AEROSPACE INFORMATION TECHNOLOGY

Design to Survive

Sergio Montenegro

Design to Survive

Namely...
Survive In Space (Hostile environment)

extremely cold /
extremely hot
high radiation -> Fault Tolerance
and alone! -> Autonomously

What could possible go wrong?

We considered ever thing!

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What could possible go wrong?

We considered ever thing!

We thing we know what is waiting for us.

We do not know!

Surprise? -> it is not as expected!

-> expect the unexpected

What could possible go wrong?

You write 1, you read 1
Your write 0, you read 0
1 + 1 = 2
Power On is Power On

or probably not?

What could possible go wrong?

In Space

You write 1, you read very probably 1
Your write 0, you read very probably 0
1 + 1 = very probably 2
Power On is very probably Power On

Something will go wrong!

In Space

You write 1, you read very probably 1
Your write 0, you read very probably 0
1 + 1 = very probably 2
Power On is very probably Power On

If so...
The spacecraft will probably survive

Do not try to avoid Anomalies

They will come!

Do not try to avoid Anomalies

They will come! Be ready

Better invest your time to be ready

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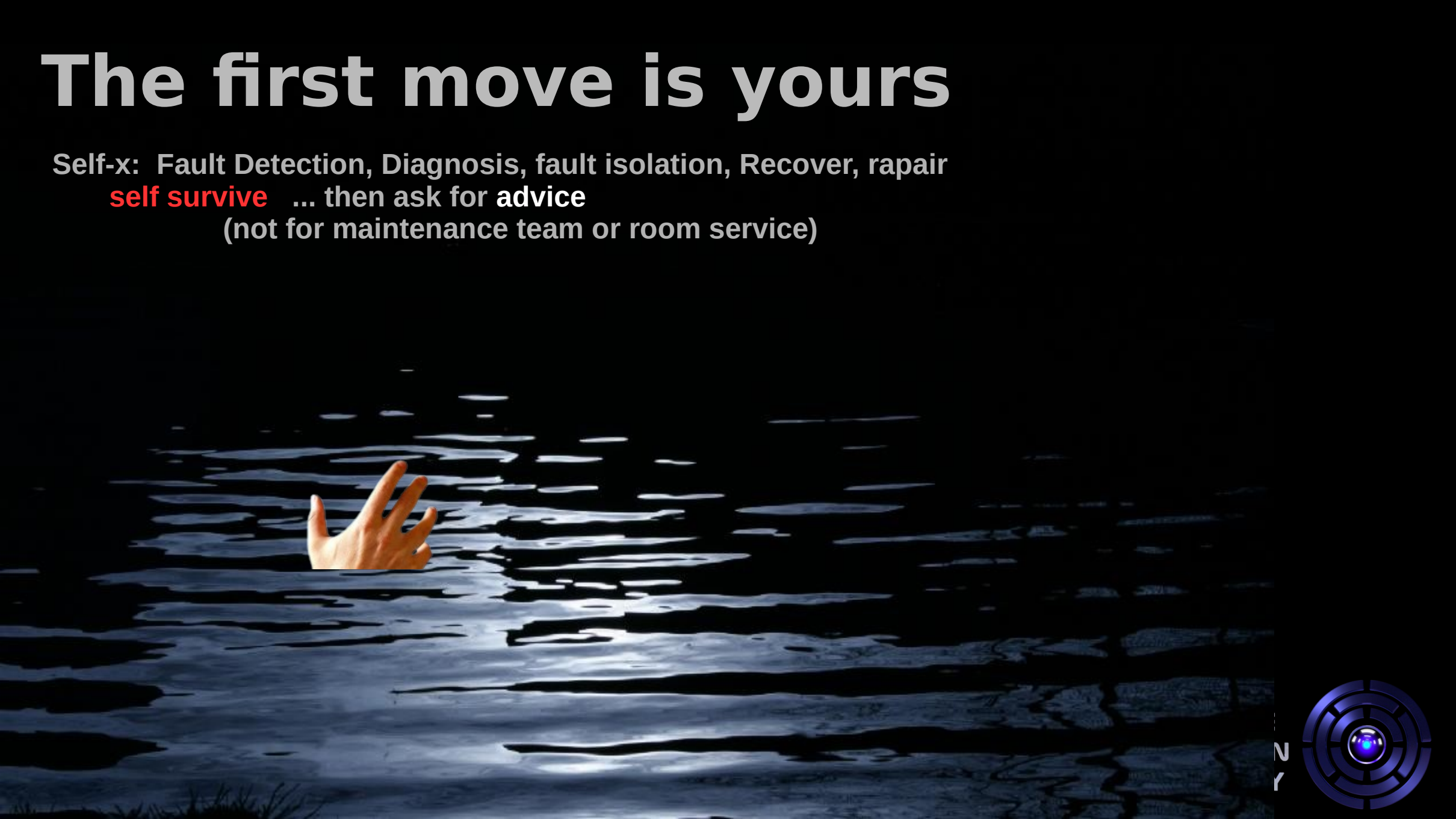
What if something goes wrong and you need help?

The first move is yours

Self-x: Fault Detection, Diagnosis, fault isolation, Recover, rapair

self survive ... then ask for **advice**

(not for maintenance team or room service)



First move: Fault Tolerance

Second Move: The operator shall get a picture of your situation

But not for today..

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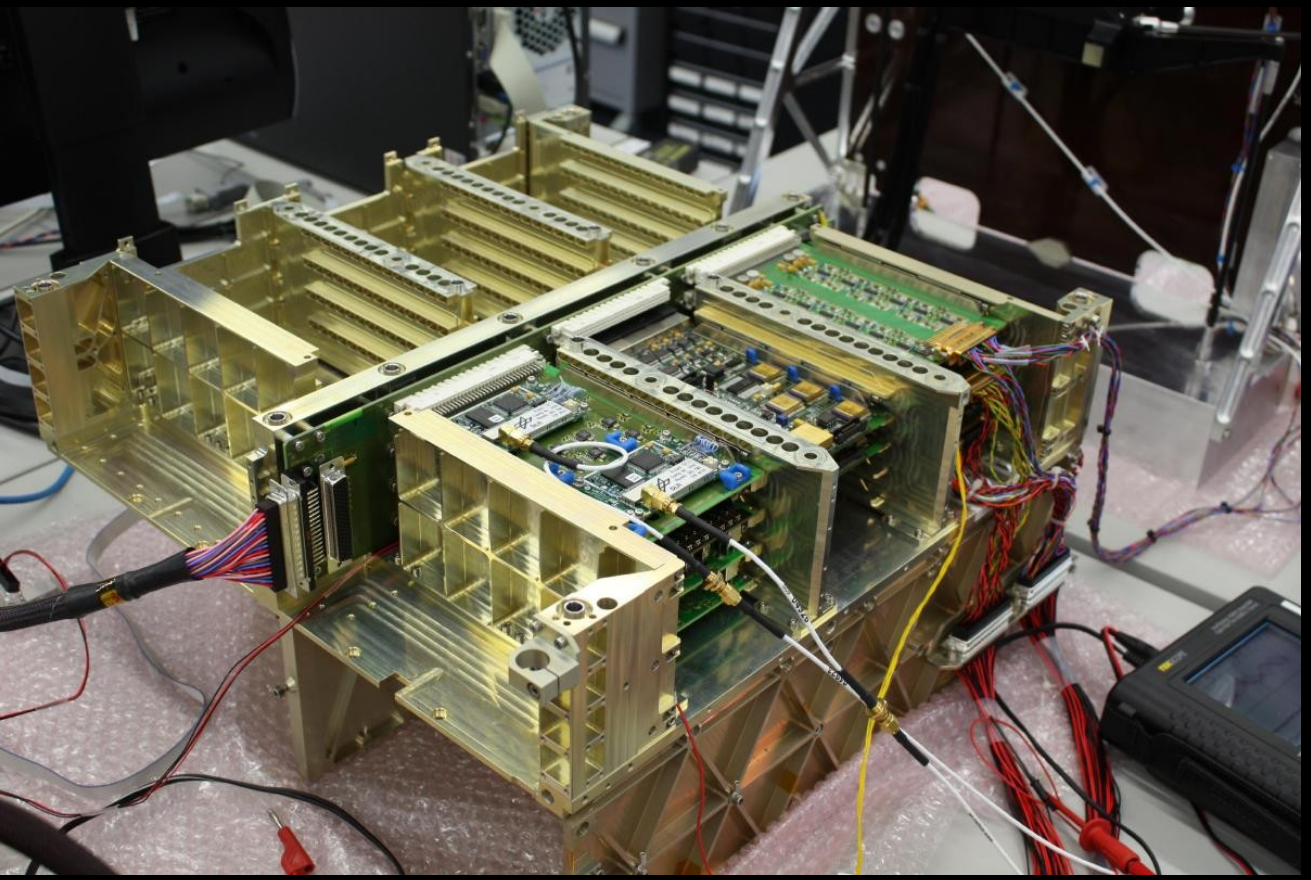
BIRD
TET
BIROS

