



Babelbee



**Open
Source**

**Electric
Power**

**Monitor-
ing**

**Manage-
ment**

Babelbee

“A Building Block for decentralized Grid Management”

– Tomi Engel, Karlsruhe, 2015.06.06

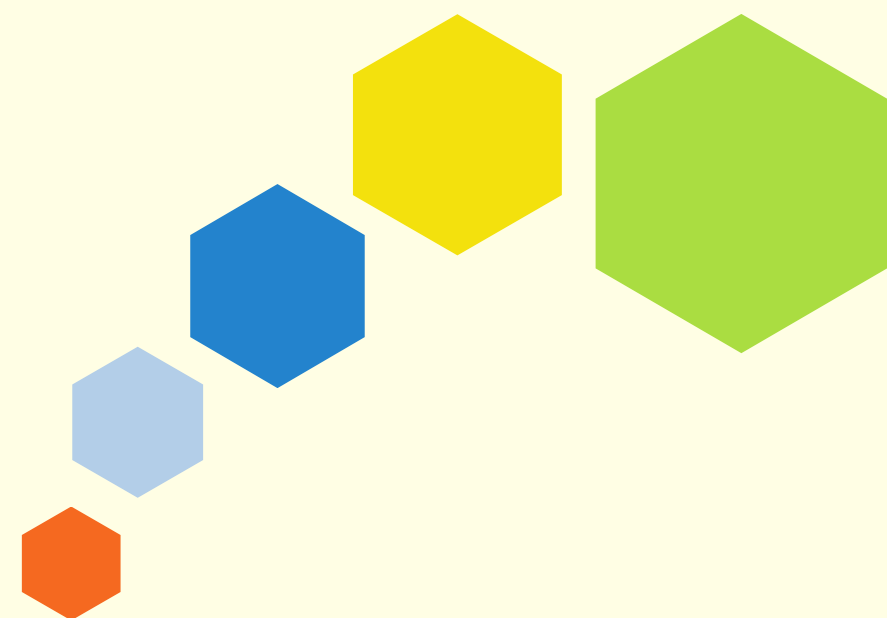


Evolution of the Babelbee





Evolution of the Babelbee

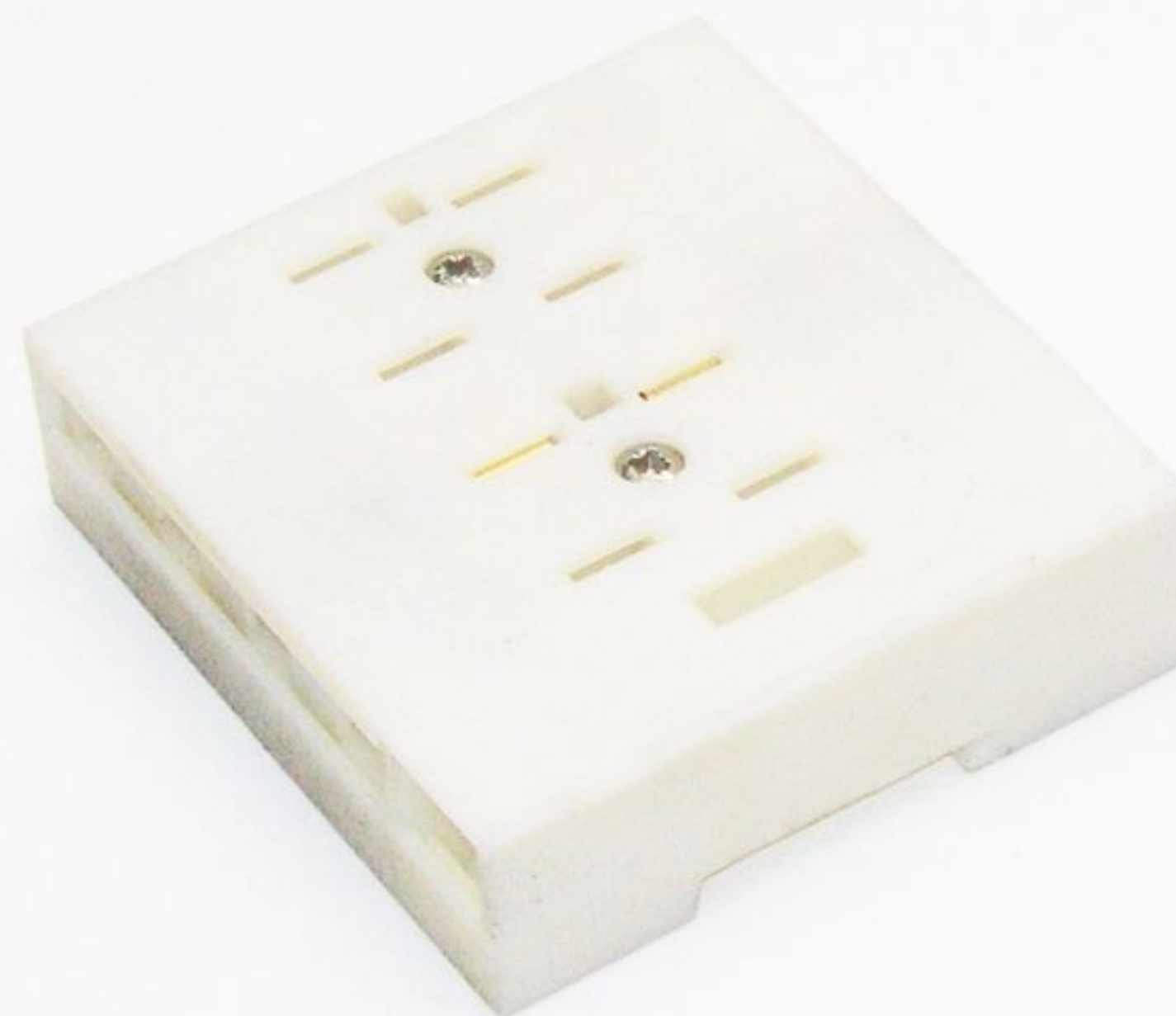




Evolution of the Babelbee



2008





Evolution of the Babelbee



