OUFTI - 1

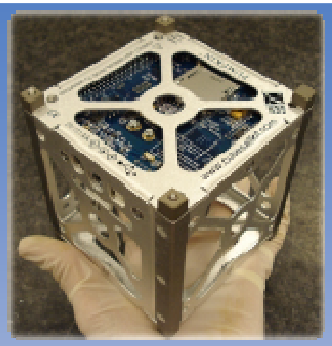
The first student satellite of Belgium

Jonathan PISANE

University of Liège

OUFTI-1 IN A NUTSHELL

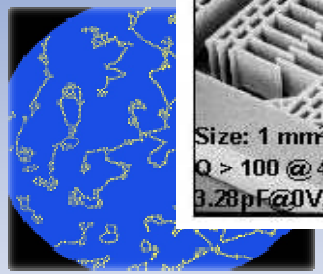
OUFTI-1
CubeSat

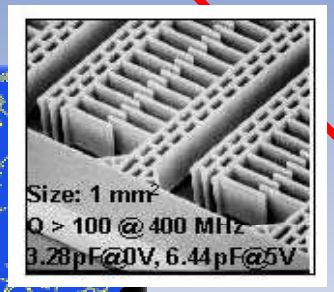


Ground station

D-STAR
amateur-radio
(ham)
communications

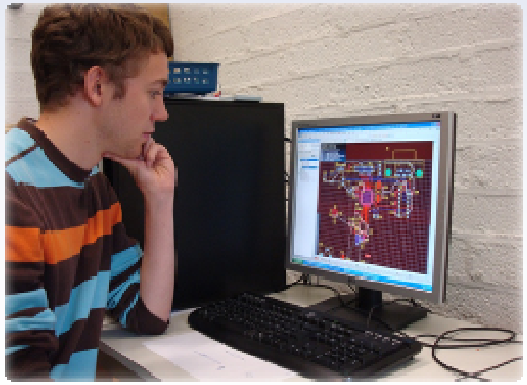
Scientific
experiments
in space





Educational project,
hands-on experience

Ham-radio
operator

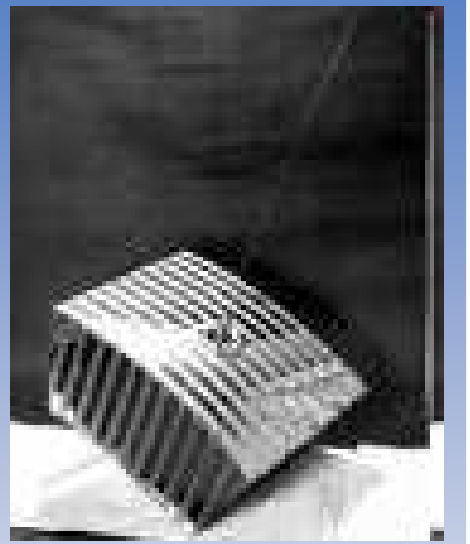


Ham-radio
operator

Université
de Liège

WHY HAM-RADIO FREQUENCY BANDS?

- Amateur-radio has a long history of satcom (since OSCAR-1 in 1961)



- Freely, quickly accessible resource to licensed users

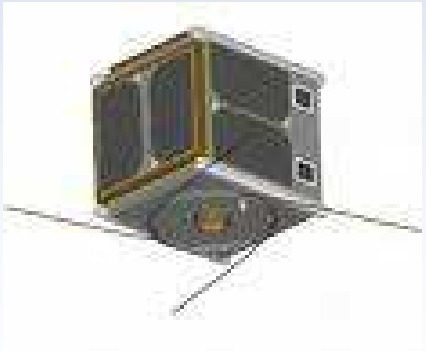
- Support from ham-radio operators worldwide, with …

- ..., in exchange, access to D-STAR satellite

FAIL-SAFE STRATEGY

- **Ground-based D-STAR repeater (Ground segment)**
  - **Hands-on experience with D-STAR**
  - **Independently useful to ham communit**
  - **Linked to future ground station**

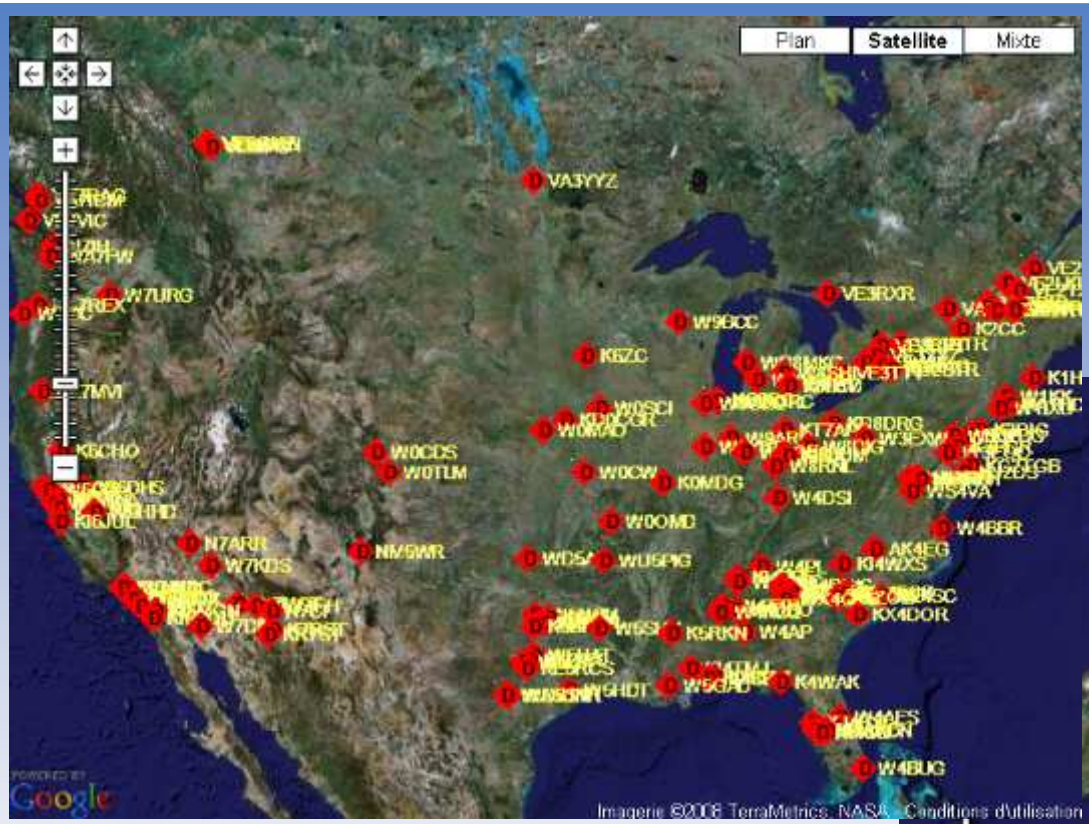
- **CubeSat and ground station (Space segment)**