Redundancy at module level



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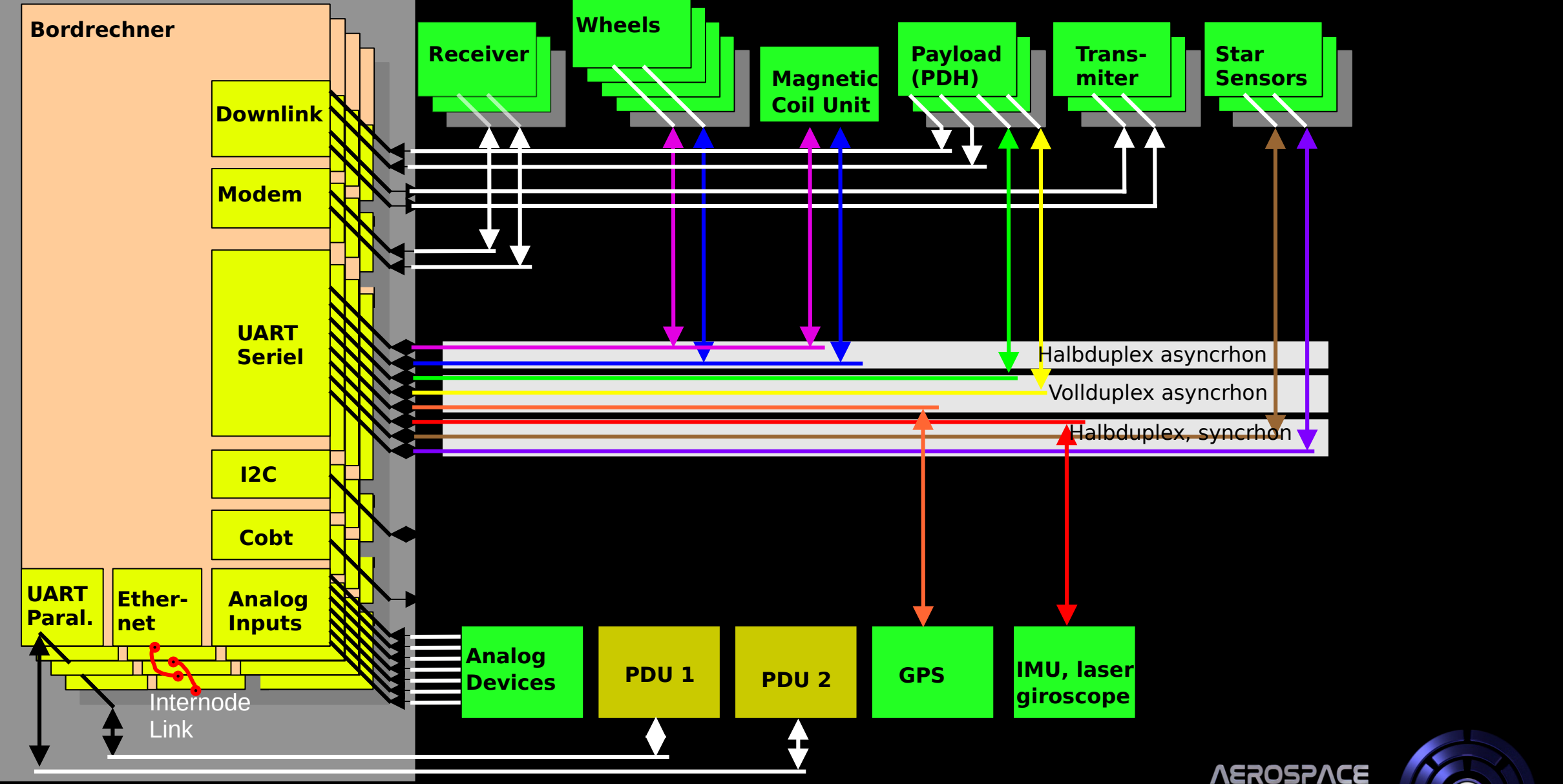

Redundancy at module layer

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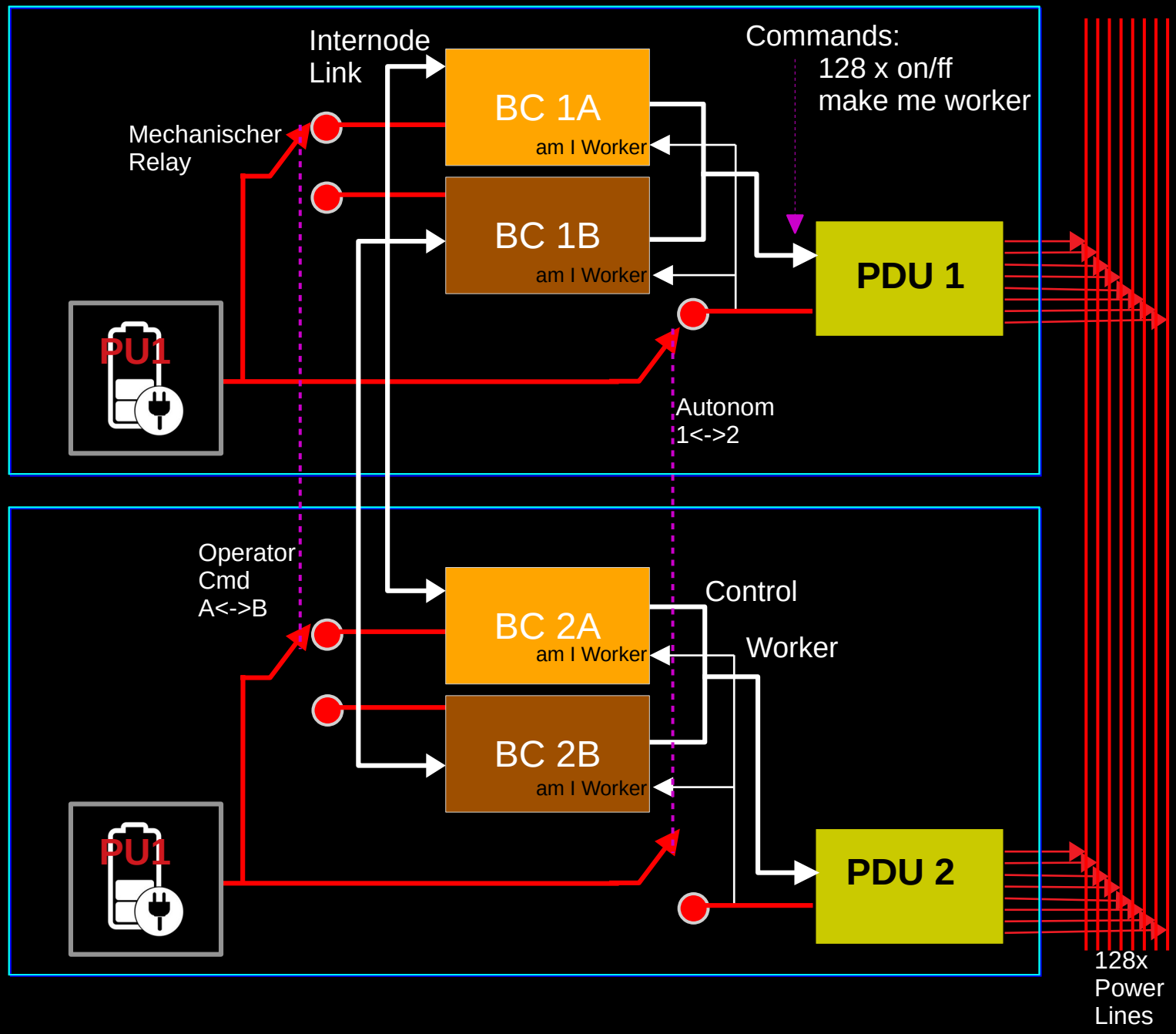

