will be orthogonal linear.

[3/] Though these specific frequencies are not currently available in the United States, other than at 101° W.L., PCSAT expects that they will be available for U.S. systems in the future, perhaps through arrangements with one of the countries to which the orbital locations have been allotted. Aruba is allotted the orbit location at 98.2° W.L. and

The 1970-1990/2160-2180 MHz bands were chosen for several reasons. First, these bands are available to MSS in Region 2. Moreover, these bands are adjacent to the frequencies allocated by the Commission for terrestrial PCS and have been reserved for the satellite component of PCS.[4] Such adjacency is ideal for the development of small, low-cost consumer terminals that operate in both the satellite and terrestrial PCS frequencies.

PCSAT proposes to operate in feederlink frequencies near the frequencies to be used by AMSC. Approximately 150 MHz of feederlink spectrum will be required to accommodate the mix and total volume of anticipated traffic. Operation in the 13/11 GHz bands provides the following benefits:

- -- Economy of scale in terms of the purchase and sparing of feederlink earth station hardware equipment.
- -- The AMSC diversity site, which operates in the 13/11 GHz band, can be used as a backup.
- -- RF equipment purchased for the first generation satellite may also be used on the PCSAT satellites.

Ecuador is allotted the orbit location at 104° W.L.

PCSAT requests a waiver of Footnote NG 104 of the Table of Allocations, Section 2.106 of the Commission's Rules, so that PCSAT may use these bands domestically. The Commission granted a similar waiver for operation of AMSC's feederlinks. See AMSC Authorization Order, 4 FCC Rcd 6041 (1989) at paras. 64-72. As discussed herein, PCSAT seeks to operate in feederlink frequencies near those to be used by AMSC to obtain economy of scale of operations and diversity in case of equipment failure. PCSAT's use of the bands is consistent with recognized FSS use of the bands, and will not adversely impact the interests of current terrestrial users because this waiver is limited to a single satellite that will operate with a limited number of earth stations, all of which will require separate authorizations that include prior coordination.

[4] Second Report and Order, 8 FCC Rcd 7700 (1993), recon. pending. These bands also are part of the Commission's allocation for emerging technologies. First Report and Order and Third Notice of Proposed Rulemaking, 7 FCC Rcd 6866 (1992).

-- No administration other than Canada has applied to launch and operate a satellite system in the 13/11 GHz band.

b. Antenna Subsystem

There will be separate antenna subsystems for the feederlink and the service links. For the feederlink, PCSAT will utilize a single Ku-band antenna beam that provides broad coverage of the United States to allow access to the satellite through feederlink earth stations in CONUS, Hawaii, Puerto Rico and most of Alaska. An example of the coverage pattern is shown in Figure 2. The technical performance parameters of the antenna are listed in Table 1.

The service link will use a pair of 10-meter antennas for the transmission and reception of signals from mobile terminals. There will be a total of 23 beams, with 19 beams illuminating the 48 contiguous states, two over Alaska, one over Hawaii and one over Puerto Rico. The beam patterns are illustrated in Figure 3. The beams will have a 45 dBi gain at the beam peak.

c. Communications Payload Subsystem

The communication subsystem will have frequency translating transponders on the forward and the return links. A block diagram of the communications subsystem is shown in Figure 4. Signals received in the Ku-band receiver will be amplified and translated to the S-band downlink through a series of amplifiers and filters that will map a section of the uplink feederlink into a section of the S-band downlink for transmission in a specific beam of the satellite. This will be done by a combination of fixed and tunable filters that will be identified with specific feederlink bandwidth, but vary with respect to the specific portion of

the S-band downlink and satellite antenna beam that can be mapped, permitting frequency management and capacity management on a beam-by-beam basis.

The S-band power amplification will be done in a hybrid matrix power amplifier, a method pioneered in AMSC's first satellite. The hybrid matrix amplifier automatically and instantaneously directs power to the desired beam simply by inserting a carrier into an input port associated with the desired beam. The output power of the carrier is directly proportional to the carrier input power. This achieves maximum power transfer flexibility between beams and power use efficiency.

Signals received in the S-band receiver will be processed in a similar fashion. After an initial stage of amplification, each portion of the S-band will be filtered and translated to a specific portion of the Ku-band downlink that corresponds with the portion of the feederlink spectrum that was used in the forward direction. The individual portions of the S-band spectrum that are received and translated on an individual beam basis will be combined and input to a 100 watt TWTA for retransmission on the Ku-band downlink.

