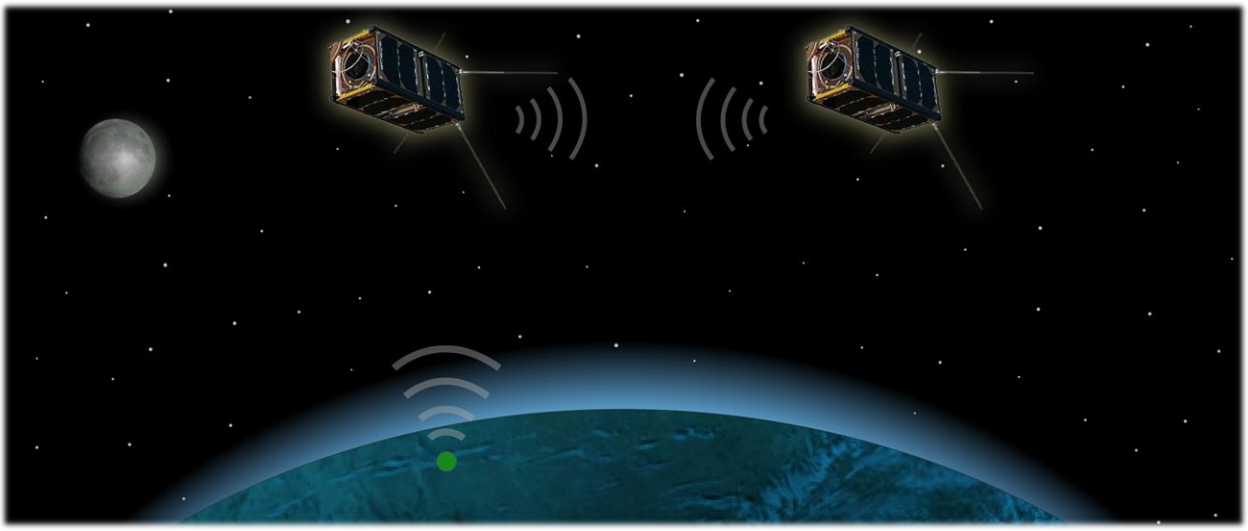


# SR2000 HSL, ISL and ASL Solutions
# NanoCom SR2000

## Sales Document

Description of three SR2000 based solutions offered by GomSpace

GomSpace A/S | Alfred Nobels Vej 21A 1. | DK-9220 Aalborg East | Denmark
gomspace.com | info@gomspace.com | T: +45 9635 6111

# 1 Table of Contents

# 2 GomSpace SDR Introduction

Currently, GomSpace's SDR Platform (Software Defined Radio) consists of the following product bundles:

- NanoMind Z7000 + NanoDock SDR
- NanoCom SDR
- SR2000

The NanoMind Z7000 + NanoDock SDR bundle is for customers who do not need the front-end transceiver module TR-600.

The NanoCom SDR includes a NanoCom TR-600 radio daughterboard:

- NanoDock SDR motherboard
- NanoMind Z7000 CPU daughterboard
- NanoCom TR-600 radio daughterboard

The three components are designed to be a modular CPU/FPGA and radio for small satellites. It is built around GomSpace's modular technology, allowing numerous configurations of modules to be implemented on a motherboard, saving significant volume and giving customers a high level of customization.

The SR2000 is based on the NanoCom SDR. The S-band radio firmware is built on top of the NanoCom SDR as closed source software. Together they form a **high speed S-band radio transceiver** – see Fig. 3.1.