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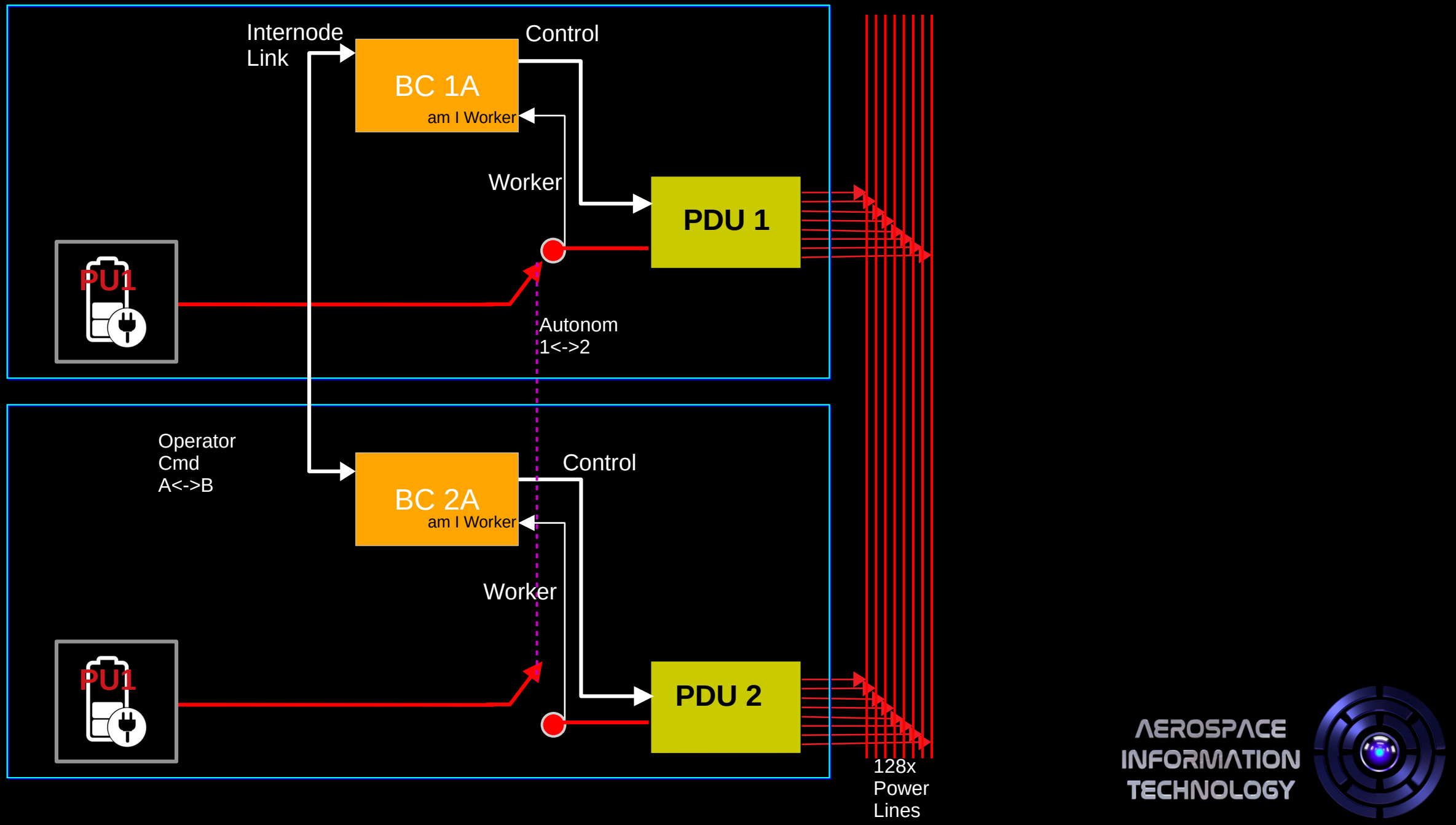