2008

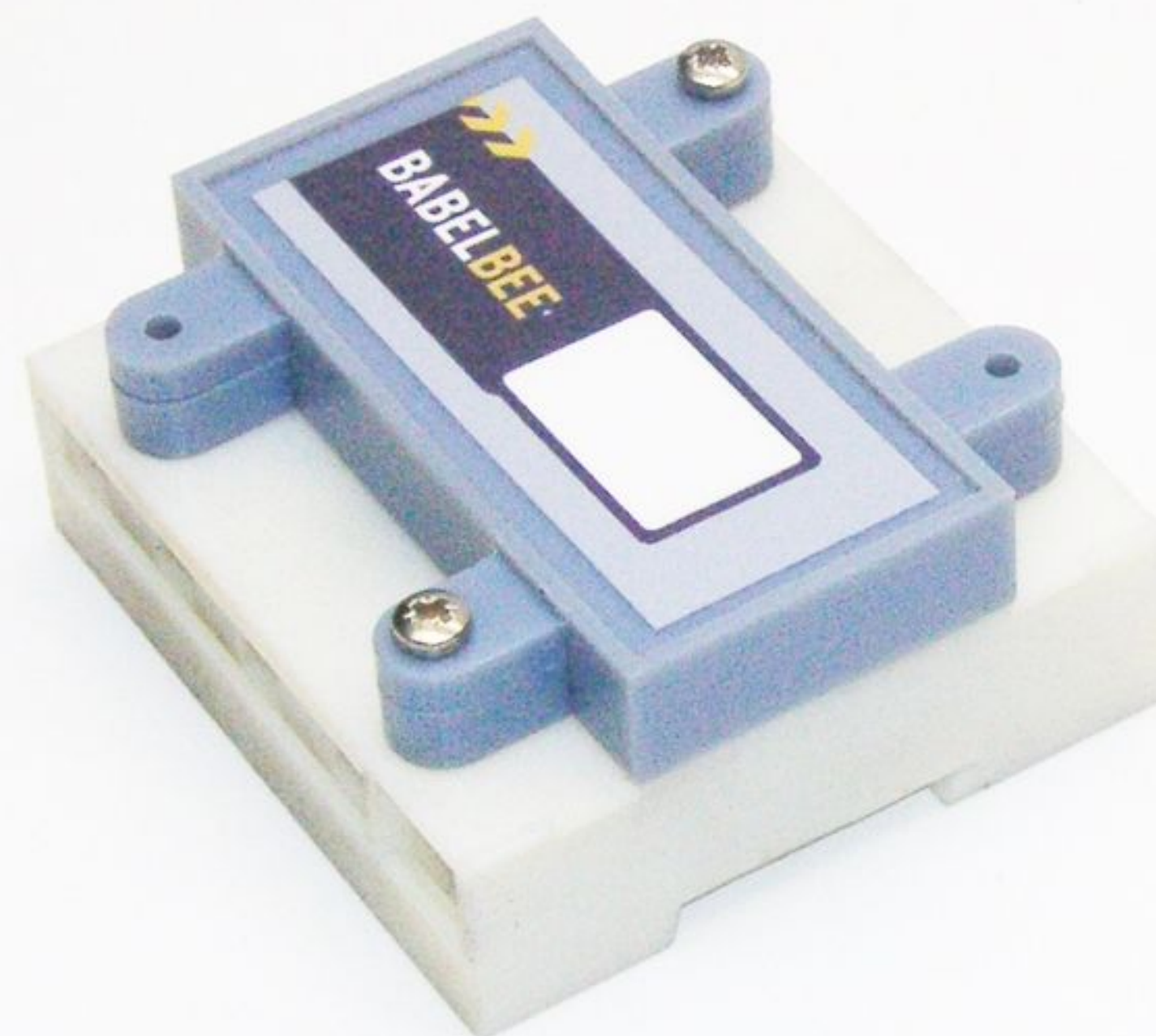




Evolution of the Babelbee



2008

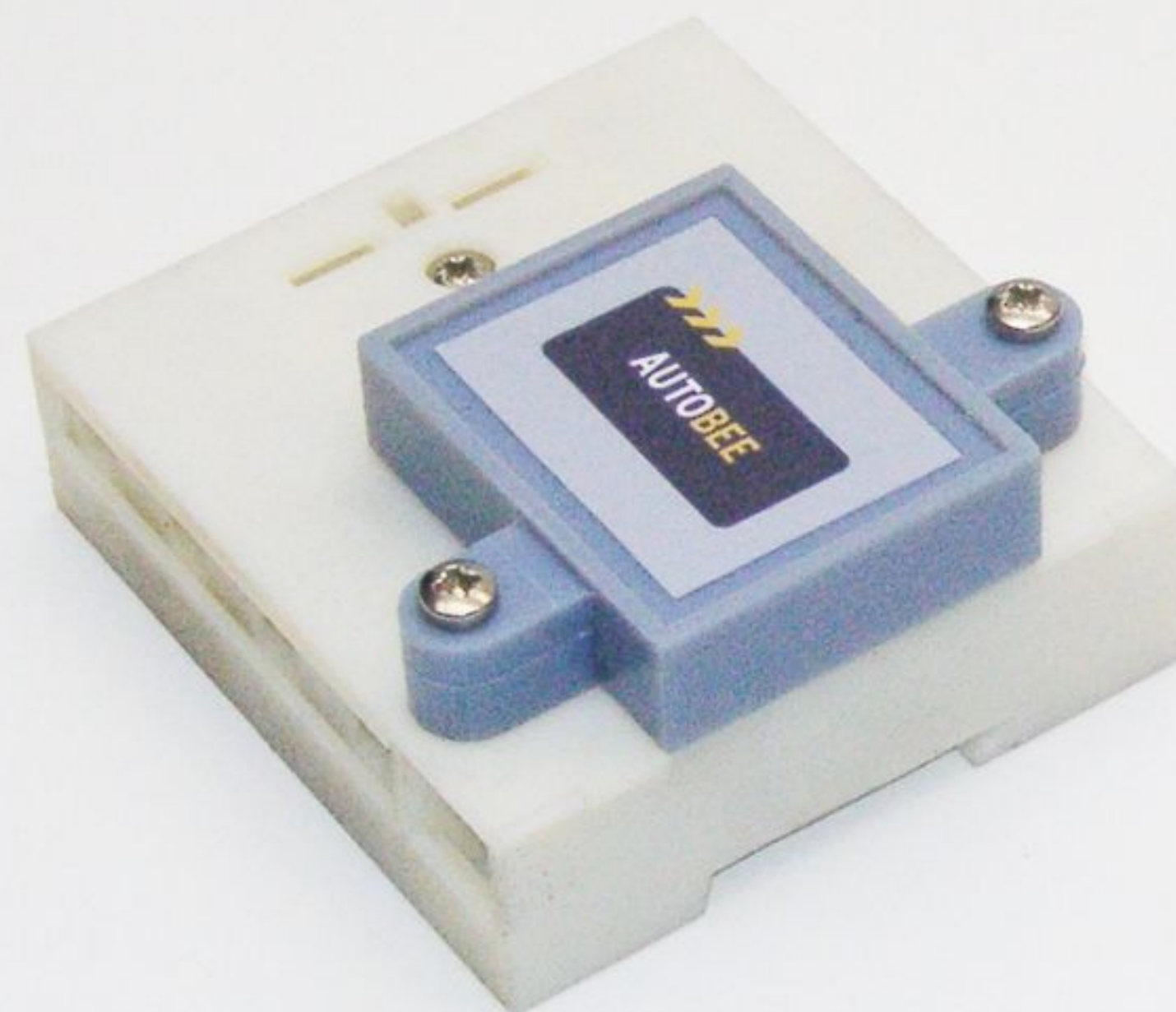




Evolution of the Babelbee



2008

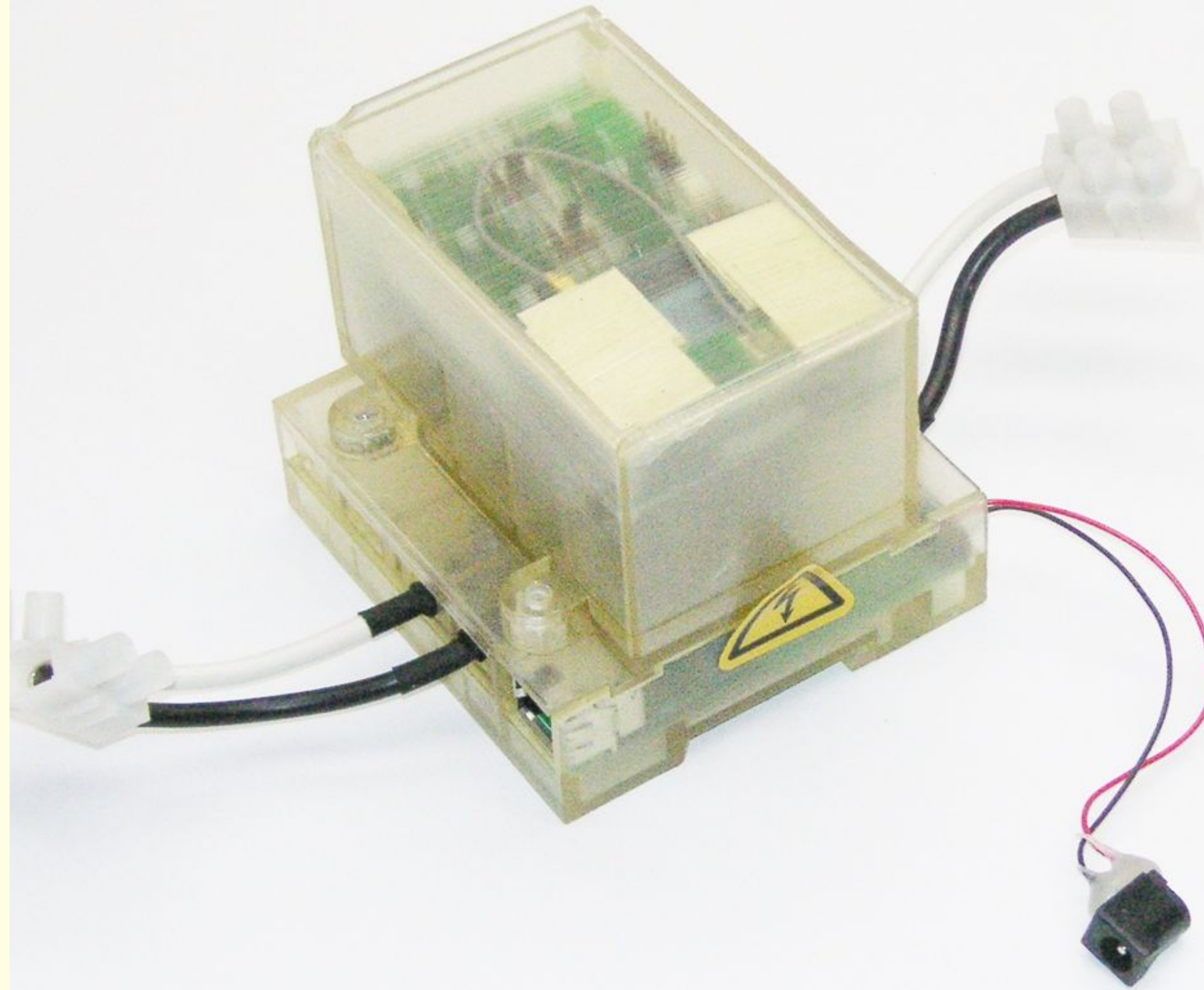




