E-LINK, HIGH SPEED TRANSPARENT ETHERNET TM SYSTEM AND FUTURE DEVELOPMENT

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ABSTRACT

This paper describes the E-Link system in short form, and its application and a possibly future development of E-link system.

During the BEXUS flight in November 2002 a prototype of ELINK was tested at Esrange. This was the first test to use transparent Ethernet instead of conventional interface in a payload for stratospheric balloon platform. This was the reason why Esrange in 2003 launched a new project called E-LINK, which stands for “Esrange Data Link System”.

E-Link is now operational system at Esrange and has been used on several payloads with very good result, customers are amazed when they see simple way of distributing data from payload to ground and to scientist.

The system is built in different units, this gives us a possibility to allocate units in different places on the gondola, example: RF unit close to the antenna and main unit with battery unit in the centre of the gondola, because of the weight.

1. SYSTEM OVERVIEW

The complete ELINK system consists of three different subsystems:

1.1 Airborne system

Payload system (Main unit + RF unit + Battery unit, see Fig 1), with two electrical transparent Ethernet user interfaces, three RS 232/RS422 serial user interfaces and two relay connections isolated from ground.

IFU (Interface Unit), is a unit that extends the functionality to support more interfaces, one synchronous PCM user interface and 8 user interfaces can be configured as Ethernet or RS232/RS422 serial interface.

Various combinations of the 8 user interfaces can be configured, as an example: 4 RS 422 serial interfaces and 2 RS 232 serial interfaces and 2 Ethernet interfaces and one fixed Ethernet user connection is always available.

PDU (Power Distribution Unit), this unit is used when E-Link is powered from external power system, and can be configured either running on external power only or as a combination of external power and E-Link batteries as back-up.

Battery unit, these units contain four 28 VDC 13 Ah battery packs. Total available amount of power is 28 VDC 52 Ah. These units can be stacked together to increase flight hours, without using external power.

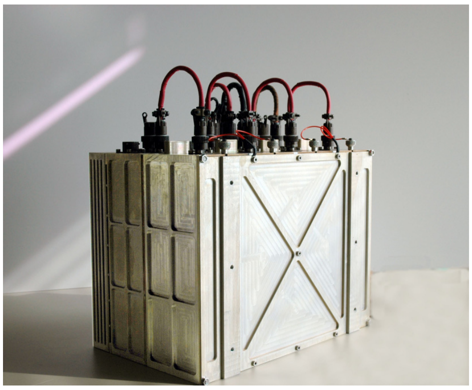

Figure 1 E-Link Airborne system

1.2 Ground system

One stationary ground system for E-Link is located at ESRANGE Space Center in Kiruna at KEOPS hill, which is a favourable position since it offers full coverage in all directions due to a low horizon profile. The station is remote controlled from Esrange TM station and the E-link data distribution to user is done over fibre optics and standard Ethernet network.

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1.3 Mobile ground system

One mobile station (Fig 2 and 3), a flexible ground station that consists of a 1.8 meters dish and a pedestal with antenna and an AZ/EL rotor. Control rack contains main control PC and antenna pointing system computer with ACU unit. LAN to LAN unit has recently been implemented to the system and these unit's enable distribution of data in real time over secure VPN.

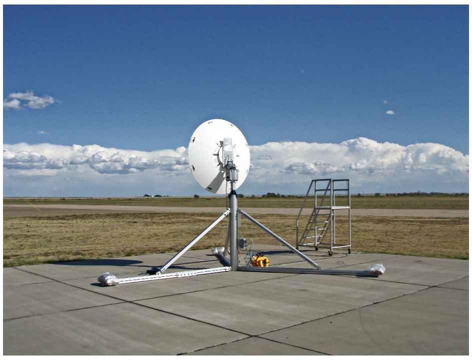

Figure 2, E-Link mobile outdoor units

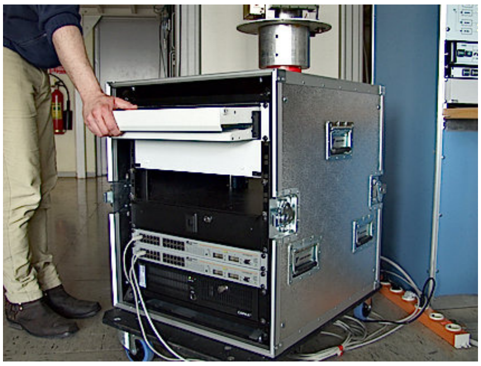

Figure 3, E-Link mobile indoor units

2. TECHNICAL DESCRIPTION

2.1 General

User interface	Ethernet 10/100 Base-T
Operating frequency	S-Band (nom. 2487 MHz)
Modulation	Spread spectrum
Channel bandwidth	± 11 MHz
Data bandwidth	2 Mbps duplex nominal
Max output power	10 Watt
Maximum range at LOS	500 km at 30 km altitude
Antenna on ground	1.8 meter parabolic dish
Airborne antenna	Vertical polarized Omni.
Airborne operational time	> 11 hours
Relay connections	max 40 V 500 mA
Airborne size	380x400x250 mm