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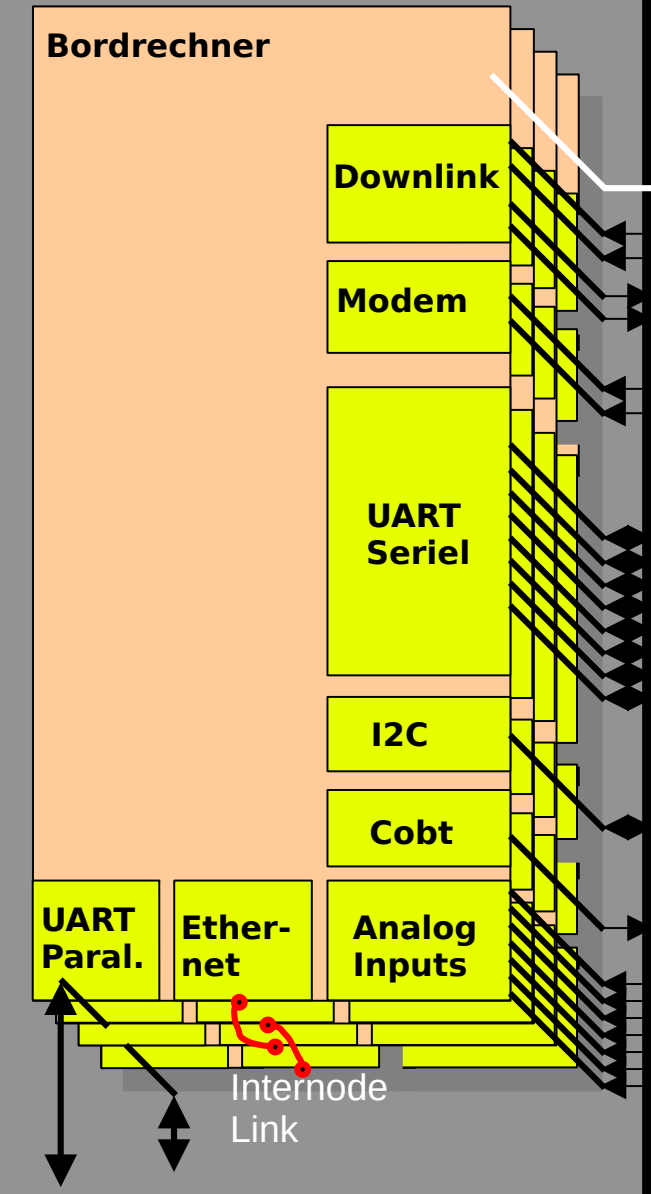
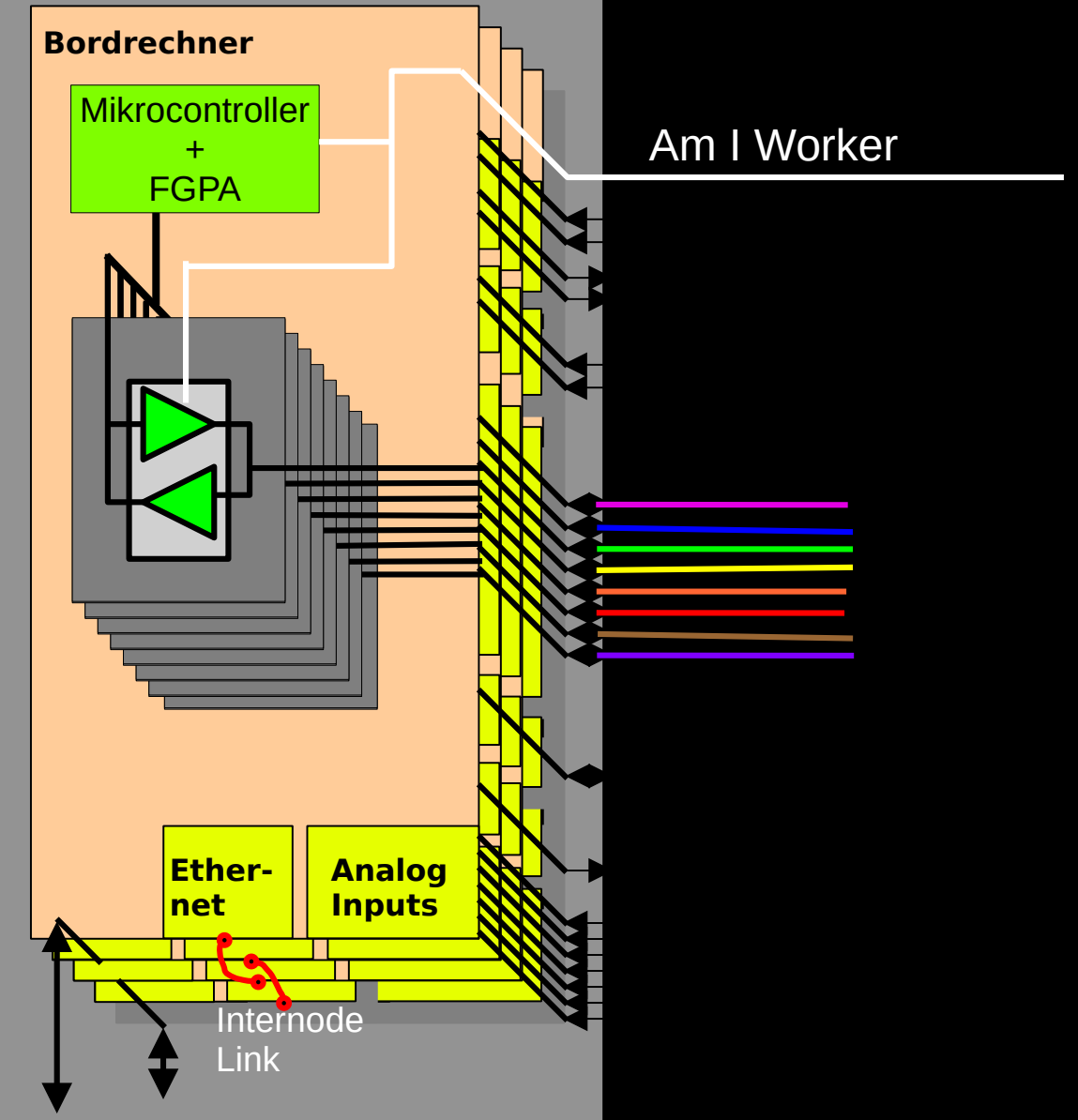
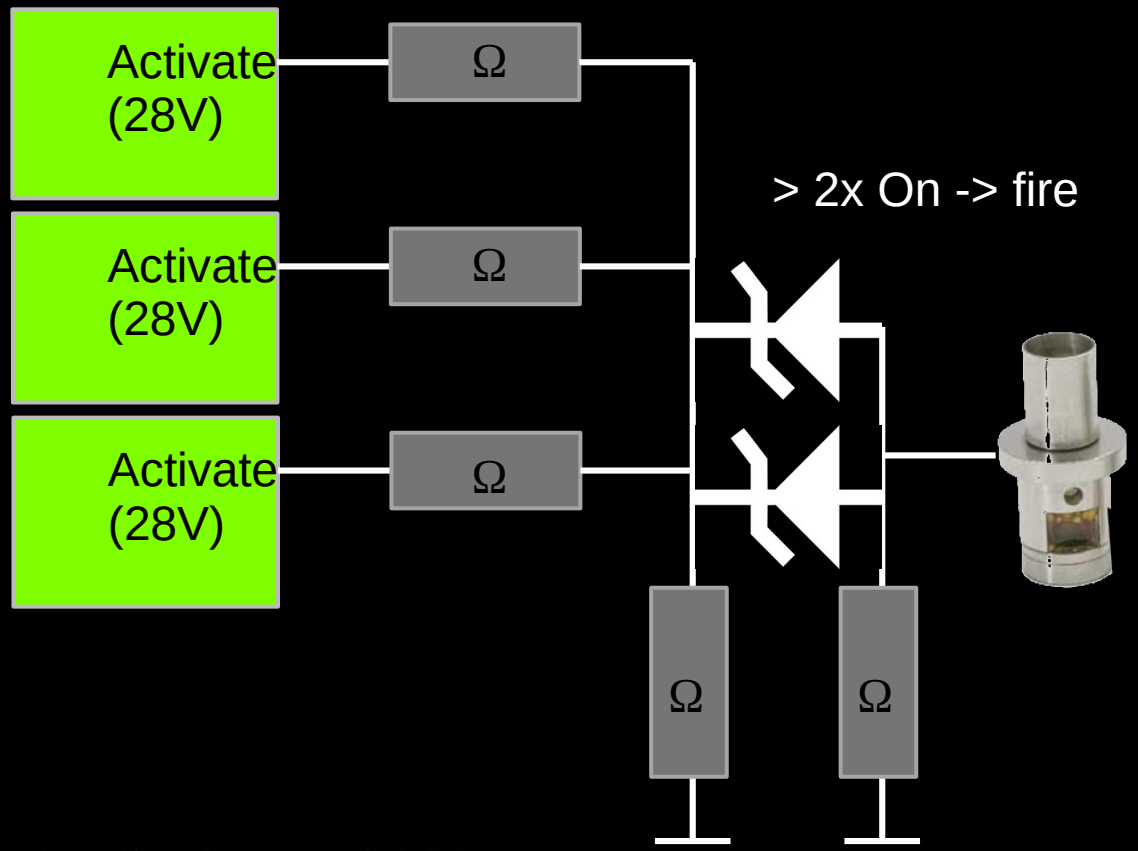
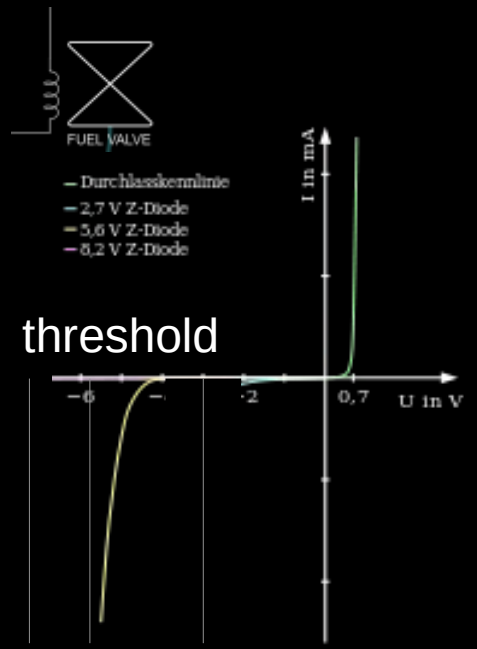