Evolution of the Babelbee



2011

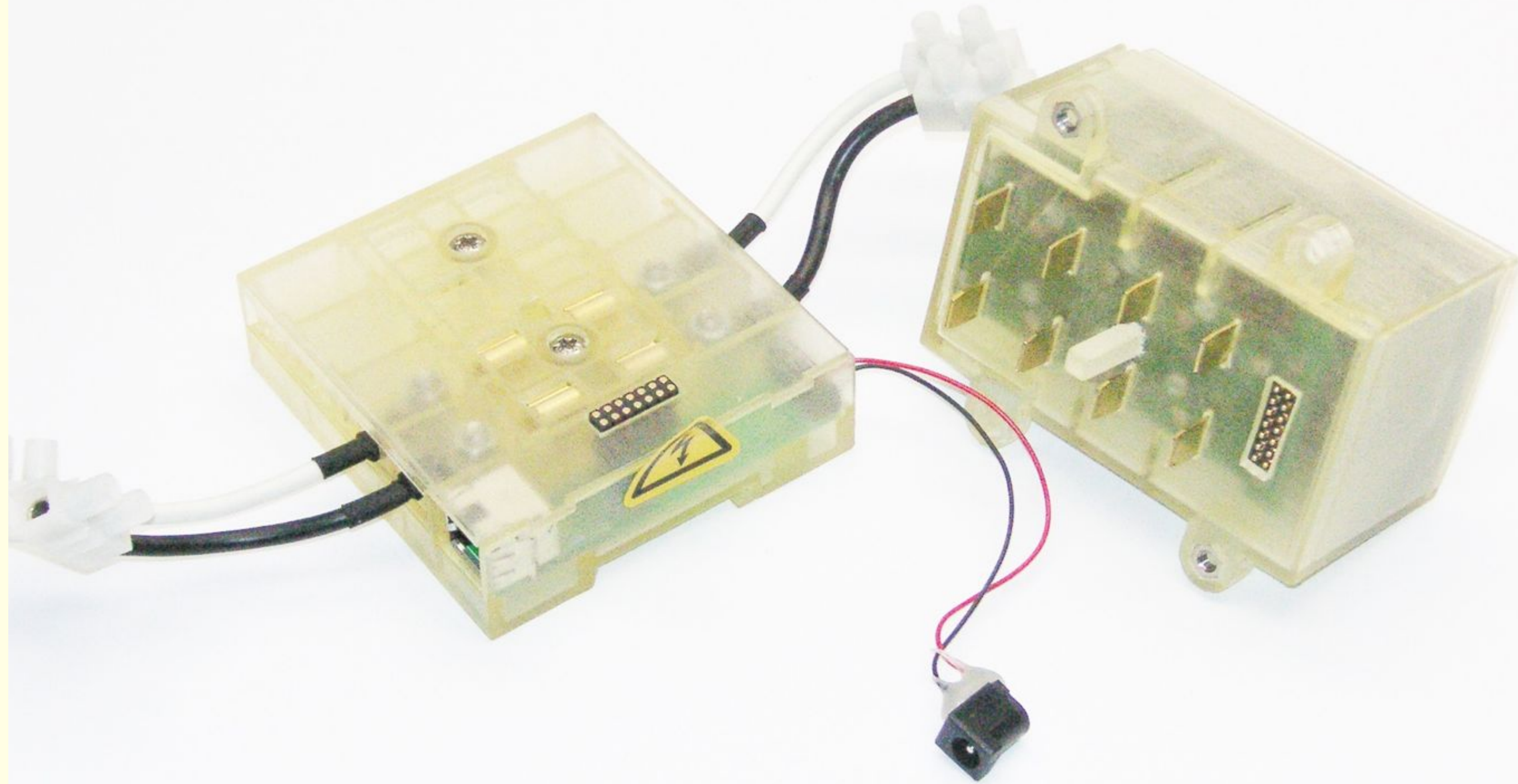




Evolution of the Babelbee



2011

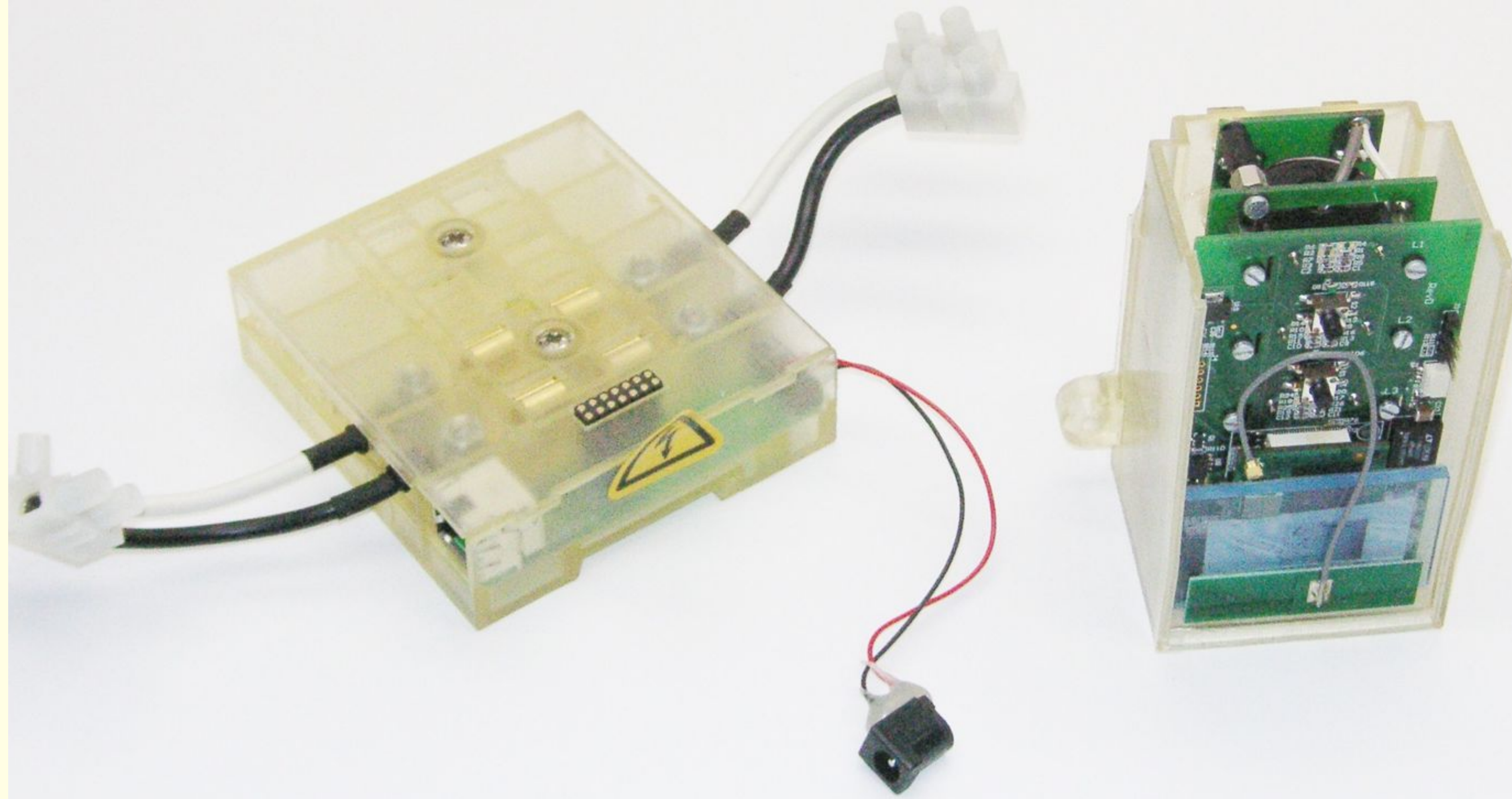




Evolution of the Babelbee



