# Satellite Link Budget Training Using SatMaster

Telecom Engineering
Brussels (Belgium)
24 - 28 Feb 2025

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**Ref:** 321387_139345 **Date:** 24 - 28 Feb 2025 **Location:** Brussels (Belgium) **Fees:** 4400 **Euro**

## Introduction

Link budgets are the standard tool for designing and assessing satellite communications transmissions, considering radio-wave propagation, satellite performance, terminal equipment, radio frequency interference RFI, and other physical layer aspects of fixed and mobile satellite systems. The format and content of the link budget must be understood by many engineers and managers with design and operation responsibilities. SatMaster is a highly-recognized yet low-cost PC-based software tool offered through the web by Arrowe Technical Services of the UK. This course reviews the principles and use of the link budget along with hands-on training in SatMaster 9, the latest version, for one- and two-way transmission of digital television; two-way interactive services using very small aperture terminals VSATs; point-to-point transmission at a wide range of data rates; and interactive communications with mobile terminals. Services at UHF, L, S, C, X, Ku, and Ka bands to fixed and mobile terminals are considered.

## Course Objectives of Satellite Link Budget Training Using SatMaster Software

- Detailed Link Design in Practice: Computer Workshop
- Principles of Satellite Links and Applicability of SatMaster
- Consideration of Interference and Workshop in Digital Link Budgets

## Course Outline of Satellite Link Budget Training Using SatMaster Software

### Day 1 - 2

### Principles of Satellite Links and Applicability of SatMaster

- Standard ground rules for satellite link budgets
- Frequency band selection: UHF, L, S, C, X, Ku, and Ka
- Satellite footprints EIRP, G/T, and SFD and transponder plans; application of on-board processors
- Propagation considerations: the isotropic source, line of sight, antenna principles
- Atmospheric effects: troposphere clear air and rain and ionosphere Faraday and scintillation
- Rain effects and rainfall regions; use of the built-in DAH and Crane rain models


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- Modulation systems QPSK, OQPSK, MSK, GMSK, 8PSK, 16 QAM, and 32 APSK
- Forward error correction techniques Viterbi, Reed-Solomon, BCH, Turbo, and LDPC codes
- Transmission equation and its relationship to the link budget
- Introduction to the user interface of SatMaster
- Differences between SatMaster 9, the current version, and previous versions
- File formats: antenna pointing, database, digital link budget, and digital processing/regenerative repeater link budget
- Built-in reference data and calculators
- Example of a digital one-way link budget DVB-S2 using equations and SatMaster

**Day 3 - 4**

**Detailed Link Design in Practice: Computer Workshop**

- Earth station block diagram and characteristics
- Antenna characteristics main beam, sidelobe, X-pol considerations, mobile antennas
- HPA characteristics, intermodulation, and sizing, uplink power control
- Link budget workshop example using SatMaster: Single Channel Per Carrier SCPC
- Transponder loading and optimum multi-carrier backoff; power equivalent bandwidth
- Review of link budget optimization techniques using the program's built-in features
- Transponder loading and optimization for minimum cost and resources, maximum throughput and availability
- Computing the minimum transmit power; uplink power control UPC
- Interference sources X-pol, adjacent satellite interference, adjacent channel interference
- Earth station power flux density limits and the use of spread spectrum for disadvantaged antennas

**Day 5**

**Consideration of Interference and Workshop in Digital Link Budgets**

- C/I estimation and trade studies
- Performance estimation for carrier-in-carrier Paired Carrier Multiple Access transmission
- Discussion of VSAT parameters and technology options as they relate to the link budget
- Example: digital VSAT, multi-carrier operation
- Use of batch location files to prepare link budgets for a large table of locations
- Case study from the class using the above elements and SatMaster

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