Bordrechner
Downlink
Modem
UART
Seriel
I2C
Cobt
UART
Paral.
Ether-
net
Analog
Inputs
Internode
Link

Am I Worker


Bordrechner
Mikrocontroller
+
FGPA
Am I Worker
Ether-
net
Analog
Inputs
Internode
Link

TMR Pyro & Valve control





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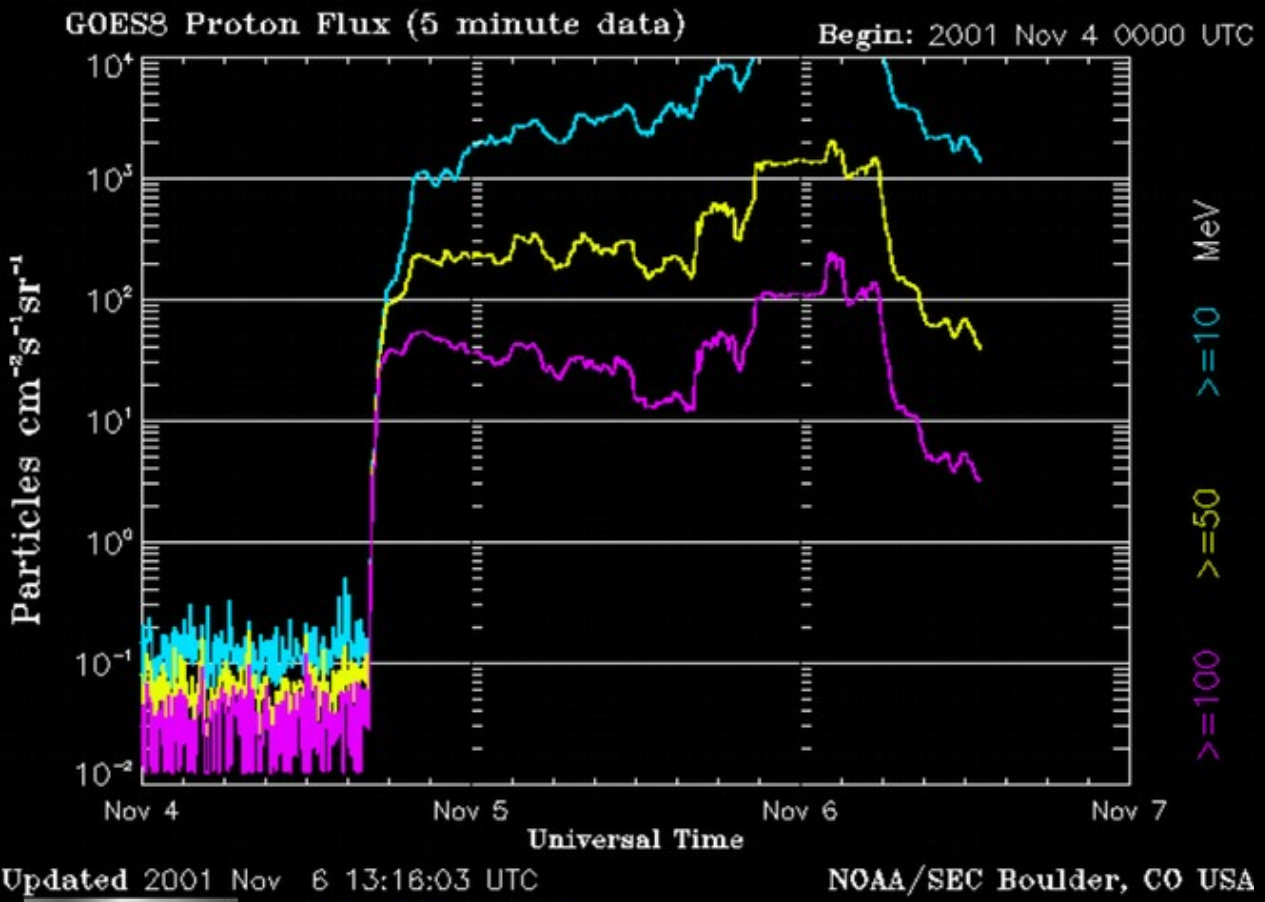
Results in Orbit



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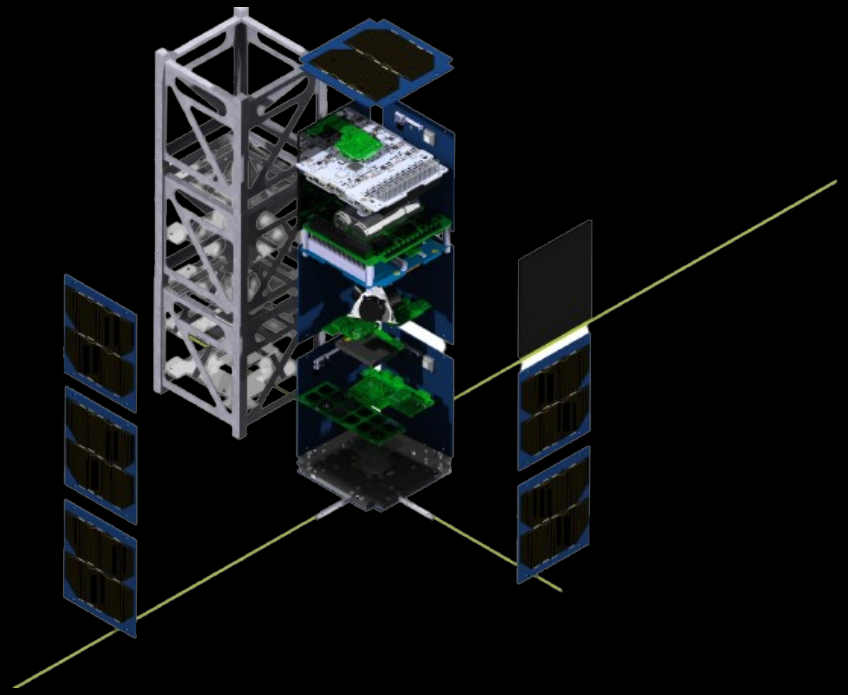
INNOCUBE