2011

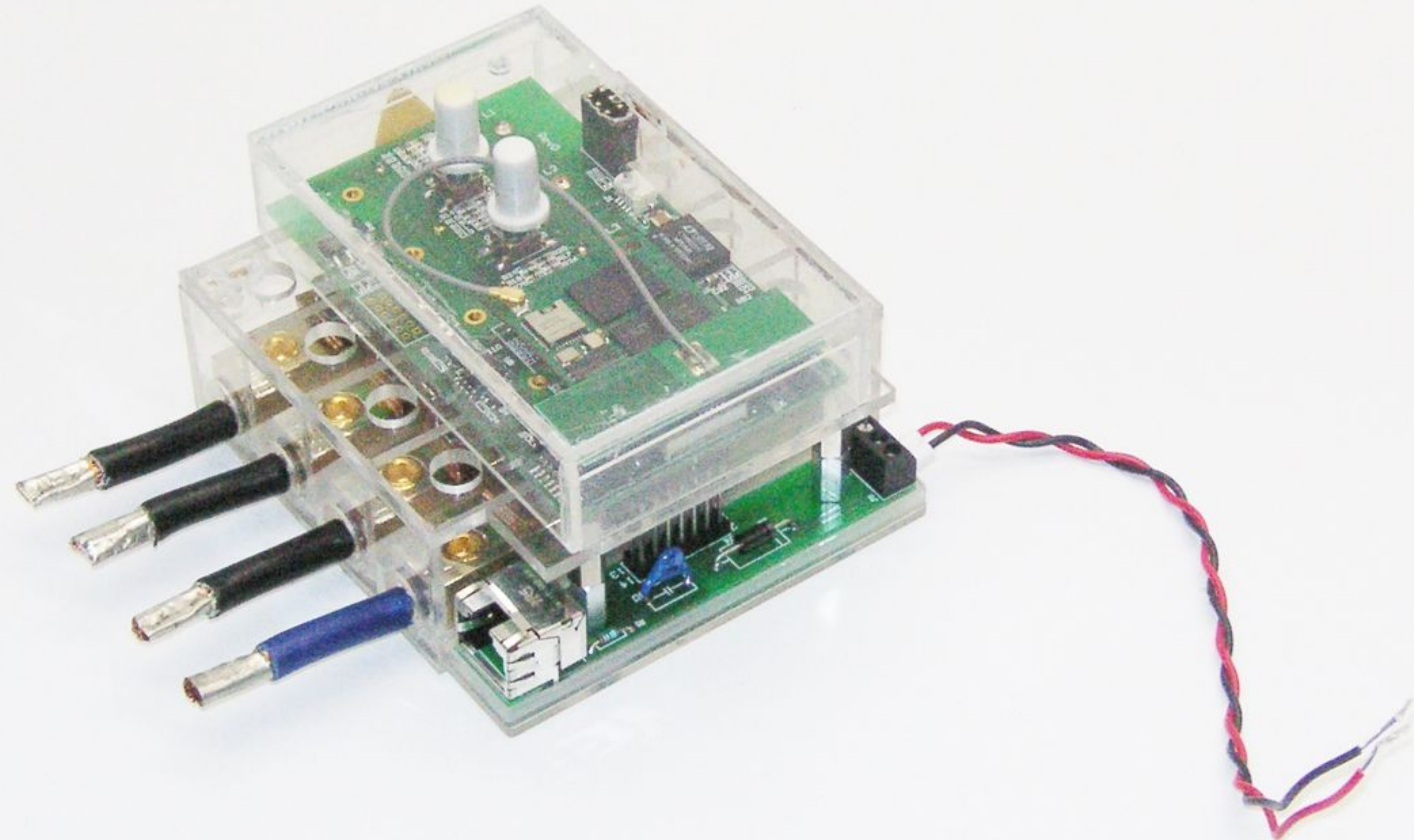




Evolution of the Babelbee



2011

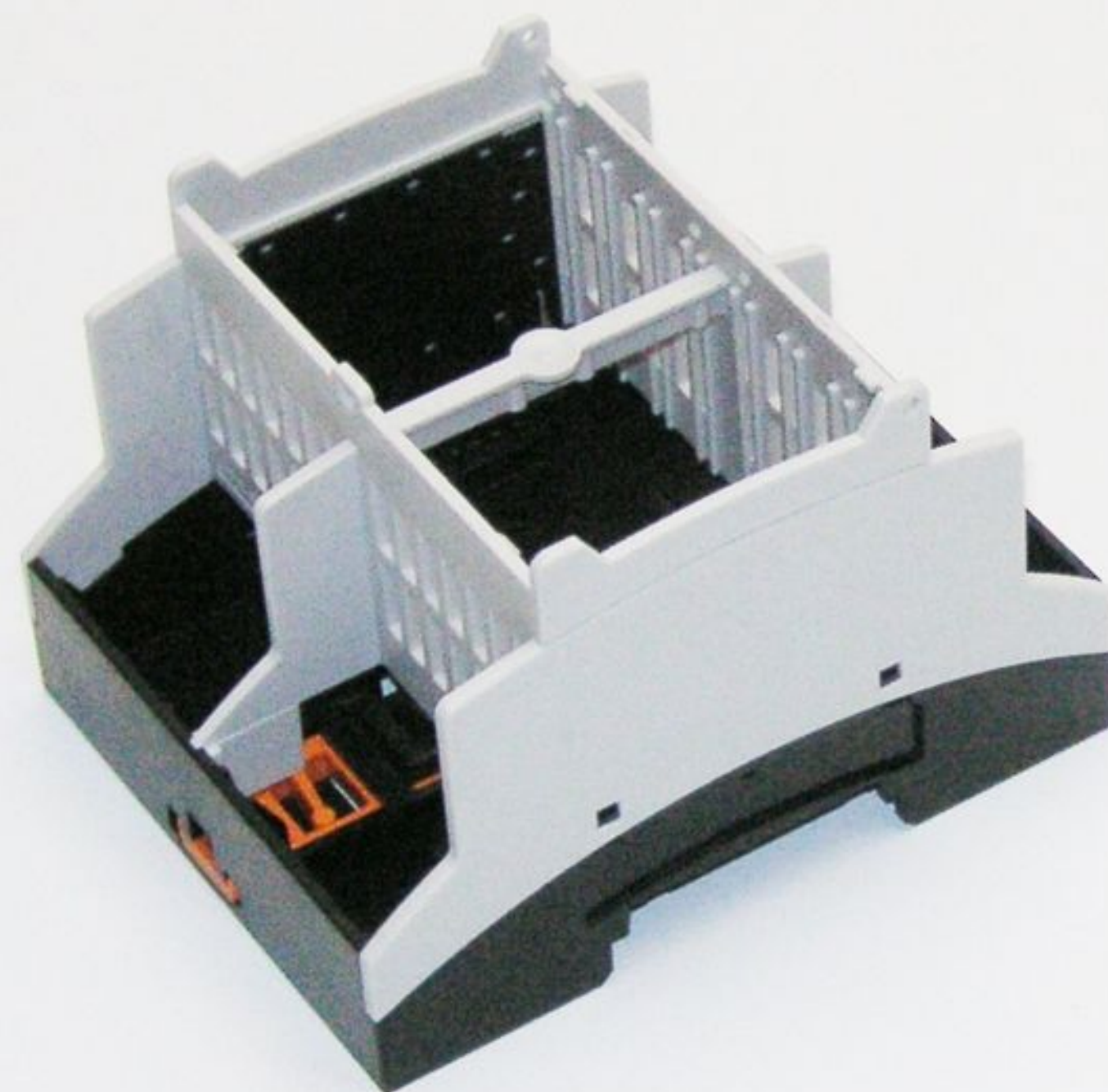




Evolution of the Babelbee



2012

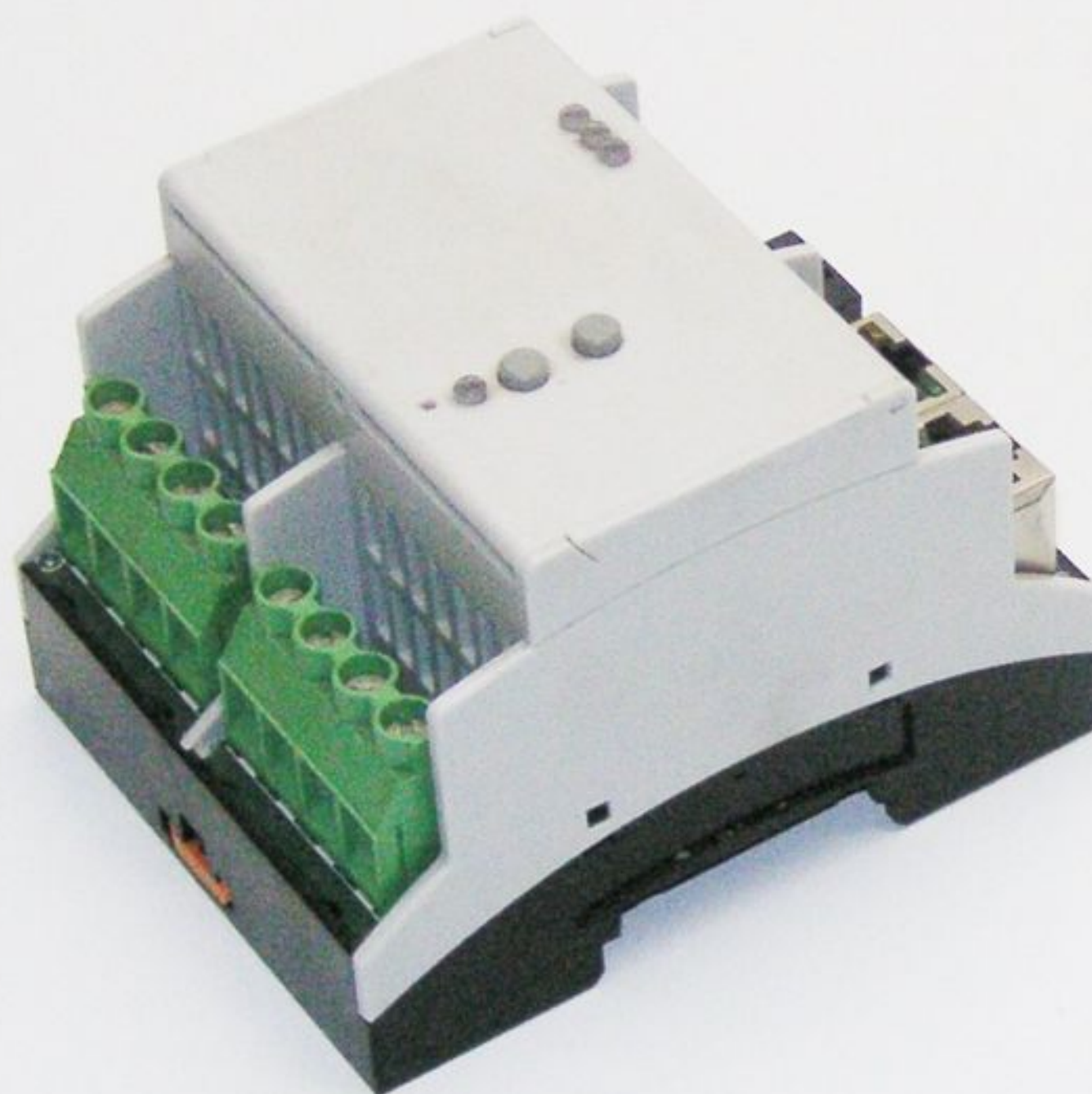