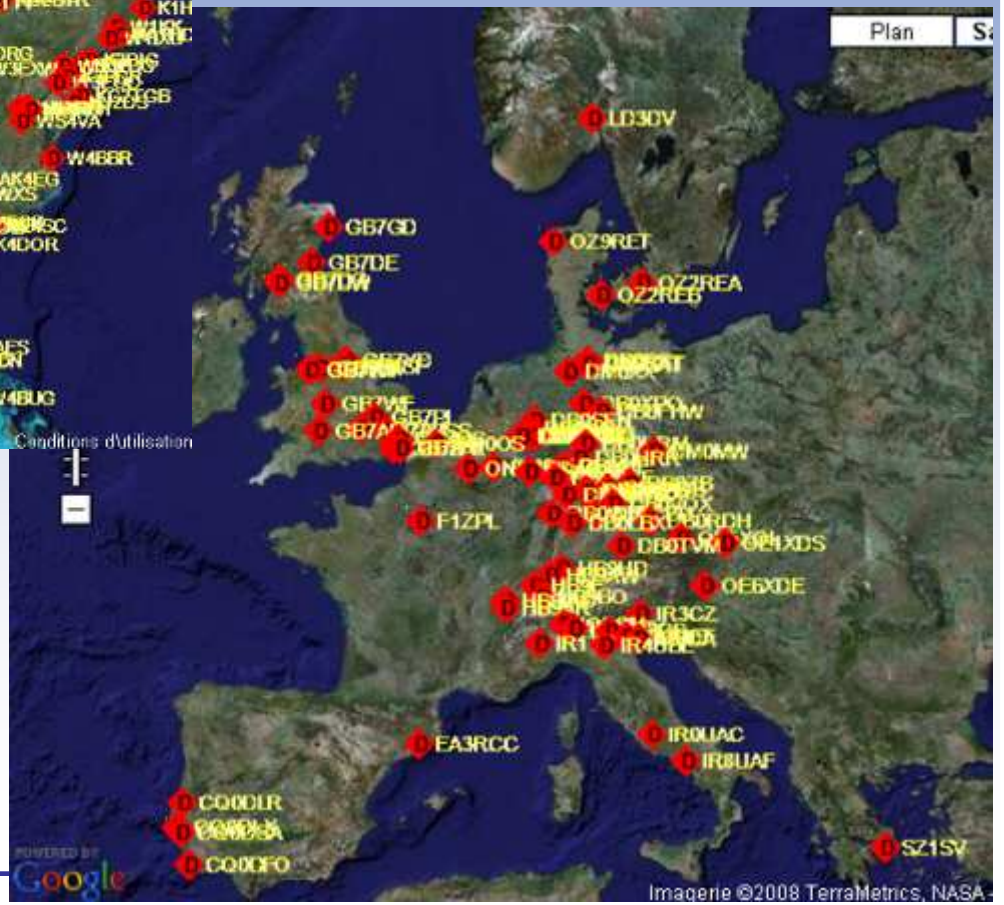


WHY D-STAR?

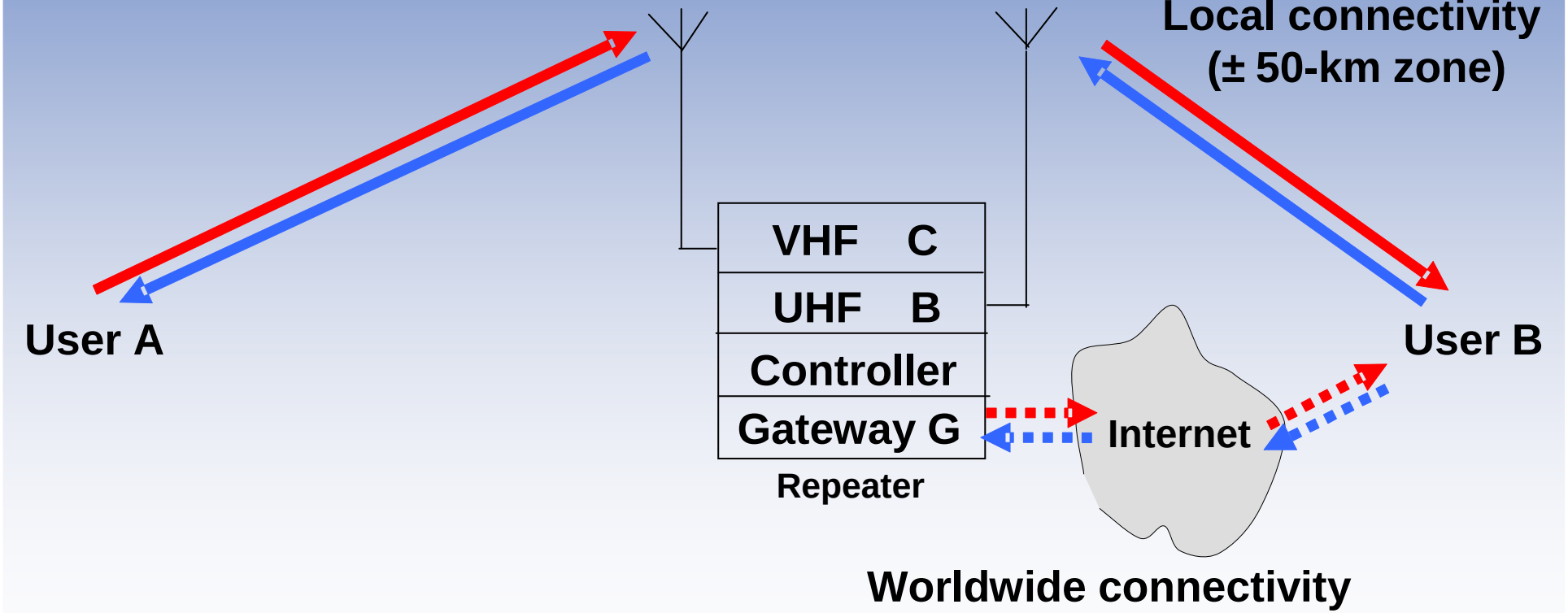
- Digital Smart Technologies for Amateur-Radio
- Latest digital radiocommunication protocol (≠FM)
- Simultaneous voice & data (files, GPS…) transmission (≠ AX.25)
- Complete routing capability, including roaming
- 3 frequencies and 2 data rates
  - 144 MHz (2 m, VHF), 4.8 kbit/sec
  - 435 MHz (70 cm, UHF), 4.8 kbit/sec
  - 1.2 GHz (23 cm, SHF), 4.8 kbit/sec or 128kbit/sec
- “Cross-band” capability