S-band and Ku-band receivers and transmitters may be interconnected efficiently by employing a combination of multiple frequency converters, fixed filters, programmable digital filters and digital cross-connect routers. For example, the incoming Ku-band spectrum could be down converted to a convenient IF frequency and separated into sub-bands by a set of fixed filters. The output of each filter is converted into a digitized stream that is further subdivided using digital filtering techniques. The output of the digitized filters is routed to a digital combiner associated with a particular S-band beam whose output is converted to analog and then frequency converted to S-band for transmission. The routing

and digital filtering would be programmable via the command system. This design minimizes the amount of feederlink spectrum required.

4. Spacecraft Bus System

a. Attitude Control Subsystem

The satellite will be a three-axis stabilized spacecraft that is a version of the Hughes HS 601 series. The bus is a body-stabilized design, utilizing an Earth sensor for satellite pointing reference and a re-programmable digital computer for executing the attitude control algorithms and commanding a gimballed momentum wheel assembly to obtain satellite attitude control torques. A telemetry and command subsystem will provide ample capacity for ground personnel to assess satellite health and status, and take corrective action as required. All components comprising the bus will be flight qualified. All subsystems will be provided with direct or functional redundancy.

b. Electrical Power Subsystem

The power subsystem utilizes solar arrays to gather and convert solar energy into electrical power for storage and operation of the satellite subsystems during sunlight hours. When the satellite is fully deployed in orbit it will extend 66.4 feet across the solar panel arrays. The energy will be stored in a nickel-hydrogen battery which will be used as a continuous power source, providing energy to the satellite during eclipse. The solar arrays are capable of providing 3600 watts at end-of-life.

c. Propulsion Subsystem

A pressure-fed liquid bipropellant propulsion system will be used to maintain the satellite in its proper position during the service life of the satellite. The system consists of the following major components:

> A single liquid apogee engine (LAE) for the apogee maneuver and perigee augmentation if required.
>
> Twelve reaction control thrusters (RCT) providing a nominal rocket engine thrust of 22 N each (but not arranged in two redundant groups of six each).
>
> Four propellant supply tanks each containing a surface tension propellant management device for propellant orientation and positive expulsion of gas-free liquids to the LAE and RCTs.
>
> Two high pressure gas tanks used for containing high pressure helium pressurant to pressurize the propellant tanks.

The design service life of the propulsion subsystem exceeds the 10 year expected life of the satellite.

d. Structure and Thermal Control Subsystem

The thermal control subsystem will utilize standard thermal control techniques for three-axes stabilized spacecraft. This will consist of north/south direct radiating panels for the high powered components mounted directly on them. Heat will be distributed by heat pipes embedded in the north/south panels. Multilayer insulation blankets (MLI) and sunshields will cover all non-radiator surfaces. An on-board processor will manage the spacecraft heaters to maintain proper temperature control. The battery and sensors will be thermally isolated from the spacecraft with their own dedicated radiator and heater.

e. Command, Ranging and Telemetry

The command, ranging and telemetry system will perform the following functions:

> The command system will receive, demodulate, decrypt, decode and distribute command messages originated either internally from the attitude control subsystem or externally via the ground over the Ku-band command link.
>
> The telemetry system will collect, format, modulate, and transmit command acknowledgments and information related to the spacecraft configuration and performance.
>
> The ranging function phase will modulate onto the telemetry downlink ranging tones received by the command uplink, thereby allowing highly accurate ground determination of spacecraft range.

The TT&C subsystem will be designed using hardware that has been flight proven on the AUSSAT-B and the AMSC and Canadian MSS satellites. The transfer orbit TT&C will be performed in the Ku-band through an omni-directional antenna. On station TT&C will be performed through the Ku-band feederlink antenna. The narrowband TT&C links will operate in the 14/12 GHz bands during transfer orbit in order to use existing TT&C ground segment facilities, and in the 13/11 GHz bands on-station.

5. Spacecraft Overall Properties

a. Overall Mass Budget

The overall mass of the satellite will be approximately 4000 kg and composed of the following major components:

Transponder	400
Antenna reflectors	310
S-band antenna feed	60
K-band antenna	30
Bus	1,200
Spacecraft dry mass	2,000
Total at launch	4,000

b. Overall Power Budget

The satellite payload and bus require approximately 3,200 watts of power, which is well within the 3,600 watt end-of-life capability of the solar arrays.

