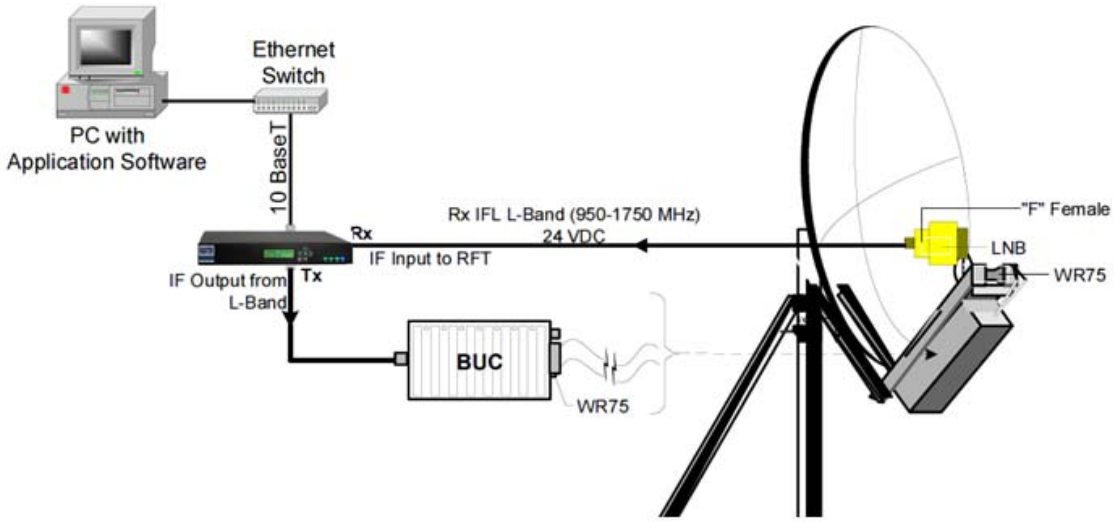
Introduction to Satellite Communications (101)



A typical Raditek VSAT

Dish directs the RF (via a power amplifier or BUC-Block Upconverter) to the satellite and receives (via an LNA or LNB-Low Noise Block downconverter or Amplifier) the signal from the satellite. Sizes can be from 1m to 1.8m for remotes. Hubs are usually much bigger.

Modem- MODulates and DEModulates baseband data, on to / from an RF carrier that passes through the satellite**.**

Common Satellite frequencies:

C Band: typically 3.7 to 4.2GHz down link, 5.9 to 6.4GHz uplink. India (Insat) has a unique different set of bands. Extended bands are also used.

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X band for military

Ku band 11.7 to 12.2GHz downlink, and 14-14.5GHz uplink.

Ka band (new band over 20GHz)

RAIN FADE:

C band is used where rain fades are likely (as it is least effected by rain) eg Indonesia is almost totally C band

Rain fade gets worse with frequency increase

Ku band most popular, if rain fades are not high. Smaller antennas than C band**.**

Ka band is newest band, with very small antennas, but high rain fades.

SATELLITE:

Acts as a *repeater* in space, Geostationary satellites are on the Clark belt, 22,000 miles above the equator. So they are always in the same place above the earth-ie they rotate with the Earth so they appear stationary from the Earth.

The Satellite has many *Transponders*, which converts and amplifiers a signal from a ground based hub in a STAR network, and from a remote in a MESH network.

The Satellite based antenna array is shaped like the geographic coverage area.

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Can be a whole country like US (CONUS) or as a concentrated small area (Spot Beam).

A satellite contour map shows on the ground G/T (gain divided by noise temperature), and EIRP (Effective Isotropic Radiated power). This data is needed for the

LINK BUDGET:

The link budget is *needed to calculate the earth station antenna size and RF Power for a link.* The Earth station antenna gain multiplied by the antenna gain gives the EIRP (Effective Isotropic Radiated power)-simply means the power directed towards the satellite. Usually power is in dBm or dBw and antenna gain is dB, so EIRP is the log sum of them.

The receive analysis determines the G/T of the ground station. The antenna is the same as uplink, of course, the T comes mainly from the LNA or LNB noise temperature.

MODEM:

To understand the way the modem can operate and where RADITEK has superior lead, it is important to understand a few technical characteristics a little:

1. **Modulations:** BPSK(1 b/s), QPSK(2b/s), 8PSK(3b/s) and 16QAM(4b/s) b/s=bit per symbol-makes better use of the available bandwidth.