D-STAR: A WORLDWIDE NETWORK

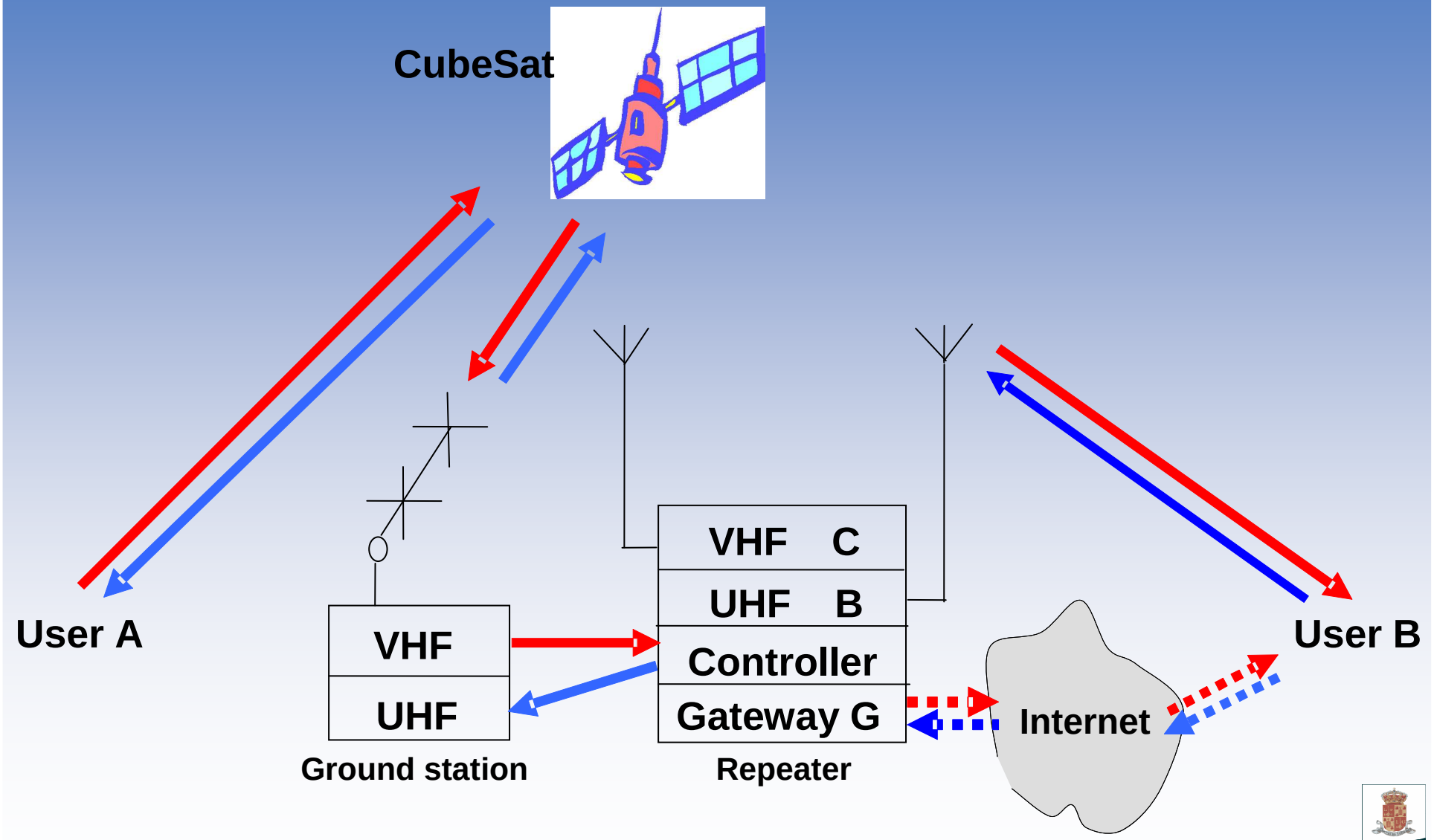




BASELINE D-STAR REPEATER



FROM TERRESTRIAL TO SPACE D-STAR



GOALS OF MASTER'S THESIS

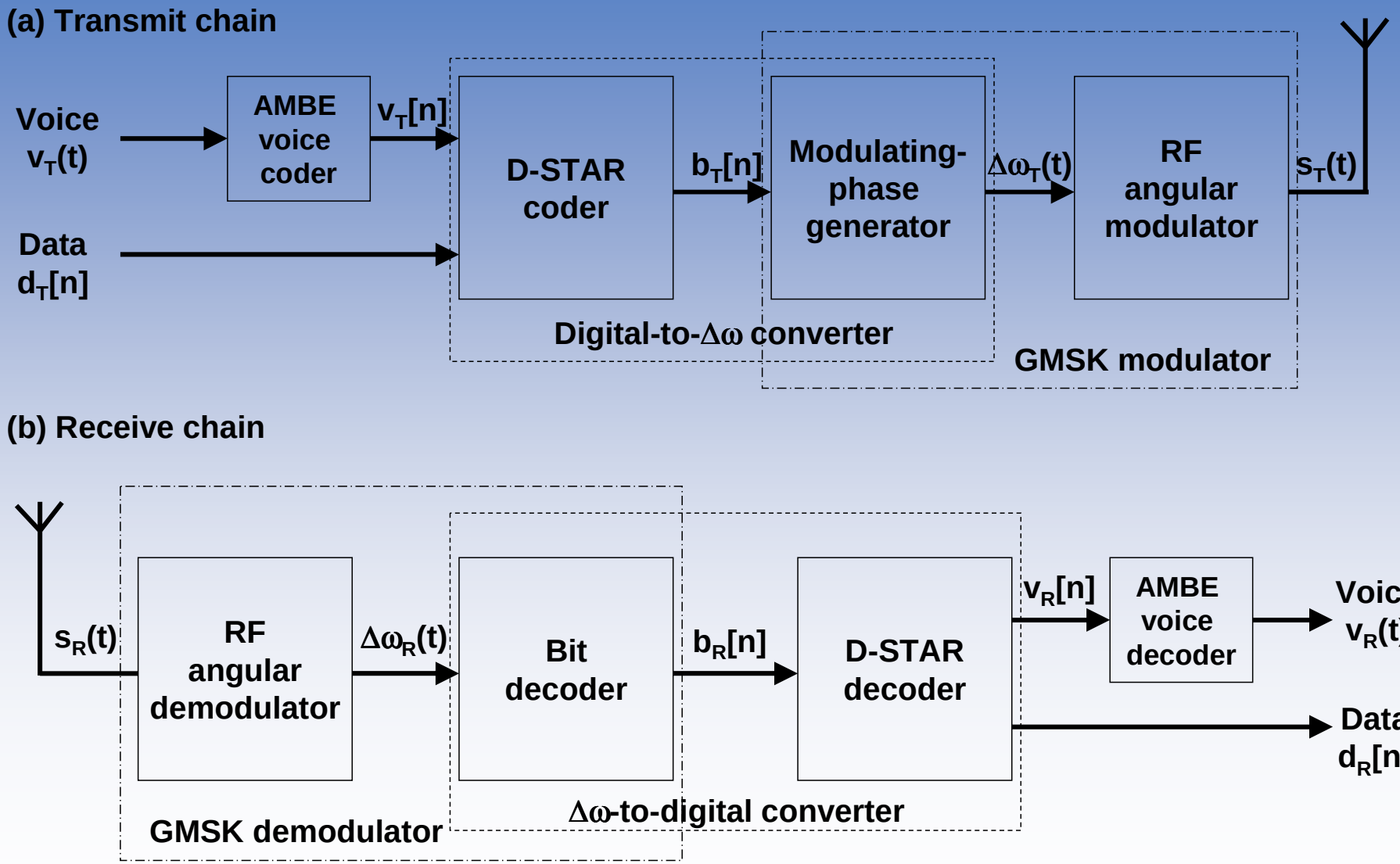
- **High-level definition of space and ground segments**
- **Get full mastery of D-STAR protocol**
- **Build testbed to produce and decode D-STAR signals**

ULG REPEATER IN PICTURES (1)

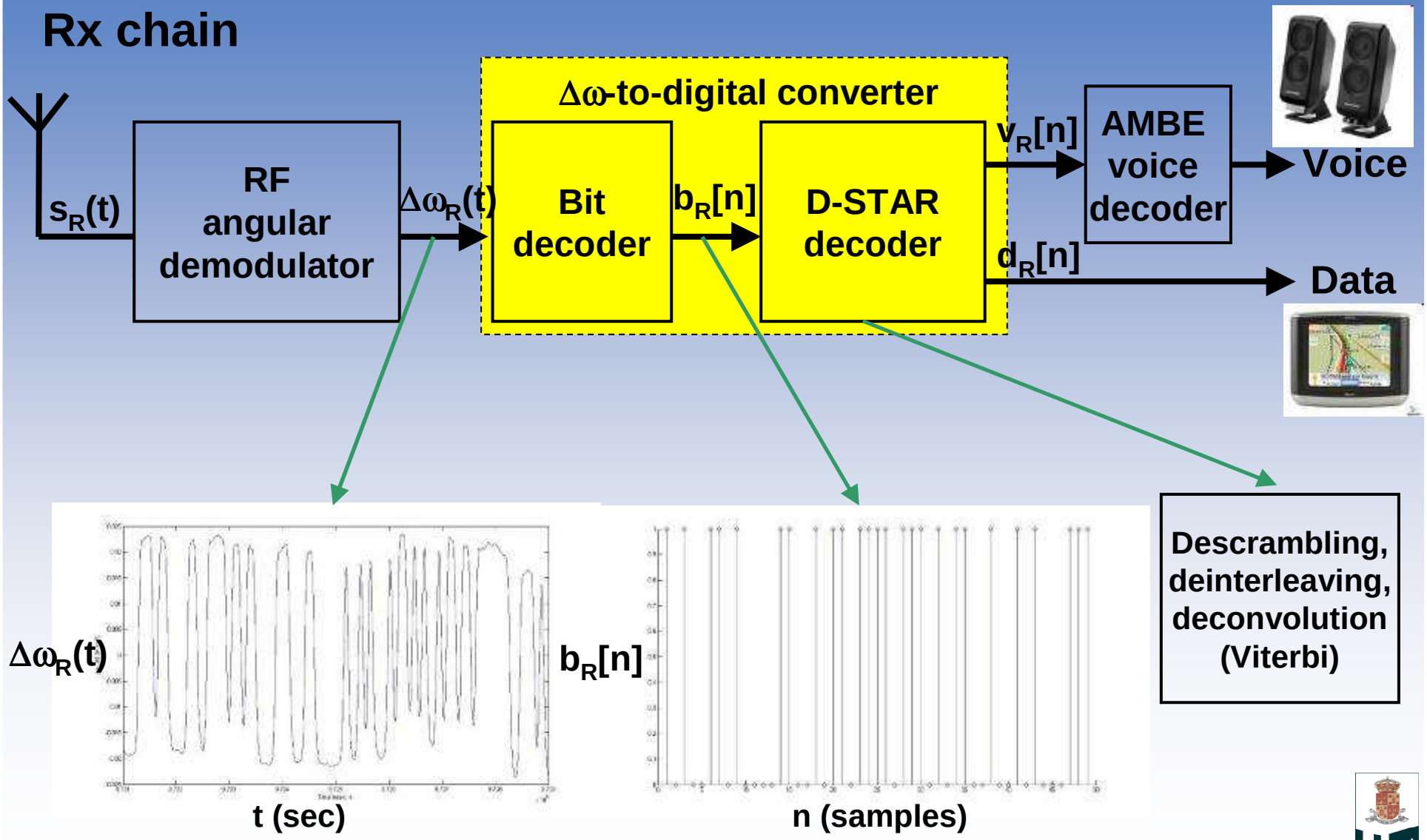
ULG REPEATER IN PICTURES (2)