6. Satellite Operational Lifetime

The satellite will be designed to sustain as many as 2 years of in-orbit storage plus 10 years of service life.

7. Satellite Reliability

The spacecraft will be designed to meet the probability of successful operation goals of 90% at year 7 of its life and 75% at year 12. These goals will be met by having redundant active components and using flight proven hardware.

B. Launch Vehicle

Launch may be obtained from either General Dynamics or Ariannespace. The launch vehicle will be an Atlas IIa, Ariane IV or similar vehicle.

Table 1
Satellite System Characteristics

	Ku to S Band	**S to Ku Band**
Frequency band		
Transmit	12751 -12901 MHz	1970 - 1990 MHz
Receive	2160 - 2180 MHz	11202 -11352 MHz
Polarization		
Receive	Linear Horizontal	RHCP
Transmit	RHCP	Linear Vertical
Channelization	Fixed and Tunable	Fixed and Tunable
Peak Antenna Gain		
Receive	28 dBi	45 dBic
Transmit	45 dBic	28 dBi
System Temperature	780 K	450 K
Peak G/T	1.0 dBK	18.5 dBK
Power into Antenna	740 W	50 W
Total EIRP @ Peak Max/beam	72.7 dBW Useable	45 dBW Saturated
Transponder Gain Nominal	163.8 dB	156 dB
Gain Adjustment Step Size	+/- 6 dB 1.5 dB	+/- 6 dB 1.5 dB
Receive Satellite Flux Density, Peak	-91.1 dBW/m^2	-111 dBW/m^2
PFD (max)	-132 dBW/4 kHz	-150 dBW/4 kHz
Emission Limitations (% authorized bandwidth)	Attenuation per 4 kHz	Attenuation per 4 kHz
50 to 100%	> 25 dB	> 25 dB
100 to 250 %	> 35 dB	> 35 dB
> 250%	> 60 dB	> 60 dB

Table 1
Satellite System Characteristics
(Continued)

Emission Designators		
2.4 kbps	2K40G1EDF	2K40G1EDF
4.8 kbps	4K80G1EDF	4K80G1EDF
32 kbps	32K0M7EDT	32K0M7EDT
144 kbps	144KG1EDF	144KG1EDF
1.25 mbps	1M25G1EDF	1M25G1EDF
Transmitter Redundancy	25 for 20	2 for 1
Maintenance of Satellite Position		
East/West		+/- 0.1°
North/South		+/- 0.5°

TT&C PARAMETERS

Antenna	Omni-directional	Directive
Command Parameters		
Frequency Band (MHz)	13000-13002	13248-13250
Flux Density (dBW/m^2)	-85	-100
Polarization	Linear	Linear
Modulation	FM	FM
Peak Dev. (kHz)	300	300
Occupied BW (kHz)	800	800
Receiver BW (kHz)	1000	1000
Emission Designator	700KF9D	700KF9D
Telemetry Parameters		
Frequency Band (MHz)	10948-10950	10948-10950
Peak EIRP (dBW)	9	11
Polarization	Linear	Linear
Modulation	Phase, 1 Rad.	Phase, 1 Rad.
Occupied BW (kHz)	100	100
Emission Designator	138KGXD	138KGXD

III. Services and Ground Segment

A. Description of Services

PCSAT has designed a satellite system that will be interoperable with terrestrial PCS. The system will provide service in what can be described as Mega Cells corresponding to the coverage area of a satellite antenna beam. A single satellite antenna beam will provide simultaneous coverage in many different types of environments, including rural, urban and multiple urban. Thus, the satellite system will be flexible to accommodate a broad range of users within a single satellite beam.

The PCSAT system will provide a variety of services, including ISDN Basic Rate Interface, video and data up to 2 Mbps from a fixed location, 7 kHz speech, hi-fi audio, and high speed mobile fax and data. Thus, a terminal may operate with different channel rates and coding schemes, depending on the type of service that is being provided and the operating environment. For example, a handheld terminal that is operating in a PCS Pico Cell may be transmitting voice at a rate of 32 kbps with a microwatt of power. That same terminal may also access the satellite with a 2.4 kbps rate and transmit 0.3 watts of power. This same handheld terminal could also be plugged into a booster in a mobile terminal to participate in a videoconference via satellite.