INNOCUBE



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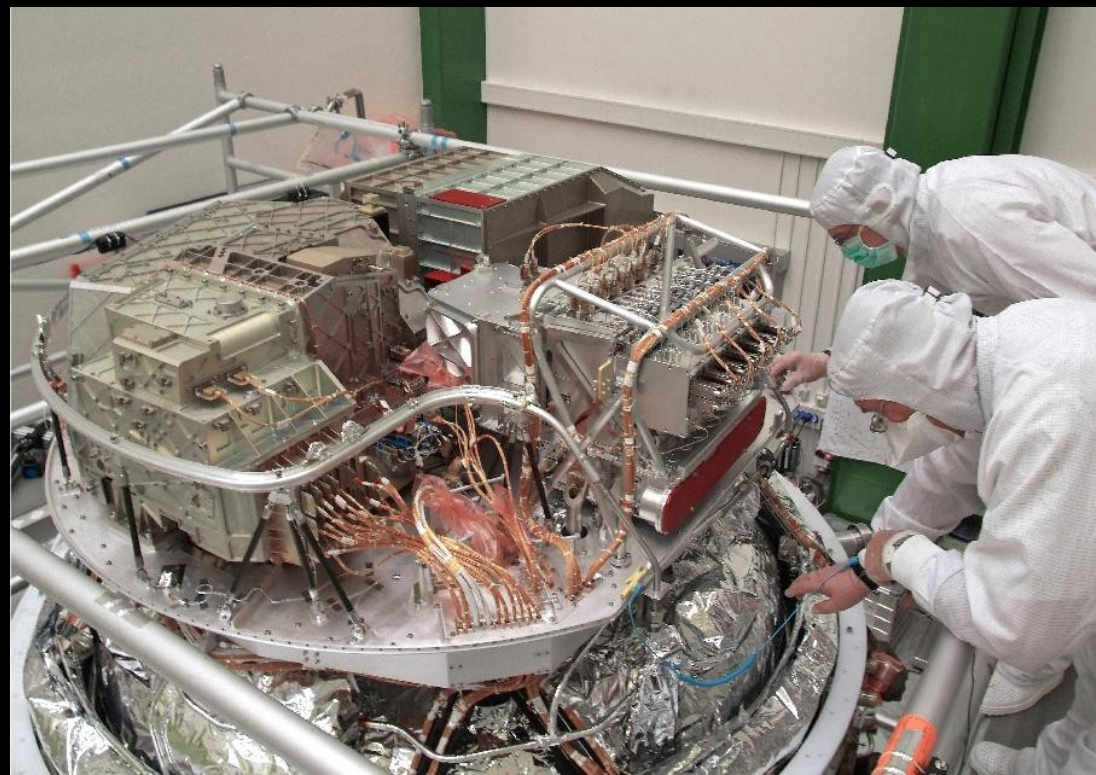
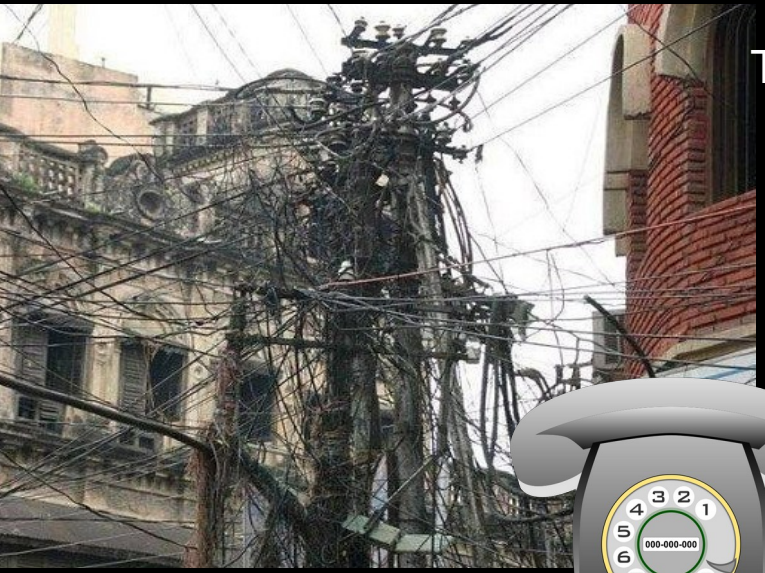
Harness

Complex / Complicated
Difficult
Expensive
Heavy
Fault prone

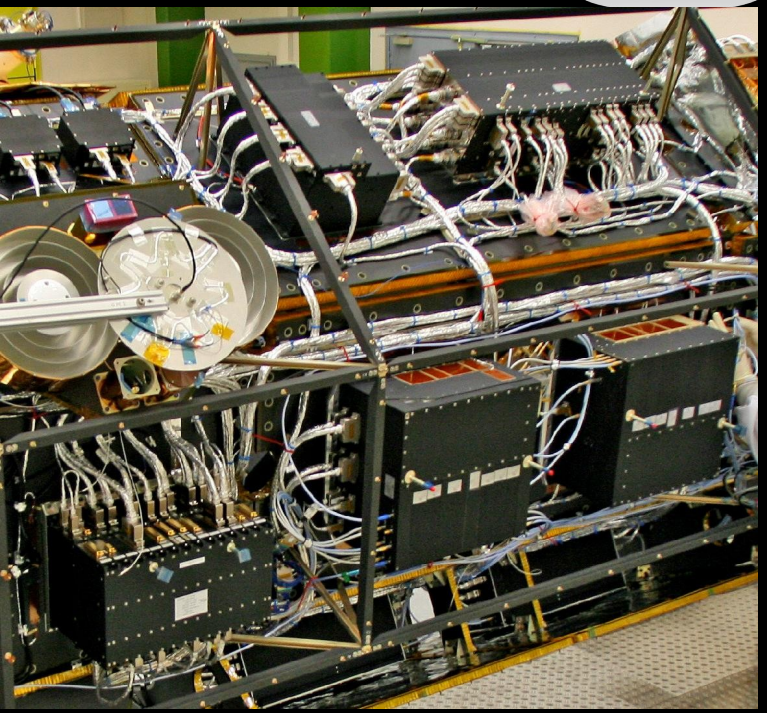




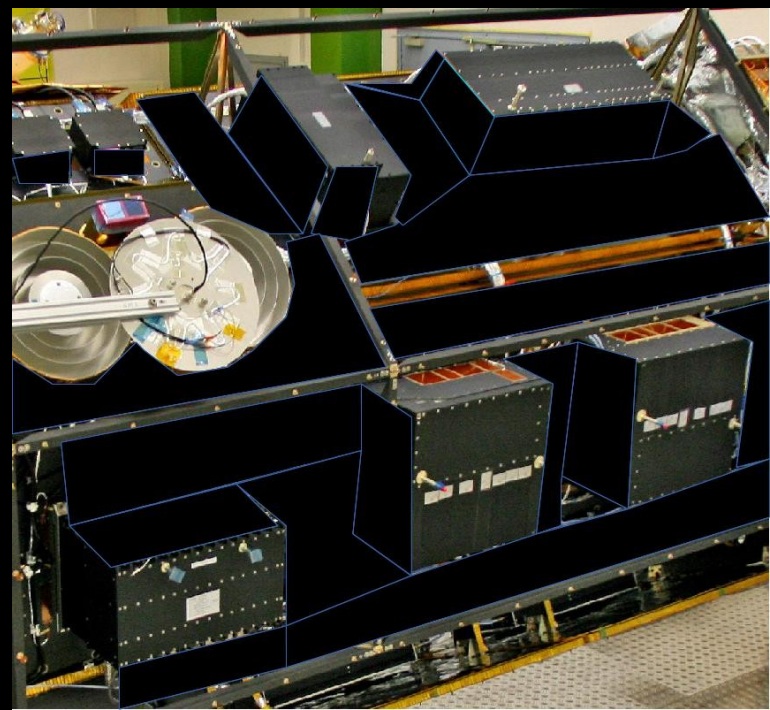
Terrestrial Applications showed the benefits