Evolution of the Babelbee



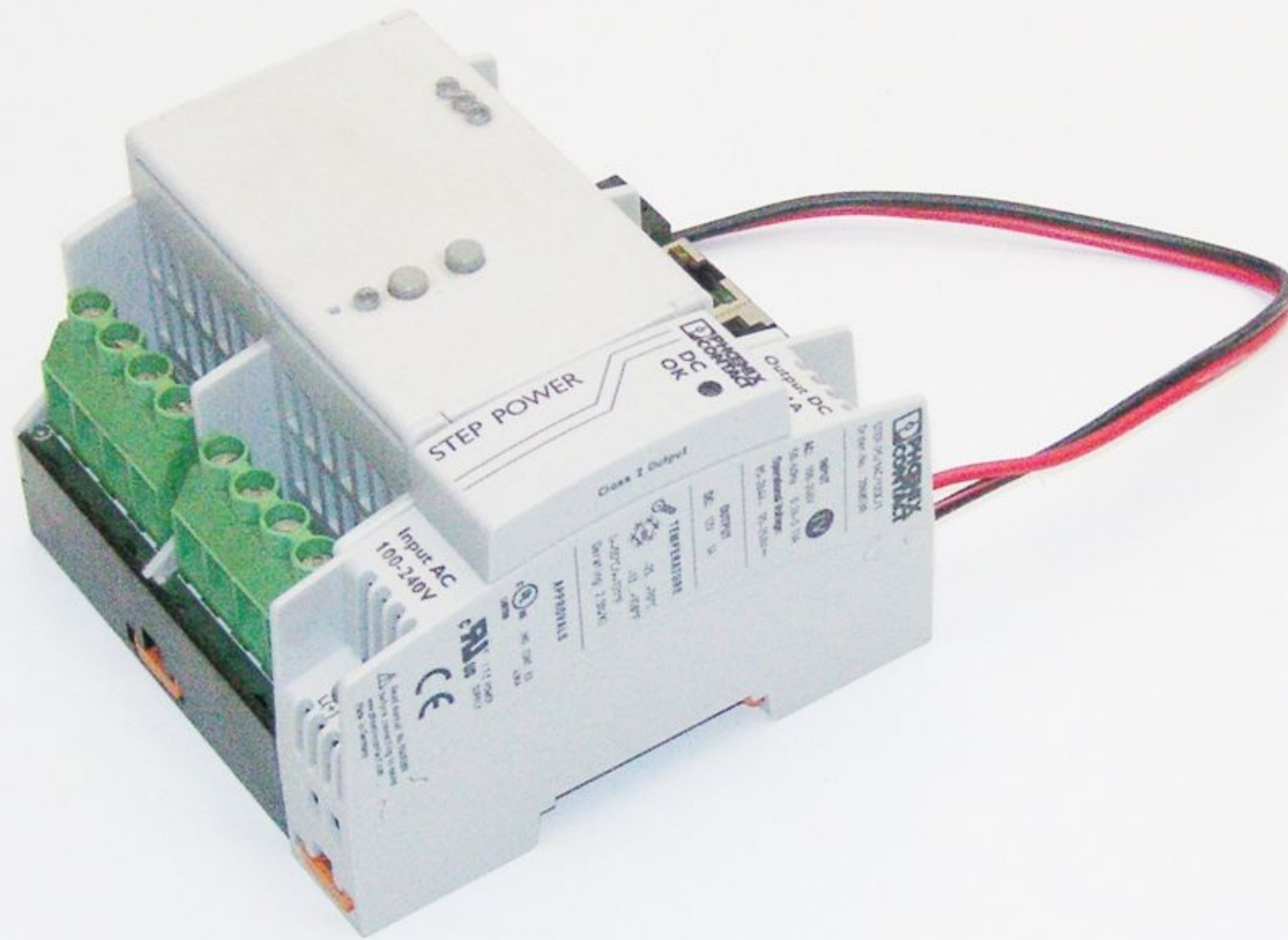
2013





Evolution of the Babelbee

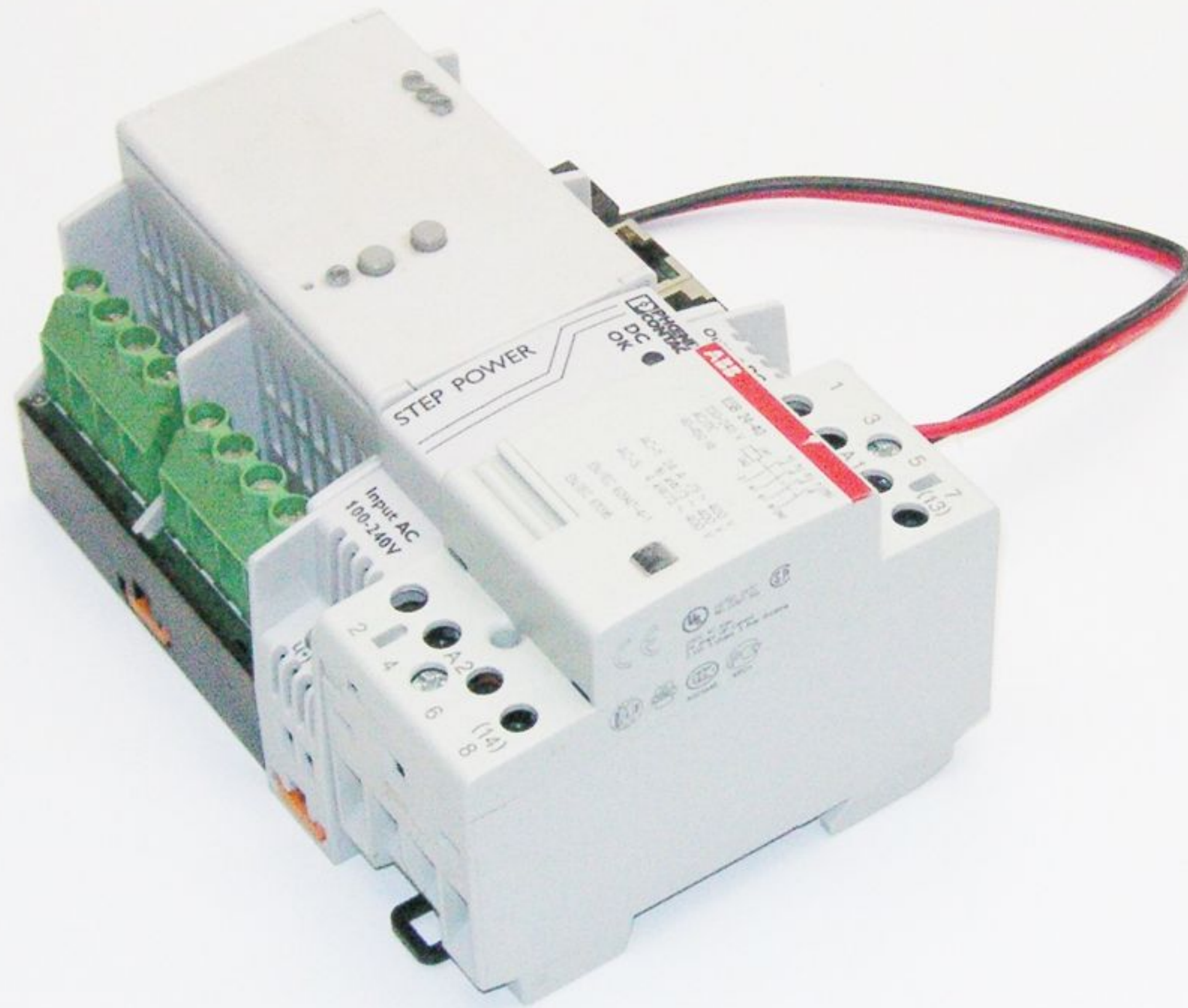

2013





Evolution of the Babelbee