This type of operating environment requires a satellite system that can provide a flexible channelization scheme to accommodate various access rates and a transponder plan that allows the assignment of spectrum to beams that vary with changes in the traffic demand. The terminals that are accessing the satellite system may be programmed to operate in both a satellite and terrestrial PCS environment, though the services may operate at different

transmission rates and coding schemes depending on the operating environment. This concept can be extended to the provision of services within the satellite system, since the transmission rates that are supported from a fixed versus a mobile satellite terminal may vary. For example, a mobile subscriber may be satisfied communicating over a voice channel that compresses voice to 2.4 kbps. However, in some cases, the same user may demand toll-quality voice from a remote telephony unit.

B. Control Segment and Earth Station Parameters

Network operational control will be centered at the feederlink earth station. The feederlink earth station will be manned 24 hours per day to ensure continuity of service. Operational personnel will provide in-house maintenance to the transmission facilities and on-line troubleshooting support. Transmission problems can originate at the earth station or on one of the terrestrial transmission facilities that interconnect the earth station with the PSTN. All active components at the earth station will be monitored through a centralized earth station monitoring system. This system will examine the health of all the active components of the earth station and switch over to redundant active components when an alarm is sensed. The system will also monitor power levels at critical junctions of the uplink chain to insure that the transmission levels remain within the tolerances of the system.

In addition, the earth station will also have line monitoring equipment to insure the continuity of the terrestrial transmission lines that are interconnecting the earth station with the PSTN or private networks. It is expected that diversely routed redundant routes would be used for these facilities, particularly if the need extended beyond the local dialing area.

Line monitoring equipment will measure the performance of the facility and switch to the redundant path, if necessary.

Operation personnel will also monitor satellite usage, which is critical if multiple feederlink earth stations are to access the satellite. Each of the carriers that are present in the satellite transponder must be maintained within the frequency assignment and power allocation tolerances of the system to protect the integrity of all the signals being received by the satellite. If signal tolerance is not maintained, the transponder may slip into a non-linear portion of its operating curve and degrade the individual link performance. Spectrum analyzers, in conjunction with network data base computers that will maintain a record of all carrier and associated power and bandwidth information, will be used on a daily basis to scan the usage of the transponder to ensure that all carriers are operating within their design parameters and no alien or unidentified carriers are present in the satellite. This will be particularly important during initial operations if U.S. terrestrial operations are operating within the 1970-1990 MHz band. PCSAT will take advantage of the software and databases that were developed for AMSC's satellite to manage the transponder activity on this satellite. The NOC software and databases will be expanded to include control of the new satellite.

The Network Control Center of the first AMSC satellite is designed to accommodate a multiple satellite system. The basic set of signalling protocols that was developed for call initiation for that satellite is also applicable here. Additional information will have to be passed between the NCC and the mobile terminal so that the NCC and the terminal fully understand the type of connection that is to be established between the mobile terminal and the earth station, along with the type of extension that is needed to terminate the call in the

PSTN. The additional information that needs to be passed can be accomplished in the signalling channel structure that has been developed for operations on the AMSC satellite.

Figure 5 is a layout of the PCSAT feederlink earth station. The earth station will have one Ku-band 11 meter antenna that will be used to access the satellite. On the uplink transmission path, the antenna will be connected to a redundant pair of HPAs that will be used to support feederlink transmissions to the satellite. Standard redundant Ku-band upconverters tuned to the band will be used to translate channels converted to a common IF frequency to the feederlink frequencies. On the downlink transmission path, the received signal will first be amplified with a redundant 280° LNA system. The output of this system will be fed to a redundant pair of downconverters that will convert the RF signals to a common IF frequency. The common IF will serve as the input/output frequencies of the baseband channel units that serve as the MSS interface to switching equipment and the terrestrial network.

The channelization equipment will interface with a switch that will be used to terminate the channels on the terrestrial side of the network and serve as the signalling interface between the MSS and the PCS. The MSS NCC and the switch will work closely together to convert signalling parameters originating on the MSS or PSTN parts of the network into beam and frequency assignments on the satellite and channel card assignments on the terrestrial portion of the network. Additional signalling protocol exchanges between the NCC and the terrestrial switch will be developed to accommodate additional services and channel types.

Baseband equipment that will be used for the transmission of broadcast channels will also be developed. It is premature to specify what the channelization equipment will be since

the standardization effort to date has identified service types, but not implementation details. There are a number of different options in terms of coding, modulation format and access schemes that are being considered at this time. Different transmission rates may be used for the same service type and the rate chosen at the time of transmission will be a function of the terminal type and the propagation environment. Channel cards will need to operate at different transmission rates, apply different coding schemes, provide unique interfaces (i.e., FAX) and send and receive control signals between the NCC and the mobile terminal. PCSAT expects that the satellite operational control will be subcontracted to a third party with experience in monitoring and controlling satellites.