**Fig. 3.1 SR2000 (SDR motherboard, Z7000, TR-600 + S-band firmware)**

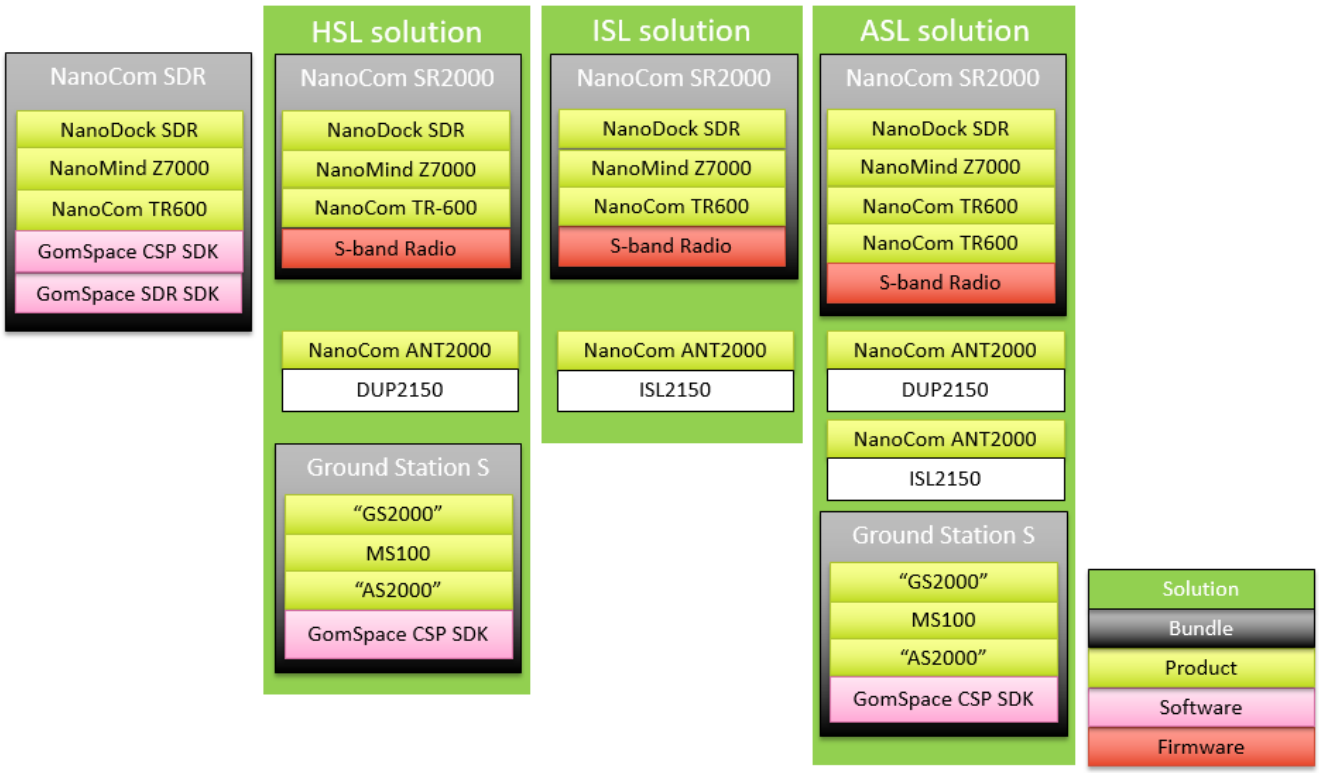
***Note**: The SR2000 differs from the NanoCom SDR. The SR2000 should be seen as an 'out of the box' solution (minimum configuration required) whereas the NanoCom SDR comes with a SDK, that allows you to develop a custom SDR solution.*

# 3 SR2000 solutions

Currently, GomSpace offers three SR2000 solutions based on the SDR Platform.

- **HSL** – High Speed Link for satellite to ground communication
- **ISL** – Inter Satellite Link for communication between satellites
- **ASL** – Advanced Space Link for both ground communication and inter satellite link

The three solutions in relation to the SDR Platform are shown below:




## 3.1 High Speed Link Solution

The HSL solution contains all elements in a **high-speed S-band ground link** consisting of the flexible high speed S-band radio transceiver (SR2000), satellite patch antenna (NanoCom ANT2000) and a complete ground station for communication with the satellite.

The complete solution is pictured in the High Speed Link solution sheet.

## 3.2 Inter Satellite Link Solution

The ISL solution allows for two satellites to communicate with each other by establishing a S-band link between the satellites. The solution consists of two S-band radios (NanoCom SR2000) and two S-band antennas (NanoCom ANT2000 ISL-2150).

The complete solution is pictured in the Inter Satellite Link solution sheet.

## 3.3 Advanced Space Link Solution

The ASL solution offers a complete satellite communication package that allows for both S-band ground-to-satellite and satellite-to-satellite communication.

The complete solution is pictured in the Advanced Space Link solution sheet.

# 4 Software for the SR2000 solutions

The supplied software depends on the specific solution. As the HSL and ASL solutions comes with a ground station, these include the GomSpace CSP SDK (formerly known as SDK for Linux) which is not included in the ISL solution. The SR2000 comes with pre-installed closed source radio firmware.

The tables below show the software packages and manuals that is delivered with the individual solutions:

**Software**

| | HSL | ISL | ASL |
|---|---|---|---|
| CSP Client | ✓ | ✓ | ✓ |
| GomSpace CSP SDK | ✓ | | ✓ |
| S-band Radio firmware (closed source) | ✓ | ✓ | ✓ |

**Manuals**

| | | | |
|---|---|---|---|
| GomSpace CSP SDK manual | ✓ | | ✓ |
| SR2000 manual | ✓ | ✓ | ✓ |
| GOSH manual | ✓ | ✓ | ✓ |

The GomSpace CSP SDK and the manuals are delivered on a USB stick.