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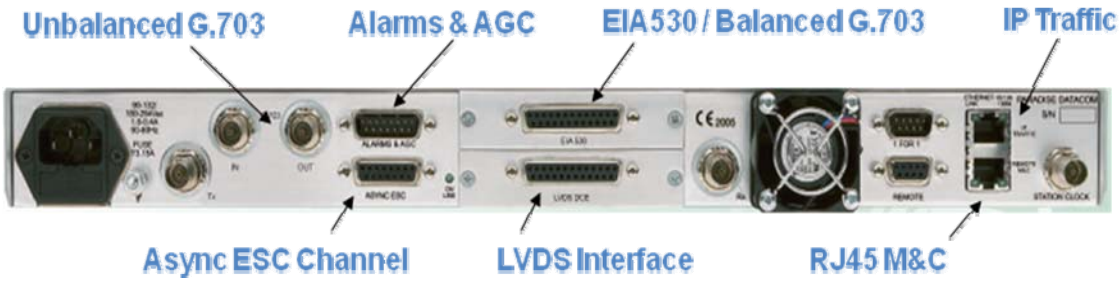
2. **Coding:** Convolutional and Reed Solomon codes (older), newer/better ones include TPC (Turbo Product Codes) and LDPC (Low density parity check)-used to restore lost bits in a trabnsmission
3. **SCPC:** (Single Channel Per Carrier) for point to point links
4. **TDMA:** (Time division Multiple Access)
5. **SCPC/DAMA: (Demand Assigned Multiple Access)**
6. **Interfaces:** IF (70 or 140MHz) and L band (950 to 1450MHz)-get upconverted via BUC to transmit frequency
7. **Baseband:** G.703(E1 or T1) for digital voice/backhaul
   a. Unbalanced using BNC interface
   b. Balanced using a multiple pin connector
8. **Internet:** (RJ45 connector(s))
9. **Data via EIA 530 port etc.**
10. **ESC-Engineering Service Channel**



The SCPC modem can support Internet OR E1/T1. Both can be supported at the *same time* with the MUX option ONLY.

LVDS-Low-voltage differential signaling is an electrical digital signaling standard that can run at very high speeds over inexpensive twisted-pair copper cables.

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RADITEK has both SCPC (rear shown) and SCPC/DAMA modems.

BUC vs. Transceiver

TRANSCEIVER

This is a module (it can be indoors in a 19 inch rack or outdoors, in a weather proof housing). It takes the 70 or 140MHz (+/- 20MHz) modulated signal from a modem and upconverts to either L band (intermediate frequency) or the final uplink frequency (C or Ku band, for example). It has a built in synthesizer that is used to tune the required satellite transponder. Whereas the modem is used (in this case) to select the channel location within that transponder. A single transponder on a geostationary satellite is capable of handling approximately 5,000 simultaneous voice or data channels. A typical satellite has 32 transponders.

BUC (Block Upconverter)

Most applications today use the BUC with an L band Modem option. L band in this case, covers 950MHz to 2GHz or some subset of that range. The BUC receives the modulated signal from an L band Modem. It then block upconverts the entire uplink band to the correct channel within the full satellite uplink band (eg 3.7 to 4.2GHz). The BUC can also be an indoor 19 inch rack or a weatherproof outdoor unit.

RADITEK125W Ku Band BUC

RADITEK has a full range of indoor and outdoor BUCs and Transceivers.

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SSPA and TWTA

SSPA (solid state power amplifier) and TWTA (Travelling wave tube amplifier) are both used in uplink applications. TWTAs are used at he very high power end and SSPAs are typically used by remotes and smaller HUBs. RADITEK has SSPAs to 400W for C band and 125W for Ku band.

The power used for SSPAs are the P1dB (1dB gain compression point).

TWTAs specify their power in Psat (saturated power). The reason is that TWTAs are very non linear, and have to be backed off several more dBs than an SSPA, to be linear enough for operation.

In any amplifier, the operating point must be at a power sufficiently backed off to reliably transmit the modulated signal. The higher the modulation level, the more (typically) it needs backing off.

Example of RADITEK's 1+1 C band transceiver system with 400W SSPAs.

Can be controlled from the front panels or by remote M and C (Monitor and control).