One wire per device

Millions of devices, no wire



We demonstrate it in space



Fire Test on the Earth

Wireless Quadrocopter : Distributed control

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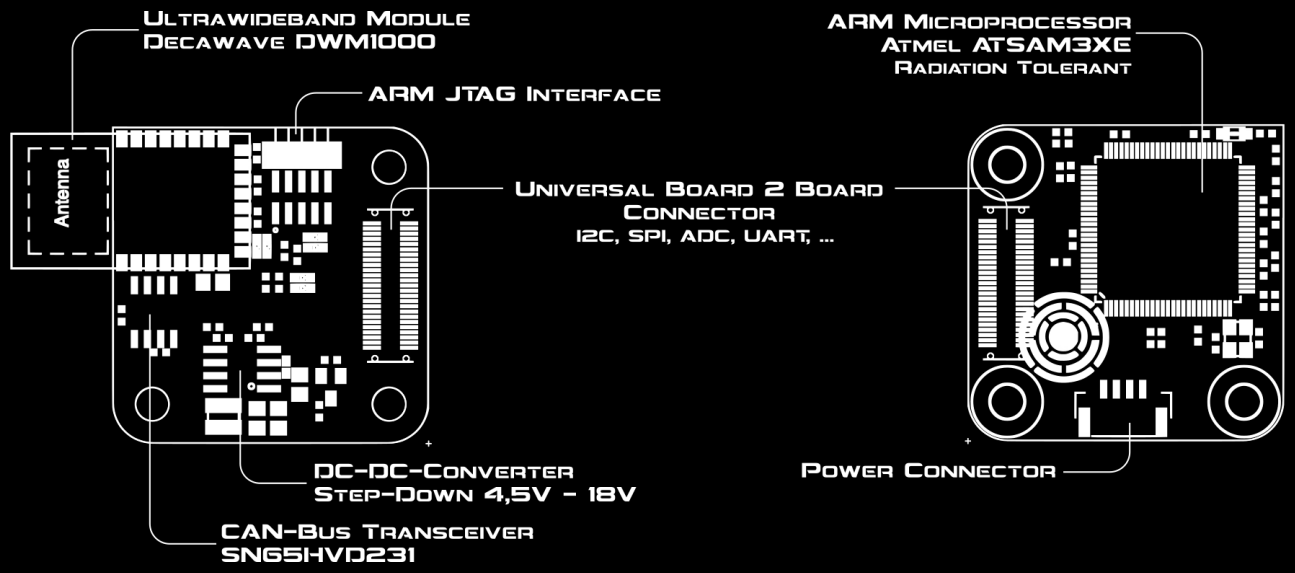
The Hardware



Same scale

SKITH

Avionics Plug

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Inside the Satellite

NoWire-Module

Micro Controller

ARM CPU

168 K RAM

1 M Flash

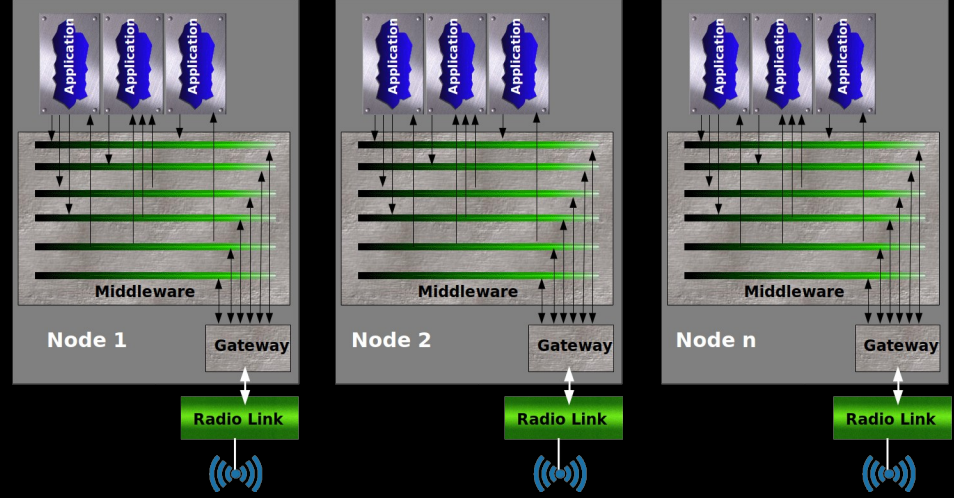
IO
SPI
I²C
UART

Timers

Low Power
Radio Module

NoWire-Module

NoWire-Module



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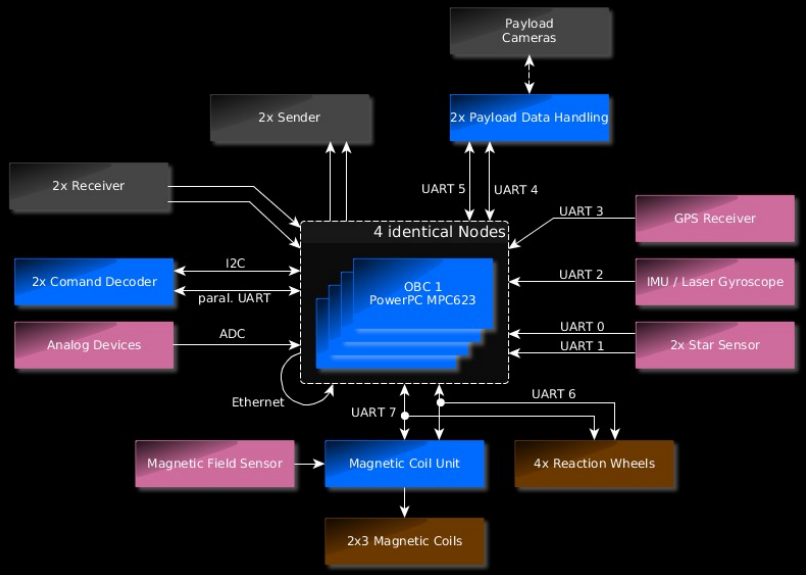