***Note**: As the radio firmware is pre-installed it is not included on the USB stick*.

## 4.1 GomSpace CSP SDK

The GomSpace CSP SDK includes a set of advanced and feature rich modules that enable fast and efficient development of Linux applications for either Ground Station or for Linux based CubeSat computers. It can also be used as an example of how to develop GomSpace compatible applications for Linux.

The GomSpace CSP SDK is delivered as a standard archived file (tarball) and easily installed via an executable build script – see the manual.

The following modules are included:

- **libcsp** - Network library
- **libftp** - File transfer
- **libgosh** - Shell interface
- **libparam** - Parameter system
- **liblog** - Logging systems
- **libutil** - Various utilities

**libcsp**

The CubeSat Space Protocol (CSP) is designed to ease communication between distributed embedded systems in smaller networks, such as Cubesats. The design follows the TCP/IP model and includes a transport protocol, a routing protocol and several MAC-layer interfaces. The core of libcsp includes a router, a socket buffer pool and a connection oriented socket API.

The idea is to give sub-system developers of cubesats the same features of a TCP/IP stack, but without adding the huge overhead of the IP header.

**libftp**

The GomSpace FTP Library implements a generic File Transfer Protocol (FTP) running over CSP. FTP allows remote transfers and manipulation of files to and from the NanoMind.

The FTP can be accessed through the GomSpace Shell.

**libgosh**

The GomSpace Shell (GOSH) provides a simple but extensive debug interface to the NanoMind computer.

The console provides a text-interface to a given input/output stream such as a serial port. This provides a mean of typing a command in human readable text format, and passing this command to the command parser.

**libparam**

The GomSpace Parameter System allows for easy communication with GomSpace satellite subsystems.

The parameter system is a generic system that translates a memory area into network messages and vice versa. It has two basic operations: Read or Write.

**liblog**

A library used for logging.

**libutil**

The GomSpace Util Library contains several useful utilities:

- Time and clock functions
- Byte order handling
- Print and print formatting functions
- CRC and checksum functions
- Delay functions
- Compression & decompression functions (LZO)
- Hash, List, Linked List and Array operation
- Linux specific functions

Each module has been thoroughly described in the GomSpace CSP SDK manual. The manual is included in the HSL and ASL solutions.

## 4.2 SR2000 Radio firmware

The SR2000 radio firmware is built on top of the NanoCom SDR firmware using GomSpace's SDR SDK. It should be noted though, that the SR2000 radio firmware is closed source and therefore isn't modifiable.

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***Note**: The GomSpace SDR SDK is not part of the software package shipped with the SR2000 solutions. Customers who want to develop their own custom SDR solution should buy a NanoCom SDR instead – see NanoCom SDR flyer at www.gomspace.com.*

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The radio firmware included in the NanoCom SR2000 allows communication even under poor link conditions by using error correction algorithms (FEC and Reed-Solomon).

Highlighted features:

- High-speed QPSK transceiver for point-to-point S-band communications
- Frequency and time division duplex support
- Symbol rate 500 kBd to 2 MBd
- Layer-3 bandwidth
  - TDD: upto 500 kbits/s
  - FDD: upto 1.25 Mbits/s
- S-band operation (1980-2290 MHz)
- Partial CCSDS Proximity-1 Compliance, Category A
- SFCG recommendation 21-4R4 spectral mask compliance
- Flexible communication interfaces
  - RS422 interface for payload data transfer (either TCP/IP via PPP or CSP)
  - CAN interface for configuration and CSP datagram transfer
- Automatic frequency compensation
- Filtered QPSK modulation
- Concatenated coding: convolutional code plus Reed-Solomon
- High sensitivity: PER less than 1e-4 at Eb/No = 5 dB
- RF output frequency configurable in 1 Hz steps
- Adjustable output power
- Fully configurable in-orbit
- Compatible with GomSpace ANT2000 series antennas
- Configurable over-temperature protection
- UART/GOSH console interface for easy use in lab setup
- Dual-modem support allows two simultaneous RF links

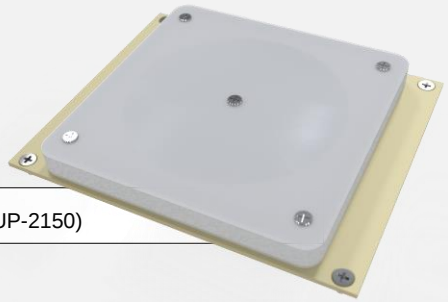
## 4.3 CSP Client

The CSP Client contains sample code of how to communicate with GomSpace's products – including the SR2000 – using the libparam and libcsp libraries described in chapter 4.1.