Glossary of terms	
A	**> Analog transmission** **Transmission of information characterized by continuously variable quantities. Regular telephone lines use analog transmission methods.** **> Antenna (dish)** **Device that concentrates a beam of electromagnetic waves so as to send and**

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Glossary of terms	
A	receive signals. > Aperture Effective cross-sectional area of the antenna. The larger the aperture, the stronger the signal the antenna receives and transmits.
B	> Backup network Alternative (secondary, emergency) network in case the main (primary) network fails. For example, when a frame relay network fails, the VSAT network is used as the backup network. > Bandwidth Range of frequencies, expressed in Hertz, that can pass through a given transmission channel. The larger the bandwidth, the more information that can be transmitted in the same period of time. > Bit Rate Speed at which bits are transmitted, usally expressed in bits per second (bps). > Broadcasting Single transmission received by all units capable of accessing the signal. The most common example is broadcast television, where a station sends a set transmission over the air to anyone with a television who is within reception area. > Bypass Establishing a communication link without using facilities of the local carrier (PTT).
C	> Capacity Maximum amount of traffic that a circuit or circuit group can handle. > C-band Frequency band in the 4-6 Ghz. The lowest of the three main frequency bands, requiring the largest antenna. > Channel An electronic communications connection between two points. A channel can be "simplex", with one-way communications such as a television broadcast, or

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Glossary of terms	
C	"duplex", where communications can go both directions as in a telephone call. > Coverage (Footprint) Area on the earth where effective transmission/reception to/from the satellite is possible. This contour is usually specified by points at half the maximum power.
D	> DA Dedicated Access-mode used when a remote site from the hub (the file transfer application) requires a higher level of throughput (continuous volume of traffic). > DAMA Demand-Assigned Multiple Access- Allows many users access the same channel on demand. > Digital Transmission Transmission of information characterized by series of discrete numbers or bits. Computers communicate email, customer records and other information digitally. > Double Hop Transmission of information from terminal to terminal in two stages: from a VSAT, via a satellite link, to the network hub, and from the network hub, via the satellite link, to another VSAT. This is the only method used in a star network. > Downlink The retransmission of a signal received by a satellite transponder back down to earth stations.
E	> E1 carrier Time division multiplexing system for carrying digital voice and data at approximately 2.048 Mbps. > Earth station Ground equipment used in conjunction with an antenna for receiving or transmitting radio frequency signals to or from a satellite.
F	> FDMA Frequency Division Multiplex Access. A broadband access scheme where each applicatoin gets a different frequency segment for communications.

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Glossary of terms	
F	> FEC Forward Error Correction. Coding of the digital signal at the source so errors can be detected and corrected at the receiver. > Feed A device mounted at the focal point of antenna that gathers signals reflected from the dish. > Footprint The area on the earth's surface that is covered by a satellite's transmission beam. > Frame relay A packet switching network protocol, typically used for national and international data networks.
G	> GEO Geostationary Earth Orbit. See Geostationary. > Geostationary (alt: Geosynchronous) Orbit in which the speed of a satellite rotation is the same as the speed of the earth’s rotation, so that satellite is always positioned above the same spot on the earth. This orbit is located at 22,300 miles (35,800 km) over the equator. Most communications satellites rotate in this orbit. > GUI Graphical User Interface.
H	> HPA Hight Power Amplifier. Used in the ODU to transmit information from the VSAT. > HSP Hub Satellite Processor. > HTTP Hyper Text Transfer Protocol. Used to request and transfer objects across the Web. > Hub Satellite central earth station controlling satellite bandwith allocation and through

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Glossary of terms	
H	which all traffic is routed in a star topology.
I	> IDU Indoor Unit. VSAT portion connecting the user terminal ports to the ODU. > IP Internet Protocol. Defines packets sent across the internet. Often used in conjunction with TCP, a higher level protocol. > ISDN Integrated Services Digital Network. > ISO International Organization for Standardization. An organization composed of multiple national standards organizations. > ITU International Telecommunication Union. A United Nations organization helping governments and private organizations coordinate global telecommunications usage.
K	> Ka Band 20-30 Ghz. The newest and highest frequency satellite communications bandwidth. Not yet in significant use. > Ku Band 10-14 Ghz. The primary frequency band for satellite communications networks.
L	> LAN Local Area Network. A computer network spanning a small area. > Leased Line Circuit or channel reserved for the exclusive use of one user or a specific group of users. Also called a "dedicated" line. > LNB Low-Noise Block. The receiver for the VSAT, part of the ODU.