C. User Terminals

There will be three general types of terminals available. One type will be a handheld portable terminal that is interoperable with terrestrial PCS. This terminal will have an approximately 25 dB range of EIRP to allow it to operate on either the satellite or terrestrial portion of the network. The terminal will use the same RF substance in accessing the satellite or terrestrial portion of the network and could support different access schemes on either. Handheld terminals will support voice, fax and data services. The transmission rate of these terminals will be a function of the propagation environment and whether the terrestrial or satellite portions of the network are used.

The second terminal is a vehicular booster unit into which subscribers will plug in their portable units when travelling. The vehicular booster will increase the EIRP of the terminal and operate through an antenna mounted outside the vehicle. The services that are available to the vehicular user will depend on the mobile environment. For example, a vehicular

mobile terminal would be able to support a videoconference operating at 112 kbps while en route. A land mobile terminal would use the additional power to overcome the effects of shadowing while in motion.

The third terminal is a transportable or fixed installation that would not move when in operation. This terminal would be able to support all the higher data rate interconnection requirements of the satellite portion of the network, such as ISDN BRI, high speed fax and data transfer, 7 kHz speech transmission and program audio transmission. This terminal is likely to take the form of a mobile booster terminal that is attached to a small planar array or parabolic dish for the additional gain needed to support the higher data rate transmissions without high transmission power.

All of these mobile terminals will have the capability to operate on both the satellite and the terrestrial portion of the PCS network, support a variety of applications and operate over digital channels. The types of channels will vary in their transmission rates, coding schemes and modulation, similar to MSS systems being deployed today that support different rates on their signalling and communications channels and use QPSK and BPSK interchangeably. In addition, different coding schemes are used for data, voice and fax transmissions. In the future, there might be an internationally accepted standard for implementation of the terrestrial portion of PCSAT. However, it is uncertain whether or not consensus will be reached on the details of the implementation of the radio portion of the standard, i.e., CDMA, TDMA or FDMA. In the United States, the FCC has granted a number of experimental licenses which implement differently the telephony portion of the PCS. Because of this uncertainty, PCSAT has designed a flexible satellite system that will be able to accommodate a number of technologies.

IV. Transmission Characteristics and Performance Objectives

Both CDMA and SCPC/FDMA transmission methods can be used to provide services through the satellite, and either method can support all of the services previously described. Table 2 summarizes the transmission characteristics of a typical SCPC/FDMA system for four types of service. Table 3 summarizes the same services for a CDMA system based on the cellular telephone EIA CDMA standard.

Table 2
Typical SCPC/FDMA Characteristics

SERVICE	VOICE	VOICE	DATA	DATA
Antenna	handheld	vehicle	vehicle	transportable
G/T, dB/K	-24	-20	-20	-10
EIRP max., dBW	-1	8	8	10
Data Rate, kbps	4.2	4.2	9.6	64
FEC	1/2	1/2	1/2	1/2
Modulation	QPSK	QPSK	QPSK	QPSK
Eb/No, dB	8	8	8	8
C/No, dB-Hz	44	44	47.5	56.5
Symbol BW, kHz	4.375	4.375	9.775	64.2
Spacing, kHz	8	8	16	100

Table 3
Typical CDMA Characteristics

SERVICE	VOICE	VOICE	DATA	DATA
Antenna	handheld	vehicle	vehicle	transportable
G/T, dB/K	-24	-20	-20	-10
EIRP max, dBW	-1	8	8	17
Data Rate, kbps	4.8	4.8	9.6	64
Eb/No, dB	4.5	4.5	4.5	4.5
C/No, dB-Hz	41.3	41.3	44.3	52.6

Chip Rate, Mcps	1.2288
Modulation	Bi-orthogonal BPSK forward, OQPSK Return
Standard	Cellular Telephone CDMA