# High Speed Link solution

**Space**


- NanoDock SDR
- NanoMind Z7000
- NanoCom TR-600
- S-Band radio firmware



- NanoCom ANT2000 (DUP-2150)

**Ground**

- S-Band Antenna
- NanoCom GS2000
- MS100
- GS CSP SDK

**Features**

*High-speed QPSK transceiver for point-to-point S-band communication*

**Symbol rate**
500-2000 kBd

**Layer-3 UDP throughput** (max)
1250 kbit/s (FDD)
500 kbit/s (TDD)

**Communication Interfaces**
RS422 for payload data transfer
CAN

**S-band operation**
1980-2290 MHz

**Orbit Example**
LEO – 500 km

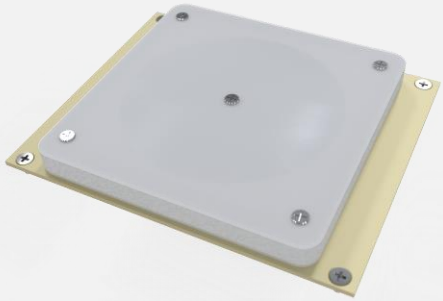
# Inter Satellite Link solution (2 satellites)

Space

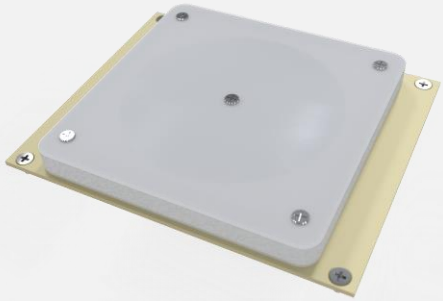
- 1 x NanoDock SDR
- 1 x NanoMind Z7000
- 1 x NanoCom TR-600
- S-Band radio firmware


- 1 x NanoDock SDR
- 1 x NanoMind Z7000
- 1 x NanoCom TR-600
- S-Band radio firmware


- 1 x NanoCom ANT2000 (ISL-2150)



- 1 x NanoCom ANT2000 (ISL-2150)



Features

*High-speed QPSK transceiver for point-to-point S-band communication*

**Symbol rate**
500-2000 kBd

**Layer-3 UDP throughput** (max)
1250 kbit/s (FDD)
500 kbit/s (TDD)

**Communication Interfaces**
RS422 for payload data transfer
CAN

**S-band operation**
1980-2290 MHz

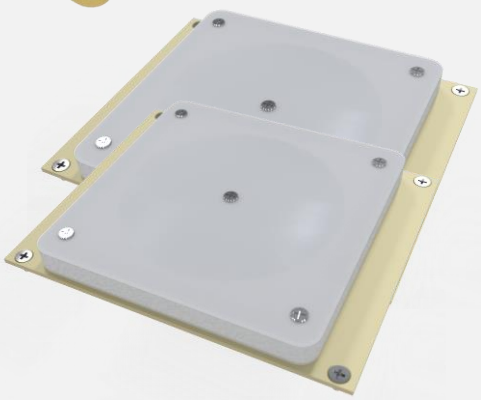
**Orbit Example**
LEO – 500 km

# Advanced Space Link solution

**Space**

- NanoDock SDR
- NanoMind Z7000
- 2 x NanoCom TR-600
- S-Band radio firmware


- 2 x NanoCom ANT2000
  (DUP-2150 and ISL-2150)



**Ground**

- S-Band Antenna
- NanoCom GS2000
- MS100
- GS CSP SDK

**Features**

*High-speed QPSK transceiver for point-to-point S-band communication*

**Symbol rate**
500-2000 kBd

**Layer-3 UDP throughput** (max)
1250 kbit/s (FDD)
500 kbit/s (TDD)

**Communication Interfaces**
RS422 for payload data transfer
CAN

**S-band operation**
1980-2290 MHz

**Orbit Example**
LEO – 500 km

# 5 Changelog

| Date | Revision | Author | Description |
|---|---|---|---|
| **10-10-2017** | 1.0 | JESM | First release |
| **06-02-2019** | 1.1 | KLK | Corrected typing error in chapter 4.2 |