ULG REPEATER LOCATION

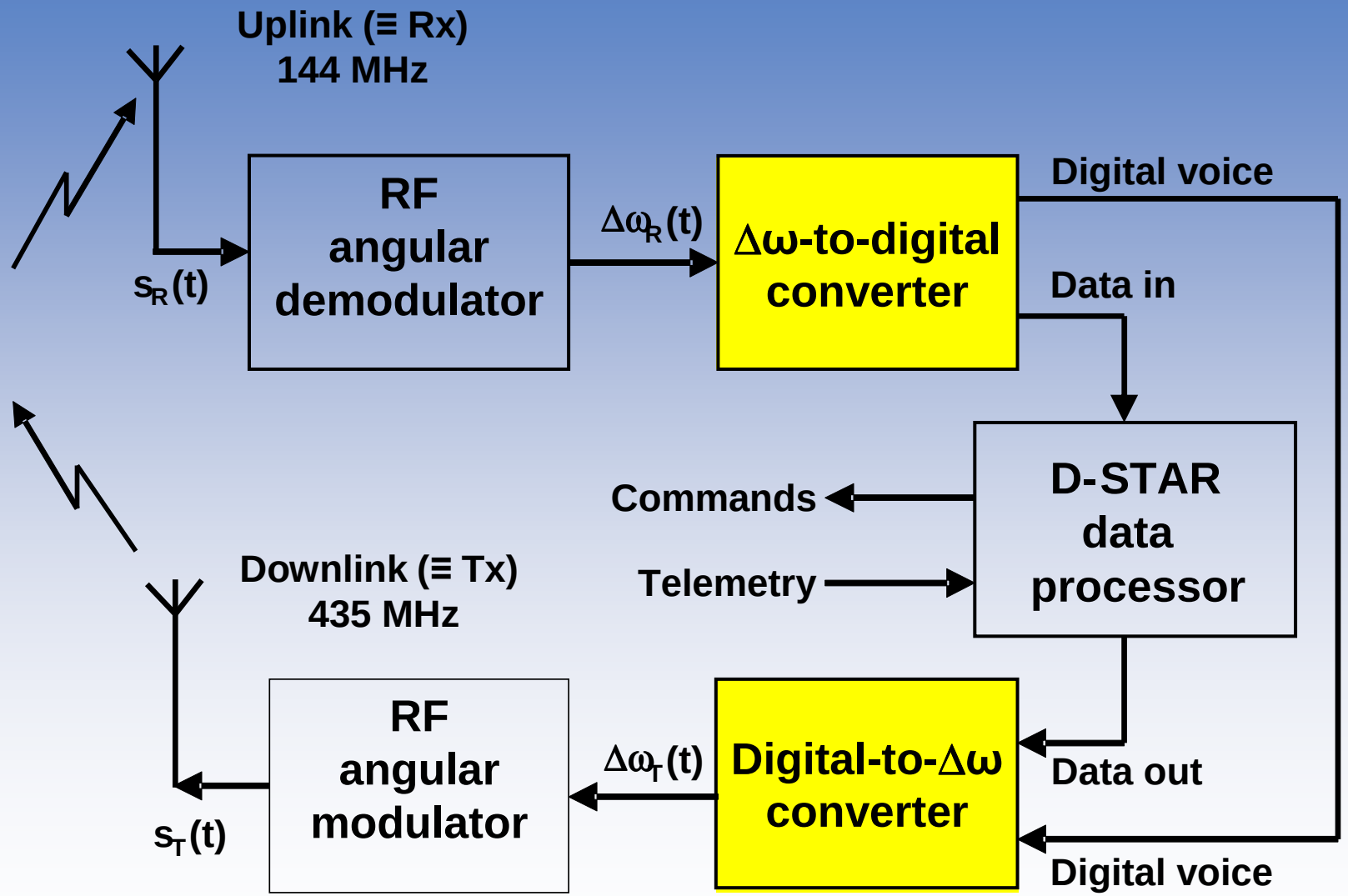
DETECTIVE WORK …



… SUPPORTED BY EXPERIMENTS …



… LEADS TO A COM ARCHITECTURE



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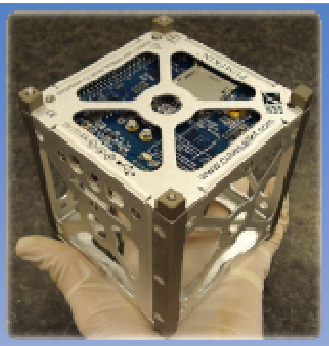
DOWNLINK LINK BUDGET

OUFTI-1 CubeSat



P_T = 0.5 W = - 3 dB(W)

G_T = 0 dB

L_T = 1.1 dB

4,110 km

L_S = 157.5 dB

T_s = 300 ℀

Ham-radio operator

G_R = 17.5 dB

L_R = 1 dB

P_R = -138.6 dB

E_b = - 175.5 dB

N_0 = - 203.8 dB

E_b/N_0 = 19.9 dB

Minimum E_b/N_0 = 10.6 dB (for BER = 10^(-5))

⇨ Margin of about 9 dB

ESA PROPOSAL

- **Project defended at ESA workshop on educational CubeSats (Jan. 2008)**
- **OUFTI-1 selected to be on VEGA Maiden Flight (June 2008)**
- **…**
- **World's first D-STAR satellite**
- **Belgium's first student satellite**

GEARING UP FOR THE BIG CHALLENGE

13 students (ULg + technical schools),
2 PhD students, 6 academics, 7 space companies