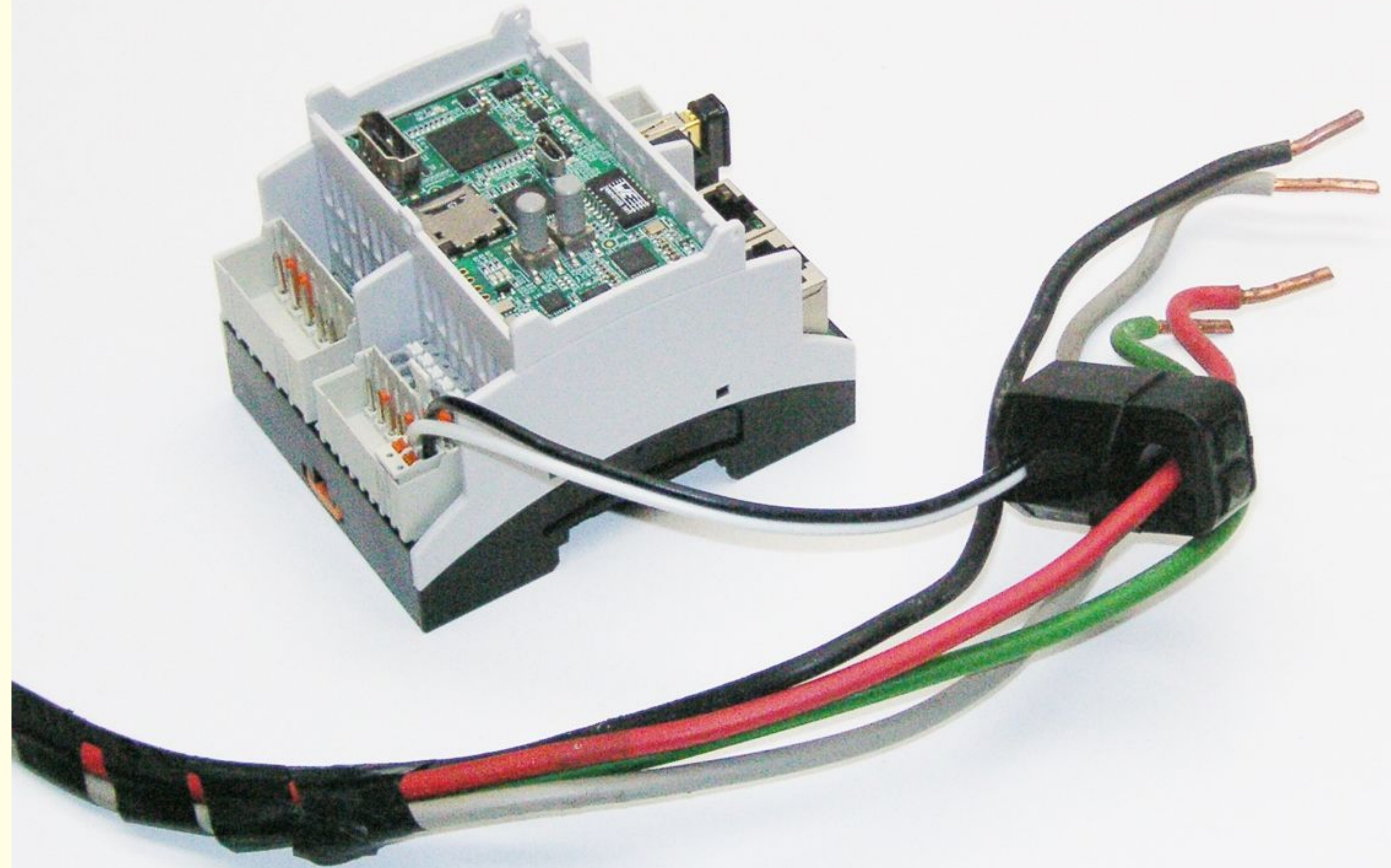
A series of five hexagons in orange, light blue, dark blue, yellow, and green, arranged in a diagonal line from bottom-left to top-right.
2013