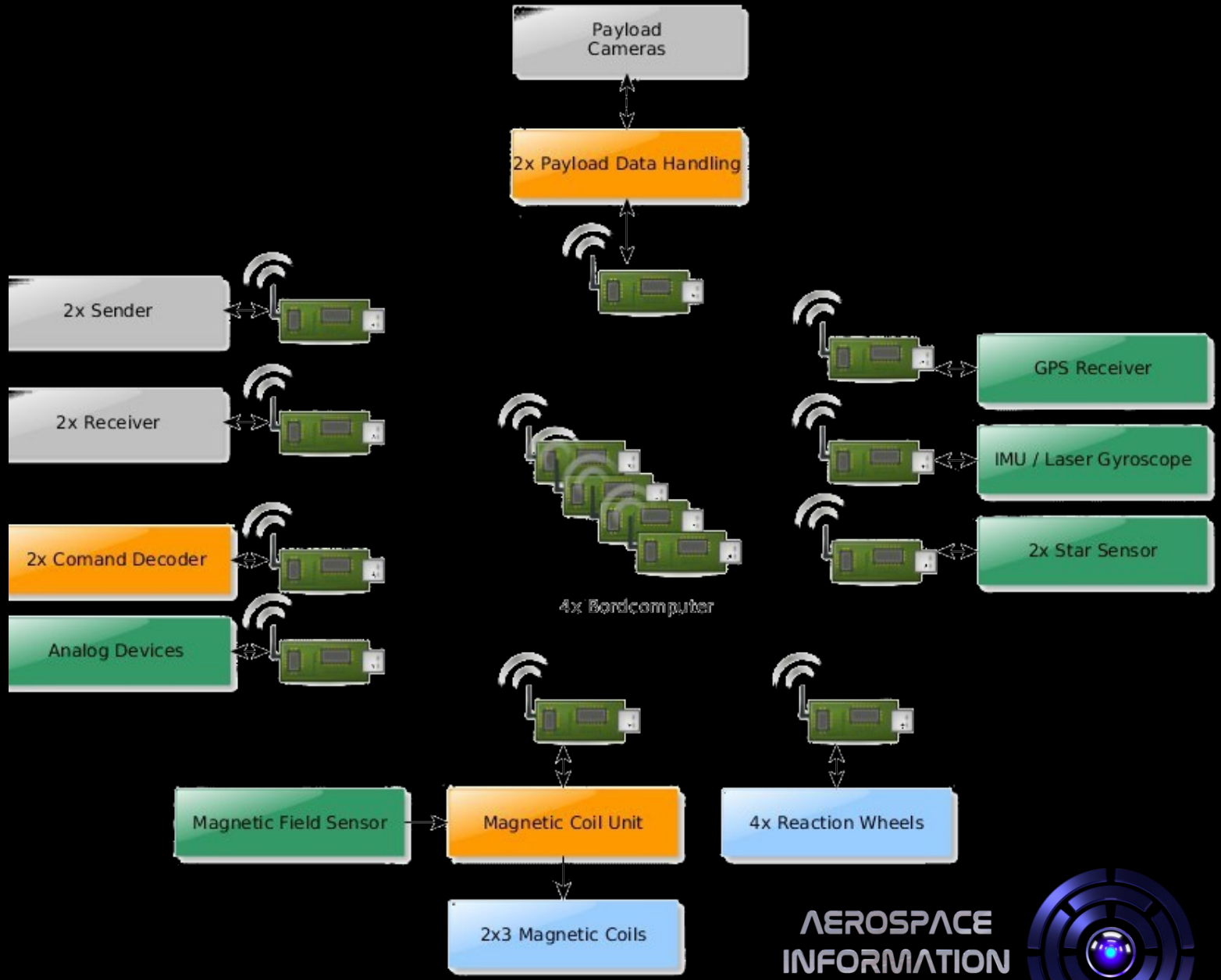

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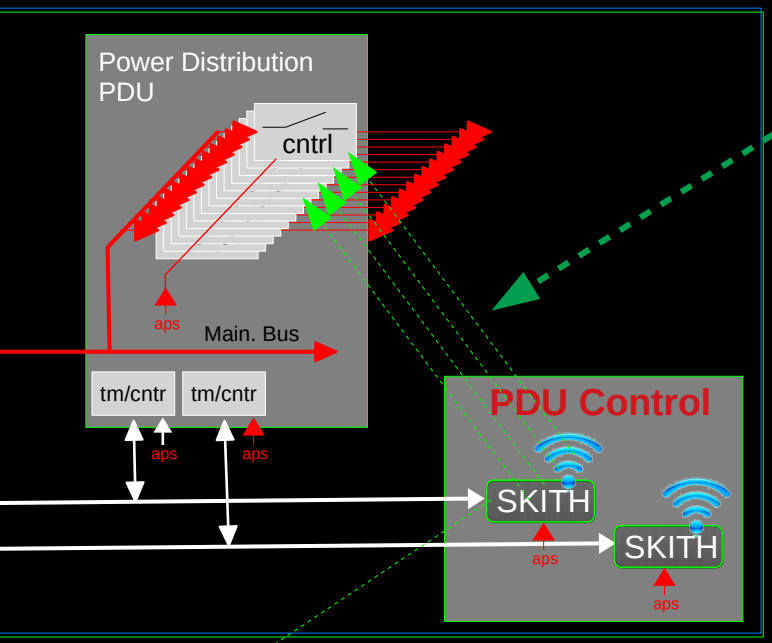

on / off

keep on

keep off

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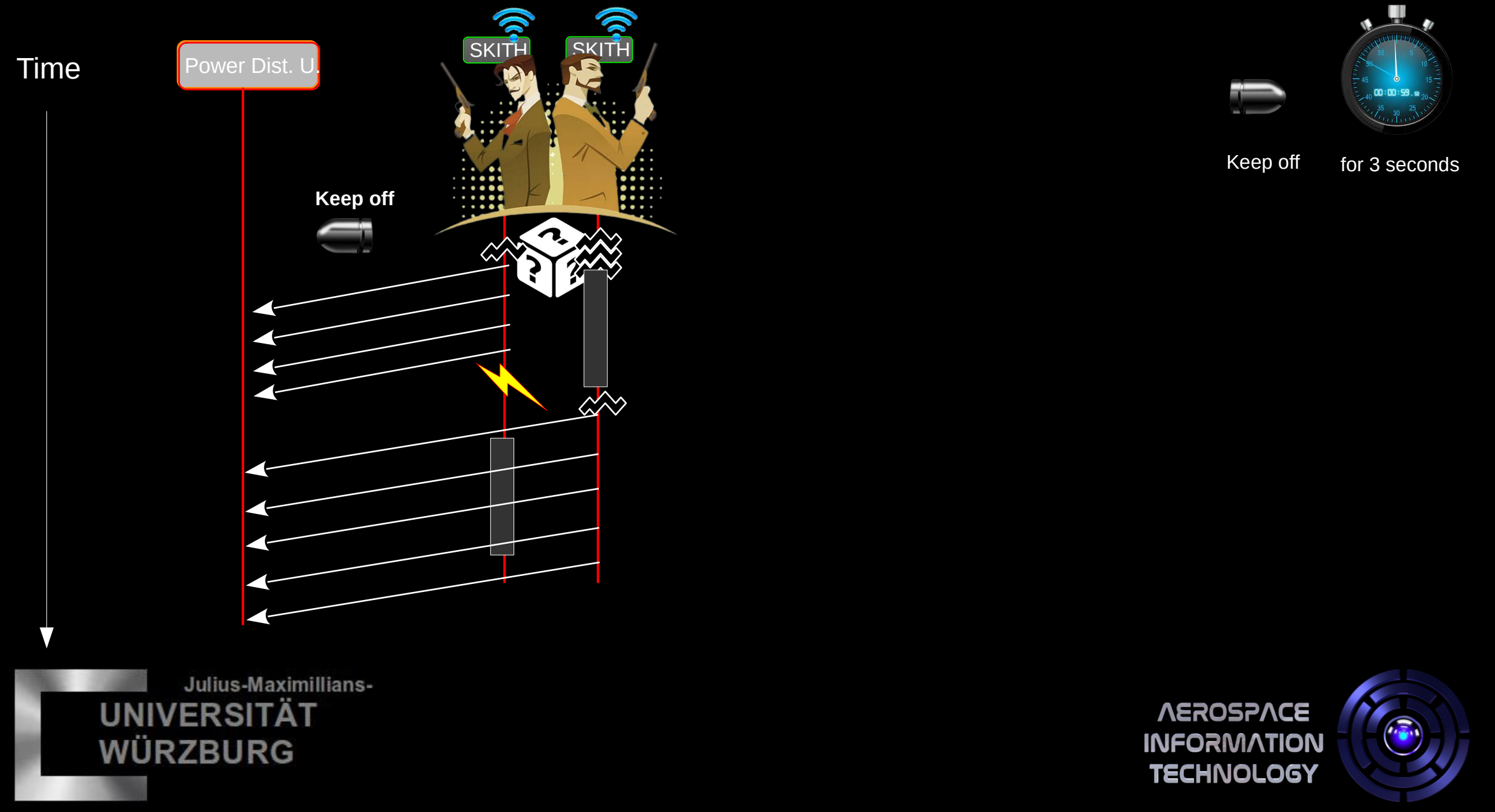
There can be only one
Es darf nur einen geben!



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Our Targets

Our Targets

Irreducibly Complexity

let ir crahs! -> Ultra fast recovery

Unified communications protocols for software and hardware.

The same communication protocols will be used
inside (**intra**) and
outside (**inter**) the space craft

Danke!

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