THE PIECES OF THE PUZZLE

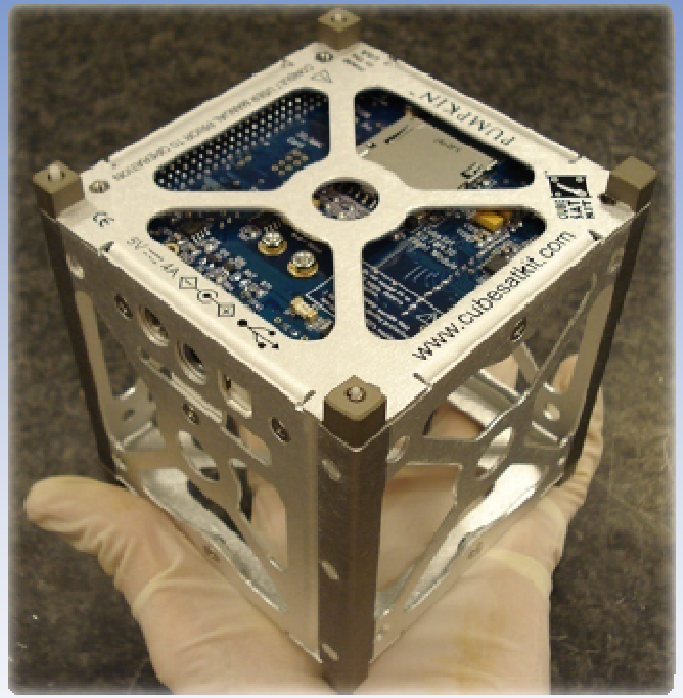
Electrical

Mission

Mechanical

Electrical power system

Structure



Emergency beacon

Thermal system

Radio-communications

Attitude control

Commands & telemetry

Radiations

1 Kg, l, W

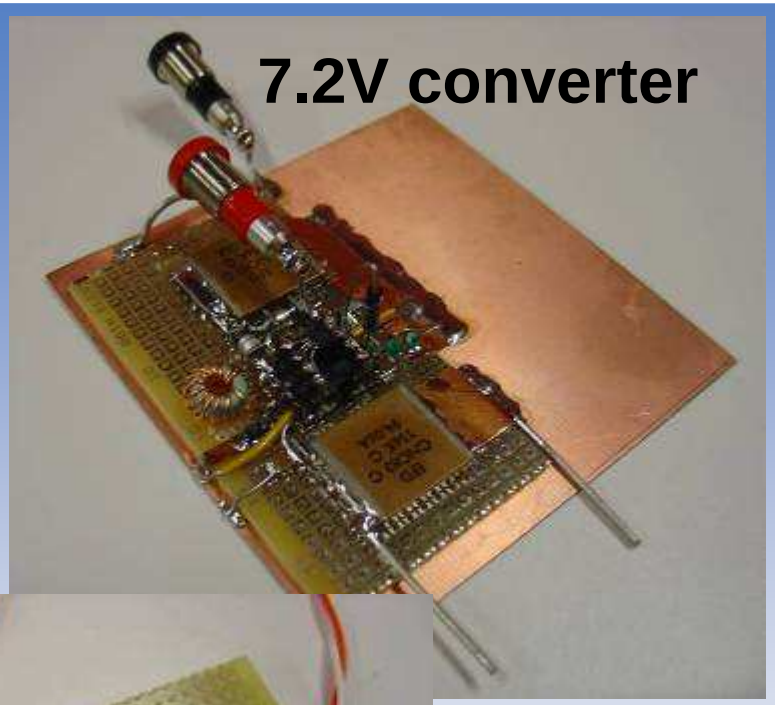
On-board computer

Antenna deployment

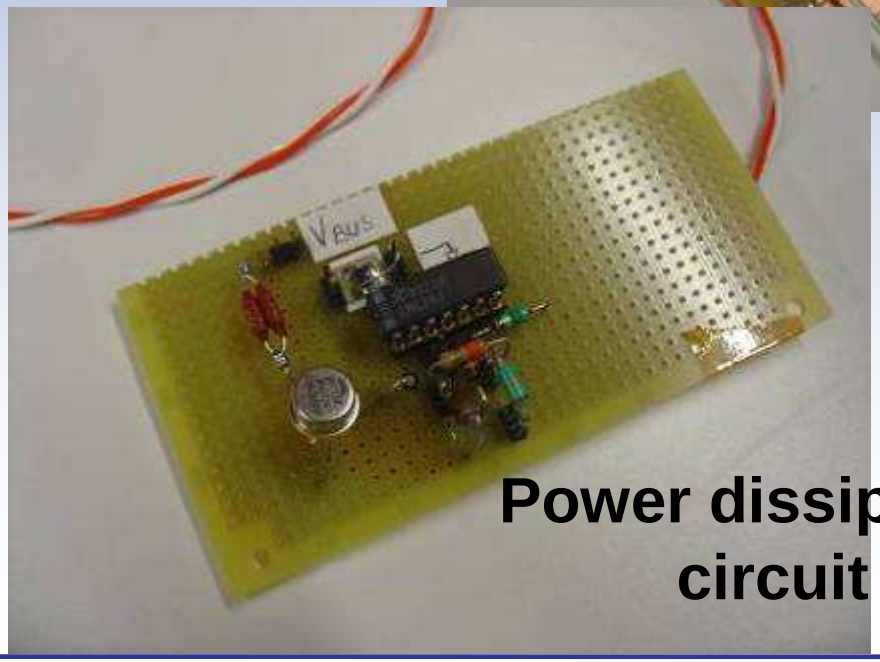
Ground segment

EXAMPLE ELECTRONIC CIRCUITS

D-STAR transmitter

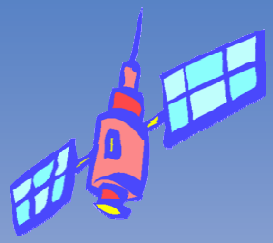


7.2V converter



Power dissipation circuit

OVERALL OUFTI-1 SYSTEM



435 MHz

145 MHz

145 MHz

435 MHz

Tracking system

VHF (2m)

UHF (70cm)

D-STAR repeater

VHF (2m)

UHF (70cm)

Ham operator

Controller

Gateway

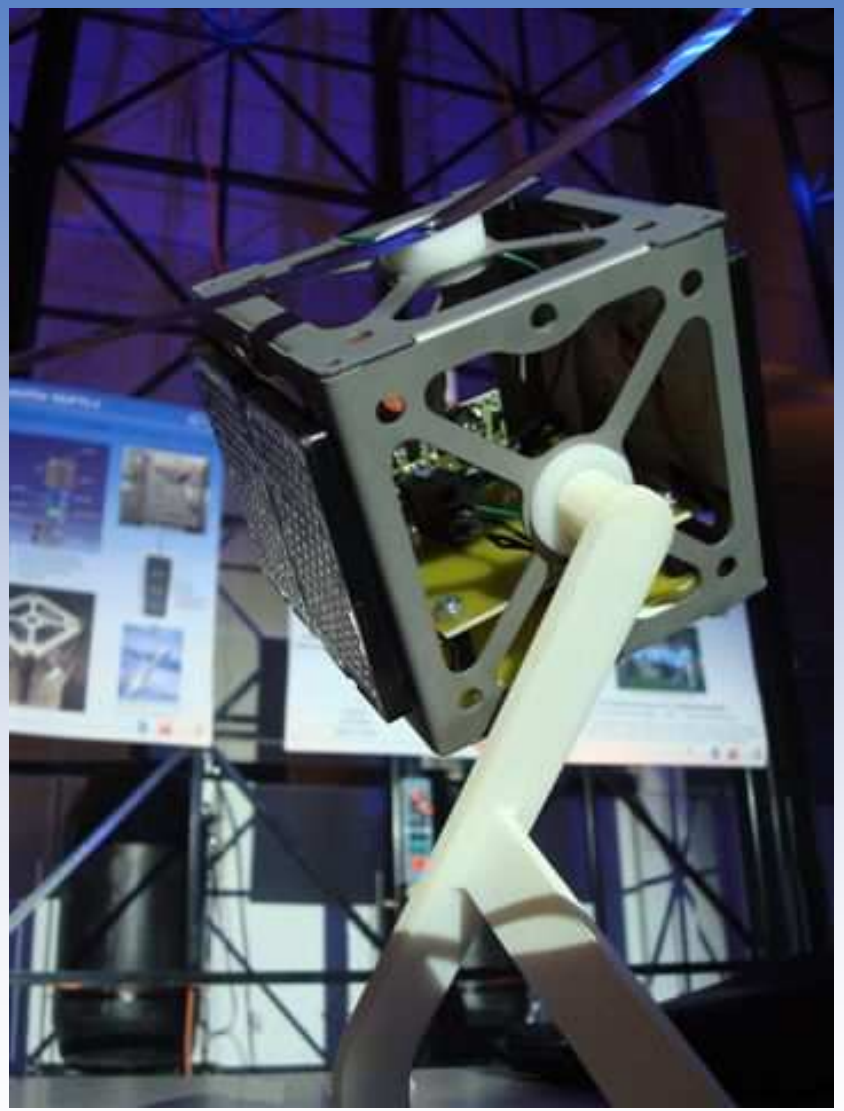
Control station

Internet

Other repeaters

STRONG EDUCATIONAL FLAVOR

“L’espace, j’en rêve”
Euro Space Center
1 Oct 2008



ACCOMPLISHMENTS

- One of the two CubeSat pioneer students at ULg
- Full mastery of D-STAR protocol
- First D-STAR repeater in Benelux
- Won ESA competition for spot aboard VEGA
- Award for Master's thesis
- OUFTI-1 project co-manager
- Supervisory role in detailed design and implementation of ground and space segments
- Several presentations, interviews, and press articles

INTERNATIONAL VISIBILITY!