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Glossary of terms	
M	> Mesh network Network wherein all points (VSATs) can directly communicate with each other in a single hop. > MF-TDMA Multiple-Frequency Time Division Multiple-Access. A broadband access method where applications are allocated segments identified by both frequency and time. > Modem Modulator/Demodulator. Accepts digital data from a computer or terminal device and transforms the data into the correct protocol for digital or analog transmission. > MTBF Mean Time Between Failures. Statistical average period of time that a system will work without failing. > Multiple Access Ability for more than one application or user to share a transponder. Examples of multiple access methods are DAMA, FDMA, FT-DAMA. > Multiplexing The ability to allow many applications to simultaneously transmit over a single circuit.
N	> NCC Network Control Center. > Network Management Configuration, supervision and gathering of statistics on a system to diagnose bottlenecks, malfunctions or other problems. Also provides information necessary to manually or automatically optimize network performance. > NMS Network Management System. The software to monitor and control the satellite network.
O	> ODU Outdoor Unit. An antenna, an HPU for transmission and an LNB for reception.

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Glossary of terms	
P	> PABX Private Automated Branch Exchange. Allows a single access number to provide service to multiple internal office numbers. > Packet An aggregate of data and controls in an ordered group, transmitted through a network as the subset of a larger message. > PAMA Permanently Assigned Multiple Access. > PBX Privet Branch Exchange. Private telephone switch that establishes voice-grade circuits over tie lines between individual users and the switched telephone network. > PCO Public Call Office. A telephone or group of telephones accessible by the public via payments, via either cash or prepayment. > POS Point of Sale. POS devices such as cash registers and credit card readers can work on networks. > POTS Plain Old Telephone System. Another acronym for PSTN. > PSTN Public Switched Telephone Network. An international standard for analog voice telephony over copper wires.
Q	> QoS Quality of Service. Level of network response time and other performance factors for each application and user. Required QoS levels are often specified in an SLA.
R	> Repeater A device that receives signals from one location, increases the signal strength and retransmits them to another location.

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Glossary of terms	
S	> Satellite A smaller object orbiting a larger one. Communications satellites receive radio signals from earth stations and retransmit them to other earth stations. > Satellite delay The time, ~0.25 seconds, taken for a transmission to reach a GEO satellite and return to earth (one "hop"). > SCADA Supervisory Control and Data Acquisition. The process of monitoring and controlling remote devices used in physical production, such as controls on pipeline segments. > Single hop Transmission of information from terminal to terminal in one stage via a satellite link (in a mesh network). > SLA Service Level Agreeemnt. Contract between a telephony or data broadband provider and its customer that defines the minimum QoS needed for customer application performance. > Space segment Portion of the satellite bandwith and transmission power assigned to the communication network. > Spoofing For a device to imitate another device. While also used by hackers, spoofing improves network performance by allowing segments to act as if they're the earlier senders. In satellite communications, network devices can spoof the original source, allowing satellite network performance that is transparent to sending and receiving systems. > Star network Network where all the terminals can communicate with each other only through the hub via a double satellite hop.
T	> T1 carrier Time division multiplexing system for carrying digital voice and data at approximately 1.544 Mbps.

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Glossary of terms	
T	> TCP Transmission Control Protocol. A higher level protocol often combined with IP. > TCP/IP The combination TCP and IP protocols. A common internet communications method. > TDMA Time Division Multiple Access. Each application has full bandwidth access for specified time periods. > Throughput Measurement of volume of user data carried by the channel during a specified time period. Expressed in bits or packets per second. > Transponder A unit in a satellite that receives an uplink signal, converts its frequency, amplifies it and retransmits it to the ground. Communications satellites generally have 10 to 40 transponders.
U	> Uplink Transmission of signal from an earth station to the satellite. > USO Universal Services Obligation. Government requirement of basic services a telephony or broadband provider must offer all customers.
V	> VSAT Very Small Aperture Terminal. A remote satellite earth station with a small antenna, 0.9-1.8 meter (3-6 feet) diameter.
W	> WAN Wide Area Network. A data communications network typically connecting multiple remote locations.

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