Table 4 is a sample link calculation for the SCPC operation with a handheld unit. These link calculations have been designed to serve PCS users outside of urban areas. It is expected that dual satellite/terrestrial handheld terminals will have approximately 0.6 watt of power into an omni antenna. Alternatively, the user in an automobile would plug into the satellite booster giving the user the extra power needed to operate effectively in the presence of shadowing and other impairments. In the mobile telephony environment, the user's handheld terminal will be connected to a booster that will have a 3 watt transmitter and be connected to an external antenna with a gain of about 4 to 5 dBi. This configuration enables the mobile user to be in service 99% of the time. Table 5 is an example of the link performance in this environment. Note that the return link EIRP is -1 dBW although the maximum EIRP from Table 2 is 8 dBW. Return link power control can be used to absorb the 9 dB difference, yielding a total margin of 13.4 dB (9 + 4.4 dB). In a nonshadowed environment, the terminal could support rates up to 9.6 kbps, as illustrated in Table 6.

For transportable or fixed applications, the same booster could be used with a small planar array or parabolic antenna and supply up to 144 kbps connections that would be

required for an ISDN Basic Rate Interface. This would effectively represent the peak rate that could be supplied from this class of mobile terminal. Table 7 provides the link budgets for a 64 kbps data rate.

Tables 8 and 9 provide the link budgets using CDMA for the handheld and vehicle mobile voice services.

Table 4
SCPC Handheld Terminal Link Budget

	FORWARD	RETURN
Noise BW, Hz	4500	4500
UPLINK		
Frequency, GHz	13	1.9
E.S. EIRP, dBW	37.5	-1
Path Loss, dB	-206.7	-190.0
Sat EOC G/T, dB/K	0	14.5
Interference Allowance, dB	0.5	0.5
C/No, dB-Hz	58.9	51.6
Satellite Gain, dB	160	162
Intermod C/I, dB	22	26
C/IMo, dB-Hz	58.5	62.5
Frequency Reuse C/I, dB	17	17
Frequency Reuse C/Io, dB	53.5	53.5
Satellite C/(No+Io), dBHz	51.5	49.3
DOWNLINK		
Frequency, GHz	2.1	11
Sat. EOC EIRP, dBW	34.5	-2
Path Loss, dB	-190.8	-205.2
E.S. G/T, dB/K	-24	38
Interference Allowance, dB	0.8	0.5
C/No, dB-Hz	47.5	58.9
Link C/(Io+No), dB	46.0	48.8
Required C/No, dB-Hz	44	44
Uplink Margin, dB	2.0	4.8
Downlink Margin, dB	2.6	10.3

Table 5
SCPC Mobile Voice Terminal Link Budget

	FORWARD	RETURN
Noise BW, Hz	4500	4500
UPLINK		
Frequency, GHz	13	1.9
E.S. EIRP, dBW	37.5	-1
Path Loss, dB	-206.7	-190.0
Sat EOC G/T, dB/K	0	14.5
Interference Allowance, dB	0.5	0.5
C/No, dB-Hz	58.9	51.6
Satellite Gain, dB	160	162
Intermod C/I, dB	22	26
C/IMo, dB-Hz	58.5	62.5
Frequency Reuse C/I, dB	17	16
Frequency Reuse C/Io, dB	53.5	52.5
Satellite C/(No+Io), dBHz	51.5	48.9
DOWNLINK		
Frequency, GHz	2.1	11
Sat. EOC EIRP, dBW	34.5	-2
Path Loss, dB	-190.8	-205.2
E.S. G/T, dB/K	-20	38
Interference Allowance, dB	0.8	0.5
C/No, dB-Hz	51.5	58.9
Link C/(Io+No), dB	48.5	48.4
Required C/No, dB-Hz	44	44
Uplink Margin, dB	4.5	4.4
Downlink Margin, dB	6.6	13.2

Table 6
SCPC Mobile Data Terminal Link Budget

	FORWARD	RETURN
Noise BW, Hz	10000	10000
UPLINK		
Frequency, GHz	13	1.9
E.S. EIRP, dBW	37.5	0
Path Loss, dB	-206.7	-190.0
Sat EOC G/T, dB/K	0	14.5
Interference Allowance, dB	0.5	0.5
C/No, dB-Hz	58.9	52.6
Satellite Gain, dB	160	162
Intermod C/I, dB	22	26
C/IMo, dB-Hz	62.0	66.0
Frequency Reuse C/I, dB	17	16
Frequency Reuse C/Io, dB	57.0	56.0
Satellite C/(No+Io), dBHz	54.1	50.8
DOWNLINK		
Frequency, GHz	2.1	11
Sat. EOC EIRP, dBW	34.5	-1
Path Loss, dB	-190.8	-205.2
E.S. G/T, dB/K	-20	38
Interference Allowance, dB	0.8	0.5
C/No, dB-Hz	51.5	59.9
Link C/(Io+No), dB	49.6	50.3
Required C/No, dB-Hz	47.5	47.5
Uplink Margin, dB	2.1	2.8
Downlink Margin, dB	2.9	6.7