ウェブリブログトップ/ログイン　[新規登録キャンペーン実施中]　トップ　プロフィール　フレンドリスト　サークルリスト

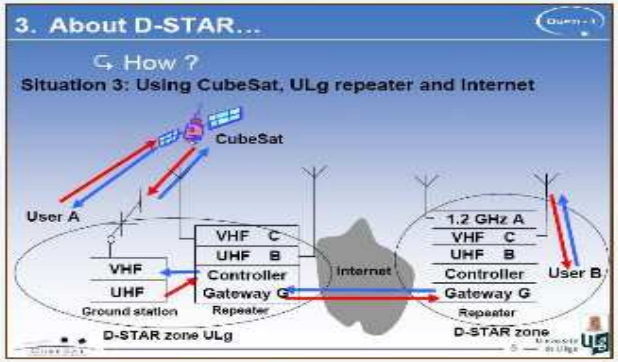
D-STAR技術情報

「CubeSatのOUFTI-1でD-STARプロトコルを使用」について

RSS help

<< 作成日時：2008/06/08 23:05 >>

トラックバック 0 / コメント 0



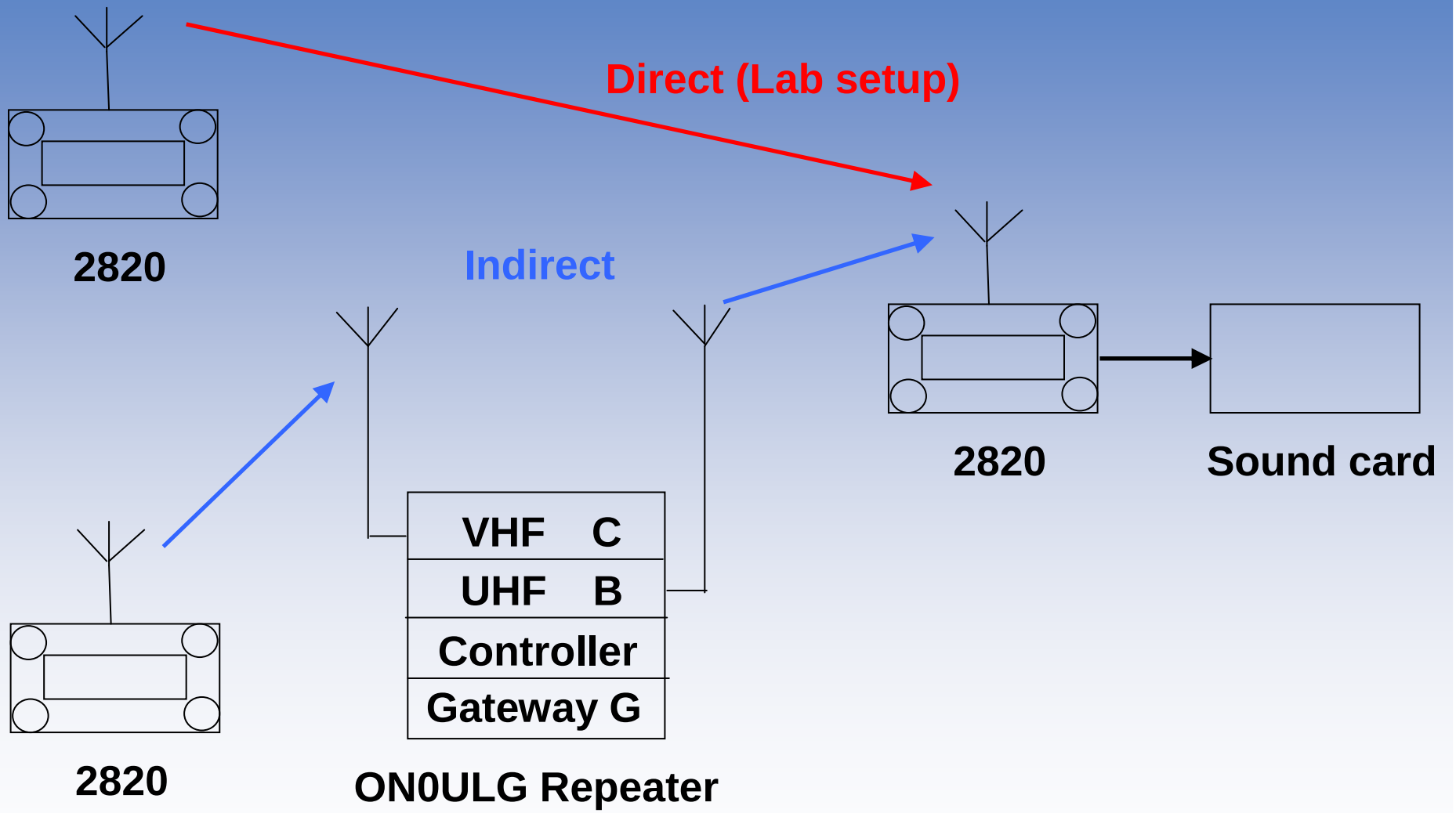
「CubeSatのOUFTI-1でD-STARプロトコルを使用」について
詳細が下記URLのpdfファイルに出ています。（上記図は、下記URLの8ページ目です。）

http://atl.calpoly.edu/~bklofas/Presentations/DevelopersWorkshop2008/session1/6-Oufti1-Amandine_Denis.pdf

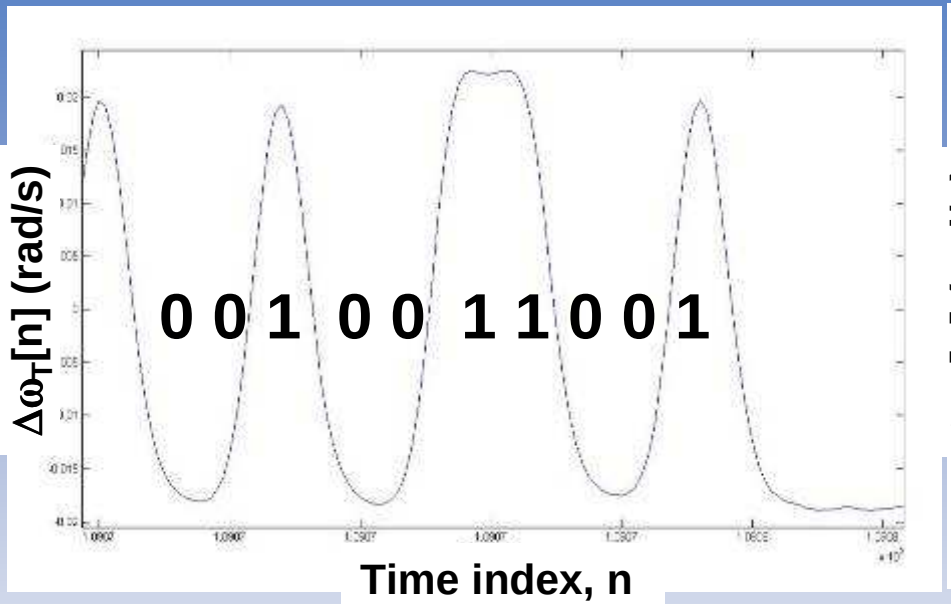
アップリンクとダウンリンクの周波数が分かりませんので日本上空を飛ぶときに交信できるかどうかは不明ですが、使用できれば広範囲な交信が出来そうです。