2.2 Airborne units

RF Unit: Microwave Modem, High power amplifier.
Main Unit: House Keeping, GPS, User interface.
Interface Unit: 8 RS422 or 8 RS232 or 8 NW, 1 PCM interface.
Power Unit: Power distribution unit for external power
Power Probe: Power and antenna measurement unit
Battery Unit: 2 – 4 Batteries.

2.3 Ground stations hardware

The computers in the ground station are standard server approved PC's, and running under Windows XP professional.

The ground station antenna is controlled by a computer, which automatically points the dish towards the payload by using GPS both on ground and in the payload. Other sources for position data can be used.

3. FLIGHT HISTORY

Bellow a list of some of E-Links flight from 2004 until 2009.

3.1 Balloon flight in Feb 2004 (Prototype version)

Balloon distance was up to 290 km (impact in north part of Finland). The available data link speed was 2 Mbps in both directions.

3.2 Balloon flight in Dec 2004

Balloon distance was up to 200 km. Available data link speed was 1.8 Mbps this time.

3.4 Balloon flight in Jan 2005

Balloon distance was up to 130 km. Available data link speed was more than 2 Mbps this time.

3.5 Balloon flights in June and August 2005

Balloon distance was up to 100 km with web-camera data transfer with good results on both flights.

3.6 Balloon flight in Mars 2005 (Validation flight)

Balloon distance was up to 400 km in a south direction from Esrange. This was a validation flight for the whole system (data speed during flight at different ground range, see table 1).

Object	100 km	200 km	300 km	375 km
Down-link	2,7	2,0	1,7	1,2
Up-link	2,0	1,6	1,4	1,2

Table 1. Data speed during validation flight 2005

3.6 Bexus

Student balloon project, E-Link has been used in different configuration during the Bexus project 2002 – 2008.

3.7 Sunrise

Solar telescope from Max Planck, Prime high speed telemetry system, first flight from Fort Sumner in USA (test flight), second time when Sunrise made a thermal test from Esrange and the final flight from Esrange 2009.

3.8 Mipas/B-telis 2009

Two payloads in one gondola, here we also used the serial interface and the two relay interface to give Mipas a reset signal and for B-Telis main power on and off.

3.9 Twin 2009

Interface unit and E-Link, on this gondola we had to separate Interface unit from E-link, one unit was allocated on top of the gondola and E-Link in the flight train, one network cable was running from E-Link to interface unit.

And several technical flights from Esrange during 2004 – 2009.

4. POSSIBLE FUTURE DEVELOPMENT

Some ideas of developing other system units to E-Link have been discussed, below a list of the most important ideas.

4.1 Satellite Ethernet modem unit

A satellite modem with Ethernet connectivity and also remain the transparent network connection but over satellite, goal is to achieve 100 – 500 Kbit/s over standard satellite modem with a special software and hardware develop at Esrange.

4.2 New microwave modem

Higher data bandwidth, other frequencies (P, low S, high S and C-band), can also give us bandwidth sharing over two different frequencies and redundancy.

4.3 Analog and Digital interface unit

Sensor interface based on ModBus standard, easy to build and write software due to this is an industrial standard. For use when students what to connect their sensors to measure them in real time, it will also give easy way to configure different interfaces.

4.4 Timeserver unit

Dedicated time server unit, to give GPS time on Ethernet onboard the gondola. This unit will act as an real time server.

4.5 Remote real time data sharing

This has already been tested during Sunrise 2009 from Esrange, were the mobile station was allocated at Alomar in Norway. Mobile and Fixt ground stations network was connected over a transparent LAN to LAN connection through a VPN tunnel. The result gives the scientist seamless real time data from two different ground stations.

5. CONCLUSION

The ELINK system is a flexible system for many different types of ballooning missions
With the attractive transparent Ethernet interface will help the customer to simplify telemetry and tele-command communication with the airborne equipment. The customer will easier understand the standardised functionality and simplify the development of airborne and ground equipment. The higher bit-rate gives new possibilities with real-time data during flight. Other advantages are standardised and simplified data distribution on ground.