Table 7
SCPC Transportable Data Terminal Link Budget

	FORWARD	RETURN
Noise BW, Hz	90000	90000
UPLINK		
Frequency, GHz	13	1.9
E.S. EIRP, dBW	39	10
Path Loss, dB	-206.7	-190.0
Sat EOC G/T, dB/K	0	14.5
Interference Allowance, dB	0.5	0.5
C/No, dB-Hz	60.4	62.6
Satellite Gain, dB	160	162
Intermod C/I, dB	22	26
C/IMo, dB-Hz	71.5	75.5
Frequency Reuse C/I, dB	17	16
Frequency Reuse C/Io, dB	66.5	65.5
Satellite C/(No+Io), dBHz	59.2	60.7
DOWNLINK		
Frequency, GHz	2.1	11
Sat. EOC EIRP, dBW	36	9
Path Loss, dB	-190.8	-205.2
E.S. G/T, dB/K	-10	38
Interference Allowance, dB	0.8	0.5
C/No, dB-Hz	63.0	69.9
Link C/(Io+No), dB	57.7	60.2
Required C/No, dB-Hz	56.5	56.5
Uplink Margin, dB	1.2	3.7
Downlink Margin, dB	3.1	8.3

Table 8
CDMA Handheld Voice Terminal Link Budget

	FORWARD	RETURN
Data Rate, bps	4800	4800
Chip Rate, Mcps	1.2288	1.2288
ON Channels in Chip Bandwidth	40	20
Bits/Symbol	1	2
UPLINK Frequency, GHz	13	1.9
E.S. EIRP, dBW	36.8	-1
Path Loss, dB	-206.7	-190.0
Sat EOC G/T, dB/K	0	14.5
Interference Allowance, dB	0.5	0.5
C/No, dB-Hz	58.2	51.6
Satellite Gain, dB	160	162
Self Noise C/Io, dBHz	X	47.9
Intermod C/I, dB	22	26
C/IMo, dB-Hz	58.8	62.8
Reuse Isolation, dB	0	3
Frequency Reuse C/Io, dB	44.9	47.9
Satellite C/(No+Io), dBHz	44.5	44.0
DOWNLINK Frequency, GHz	2.1	11
Sat. EOC EIRP, dBW	33.8	-2
Path Loss, dB	-190.8	-205.2
E.S. G/T, dB/K	-24	38
Interference Allowance, dB	0.8	0.5
C/No, dB-Hz	46.8	58.9
Link C/(Io+No), dB	42.5	43.8
Required C/No, dB-Hz	41.3	41.3
Uplink Margin, dB	1.2	2.5
Downlink Margin, dB	2.6	11.2

Table 9
CDMA Mobile Voice Terminal Link Budget

	FORWARD	RETURN
Data Rate, bps	4800	4800
Chip Rate, Mcps	1.2288	1.2288
ON Channels in Chip Bandwidth	40	20
Bits/Symbol	1	2
UPLINK Frequency, GHz	13	1.9
E.S. EIRP, dBW	36.8	-1
Path Loss, dB	-206.7	-190.0
Sat EOC G/T, dB/K	0	14.5
Interference Allowance, dB	0.5	0.5
C/No, dB-Hz	58.2	51.6
Satellite Gain, Db	160	162
Self Noise C/Io, dBHz	X	47.9
Intermod C/I, dB	22	26
C/IMo, dB-Hz	58.8	62.8
Reuse Isolation, dB	0	3
Frequency Reuse C/Io, dB	44.9	47.9
Satellite C/(No+Io), dBHz	44.5	44.0
DOWNLINK Frequency, GHz	2.1	11
Sat. EOC EIRP, dBW	33.8	-2
Path Loss, dB	-190.8	-205.2
E.S. G/T, dB/K	-20	38
Interference Allowance, dB	0.8	0.5
C/No, dB-Hz	50.8	58.9
Link C/(Io+No), dB	43.6	43.8
Required C/No, dB-Hz	41.3	41.3
Uplink Margin, dB	2.3	2.5
Downlink Margin, dB	6.6	11.2