BACKUP SLIDES

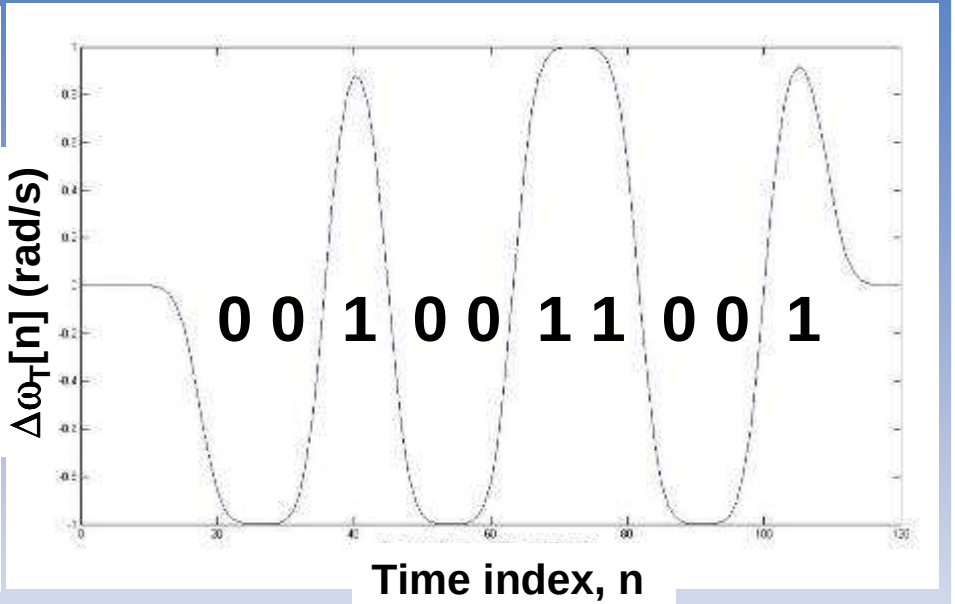
MS THESIS EXPERIMENTAL SETUP



EXAMPLES OF GMSK SIGNALS



Real signal

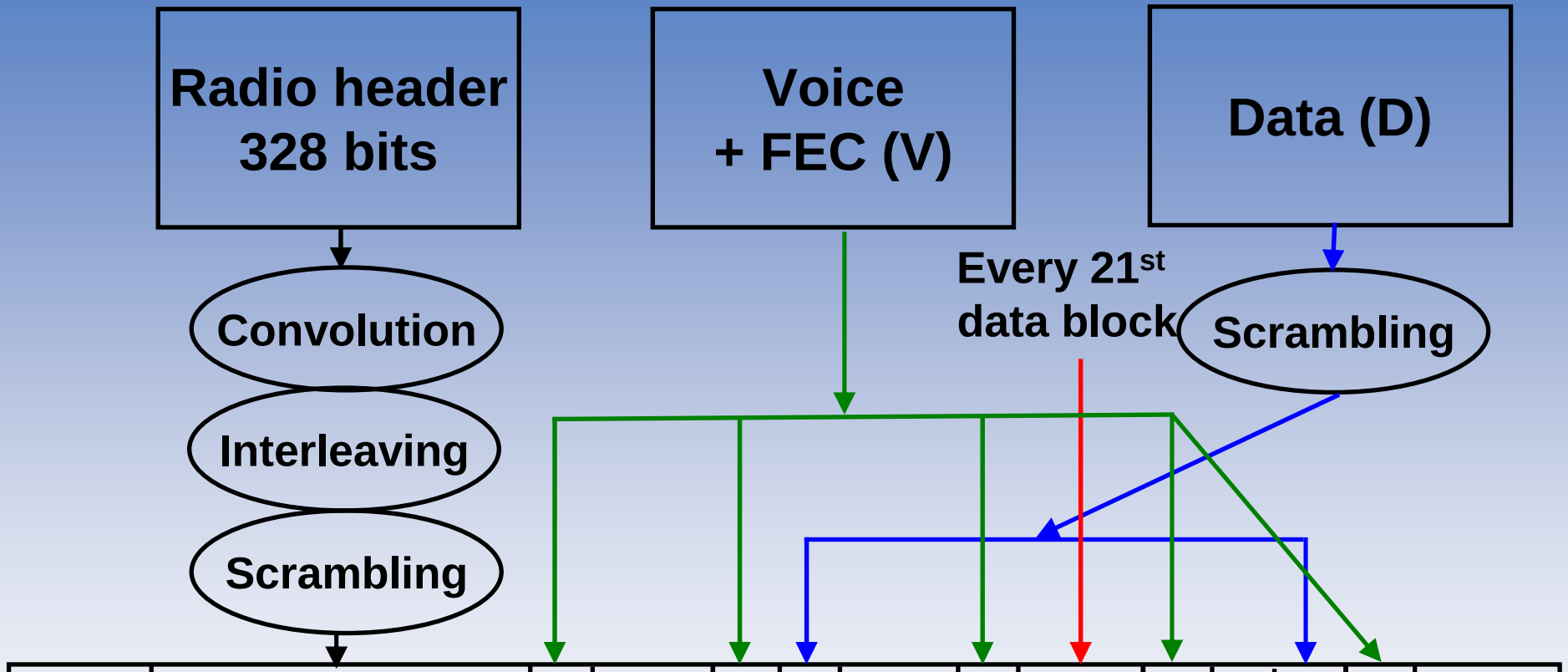


Synthetic signal

$$\Delta\omega_T(t) = \sum c_{T,\sigma,I}(\tau_i)$$

$$c_{T,\sigma,I}(\tau_i) = Q[(\tau_i - T/2)/\sigma] - Q[(\tau_i + T/2)/\sigma]$$

GENERATION OF D-STAR FRAMES



Sync	Radio header	V	Data sync	V	D	…	V	Data sync	V	…	D	V	End-of frame
64 + 15 bits	660 bits	72	24	72	24		72	24	72		24	72	48 bits

OUFTI-1 PROJECT ORGANIZATION

MANAGEMENT

L. Halbach, G. Kerschen, J. Verly

STUDENTS TEAM LEADER & CONTACT POINT

A. Denis
(Amandine.Denis@ulg.ac.be)

SCIENTIFIC PAYLOAD INVESTIGATOR

P. Rochus

GROUND SEGMENT

CONTROL STATION
J. Charlier
L. Halbach G. Kerschen J. Verly
D-STAR REPEATER
L. Halbach J. Verly

SPACE SEGMENT

ADCS	COMM	EPS	MECH
S. Hannay	R. Henrard F. Mahy	P. Ledent	J. Wertz
C. Geuzaine G. Kerschen	V. Broun L. Halbach J. Verly	L. Halbach J. Verly	O. Bruls G. Kerschen V. Lenaerts
Open Engineering		*Thales Alenia Space ETCA*	
MIAS	**OBC**	**STRU**	**THER**
V. Beukelaers	N. Evrard J. Hardy D. Teney	G. Pierlot	L. Jacques
L. Halbach G. Kerschen J. Verly	B. Boigelot L. Halbach J. Verly N. Vetcour	G. Kerschen	G. Kerschen P. Rochus
LuxSpace	*Spacebel*	*V_2i & CSL*	*CSL*

PUBLIC RELATION

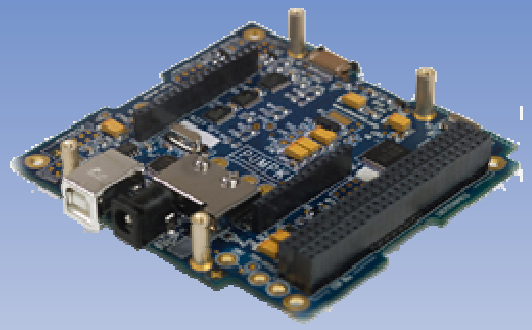
T. Pirard

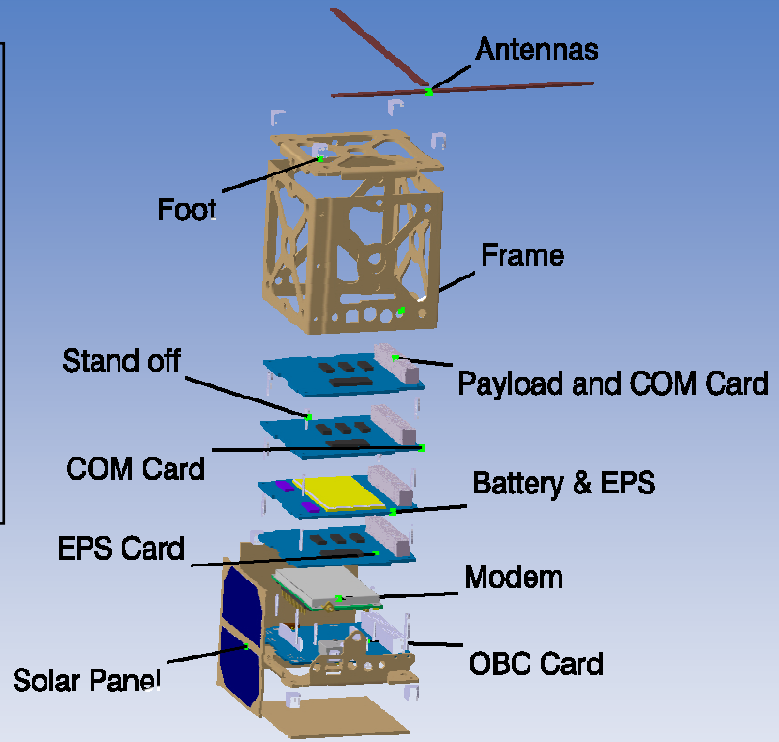
HAM RADIO TEAM

ON4YY
ON6JY
ON8PS

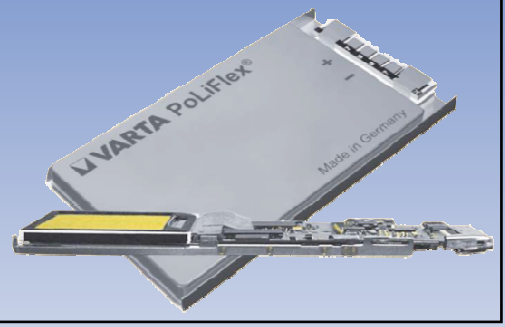
ELECTRICAL SUBSYSTEMS

OBC





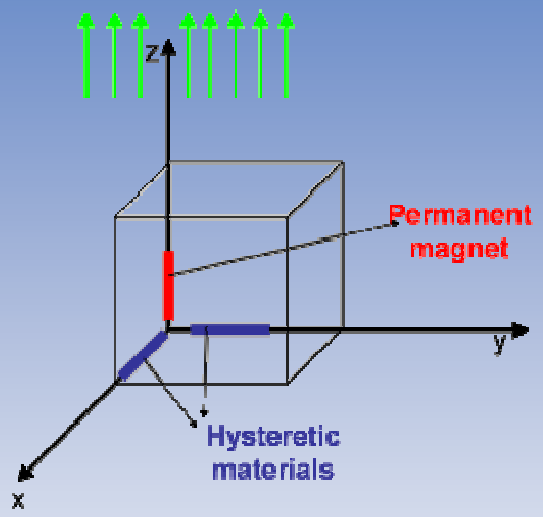
EPS: analog & digital

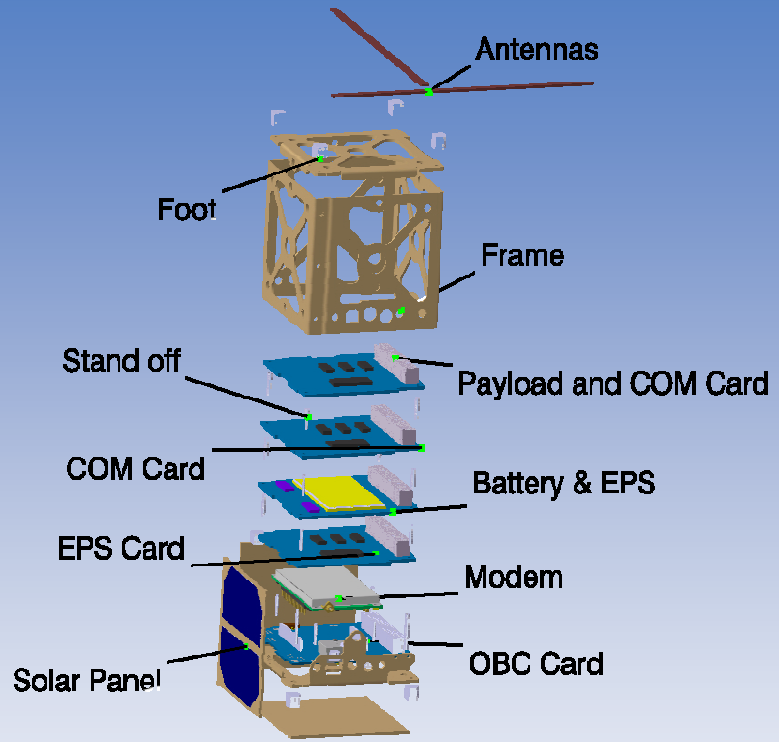


COM

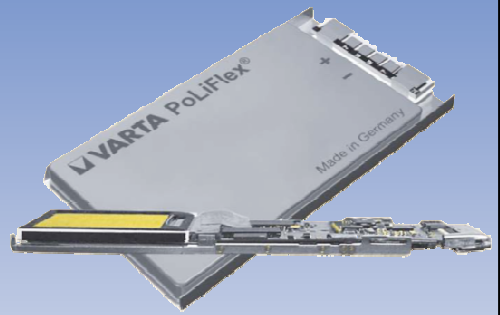
MECHANICAL SUBSYSTEMS

Attitude control



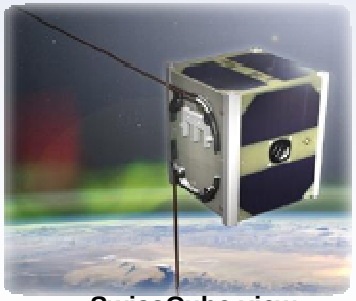


Thermic



0-45°C

Antenna deployment



SwissCube view

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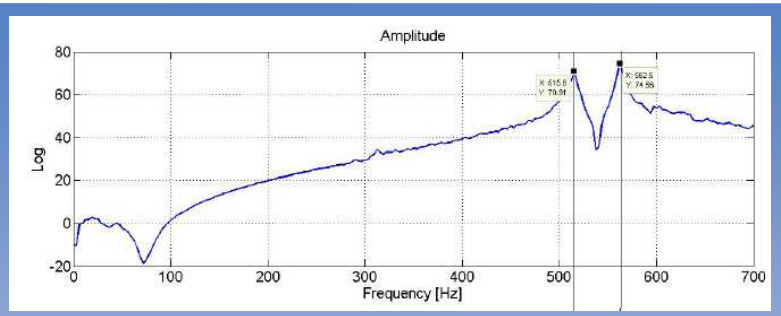
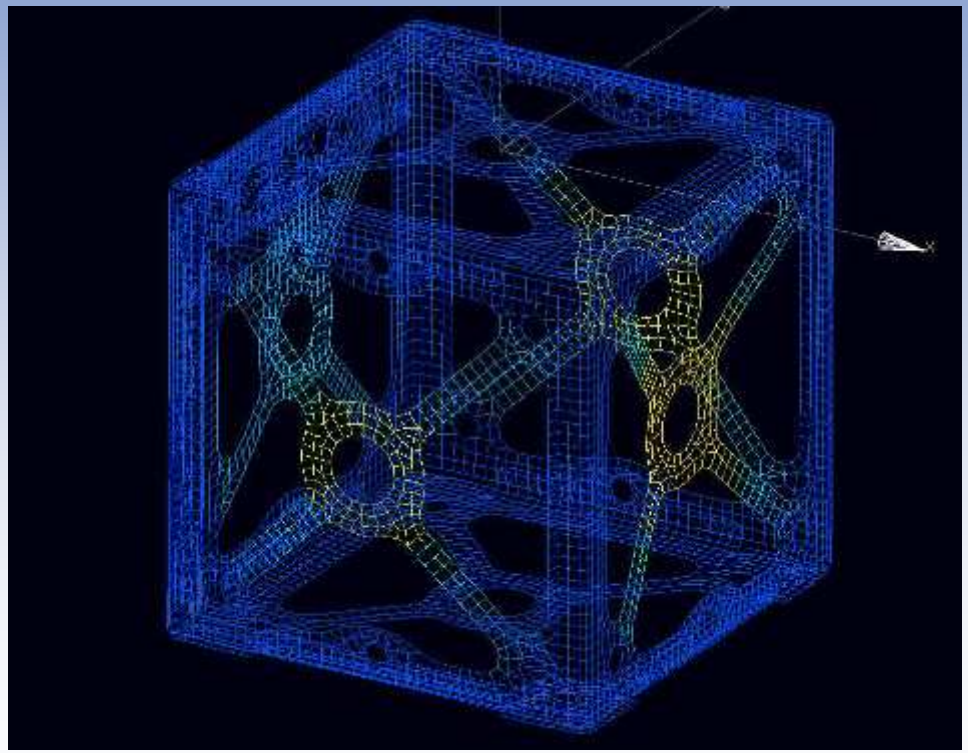
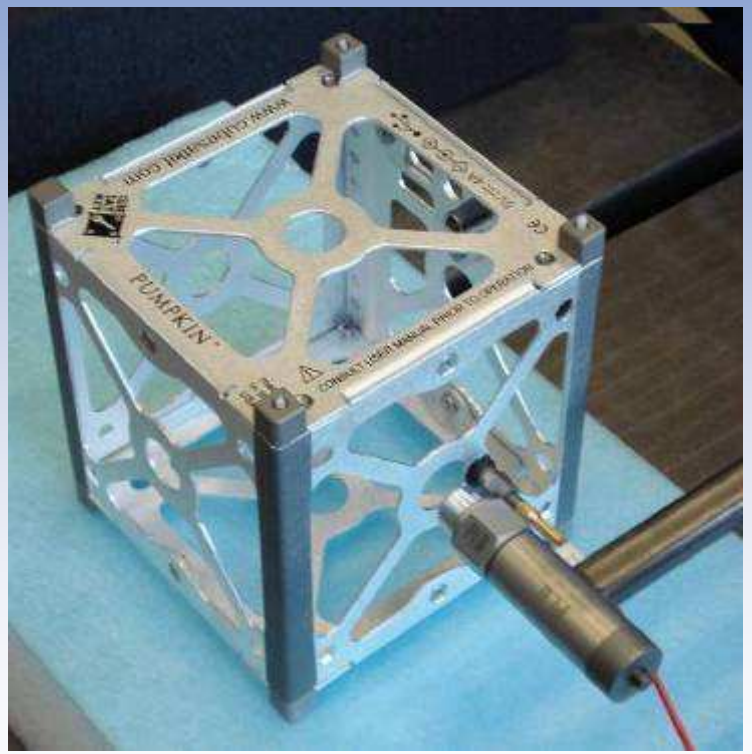
VIBRATIONS







Theory…

Experimentation

ORBIT