Evolution of the Babelbee

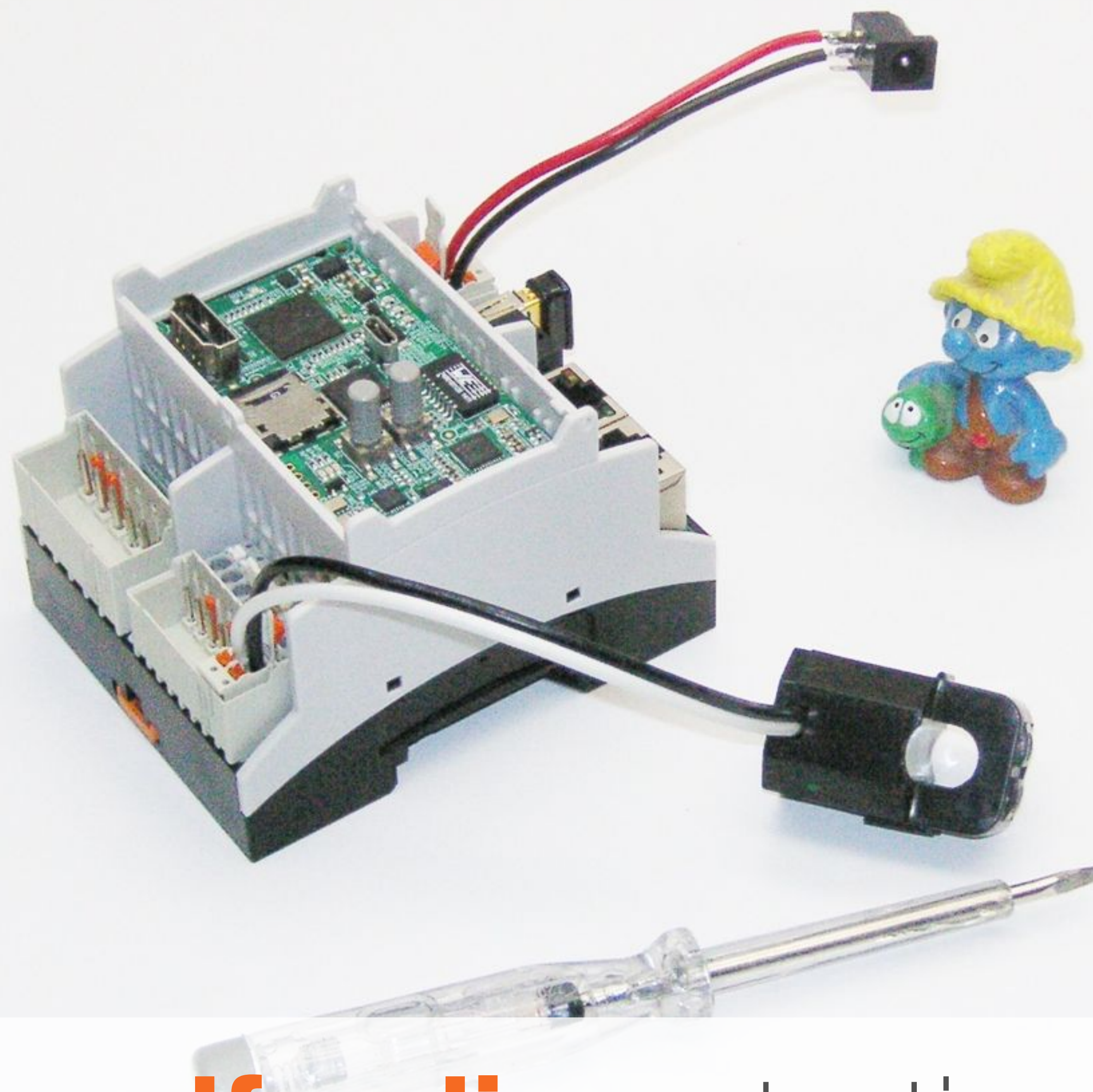
A series of five hexagons in a diagonal line, colored from bottom-left to top-right: orange, light blue, dark blue, yellow, and green.
2014





Evolution of the Babelbee


2015



Crowdfunding starting soon...



Why it is froody!

More with less...

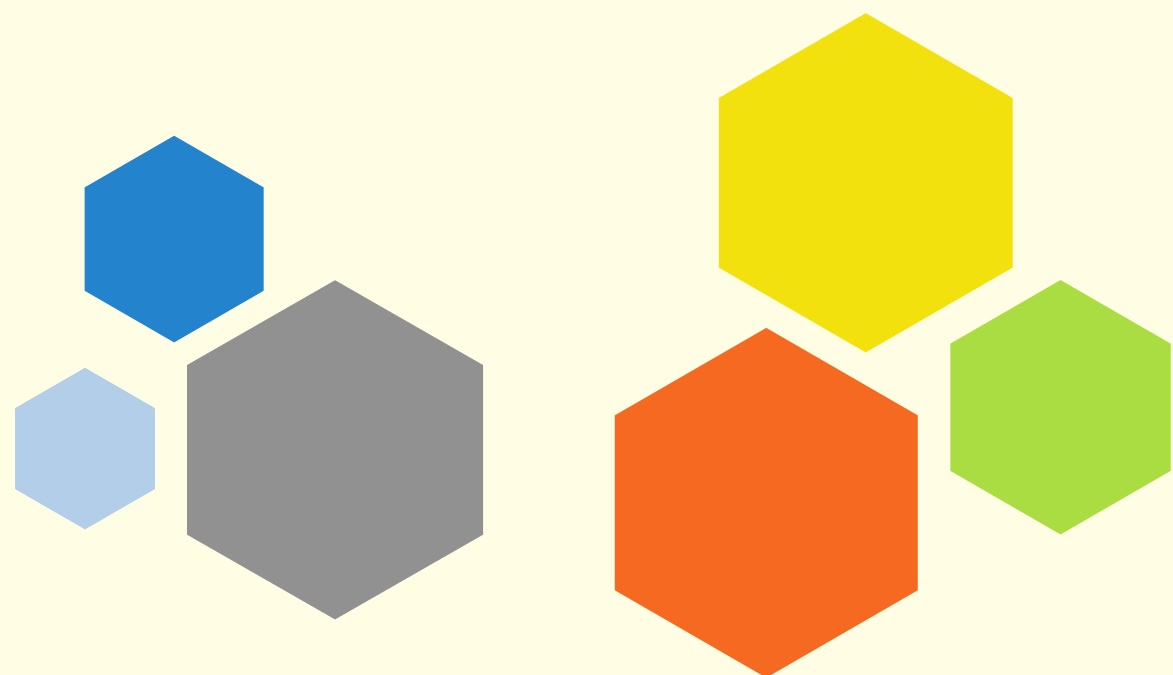


Why it is froody



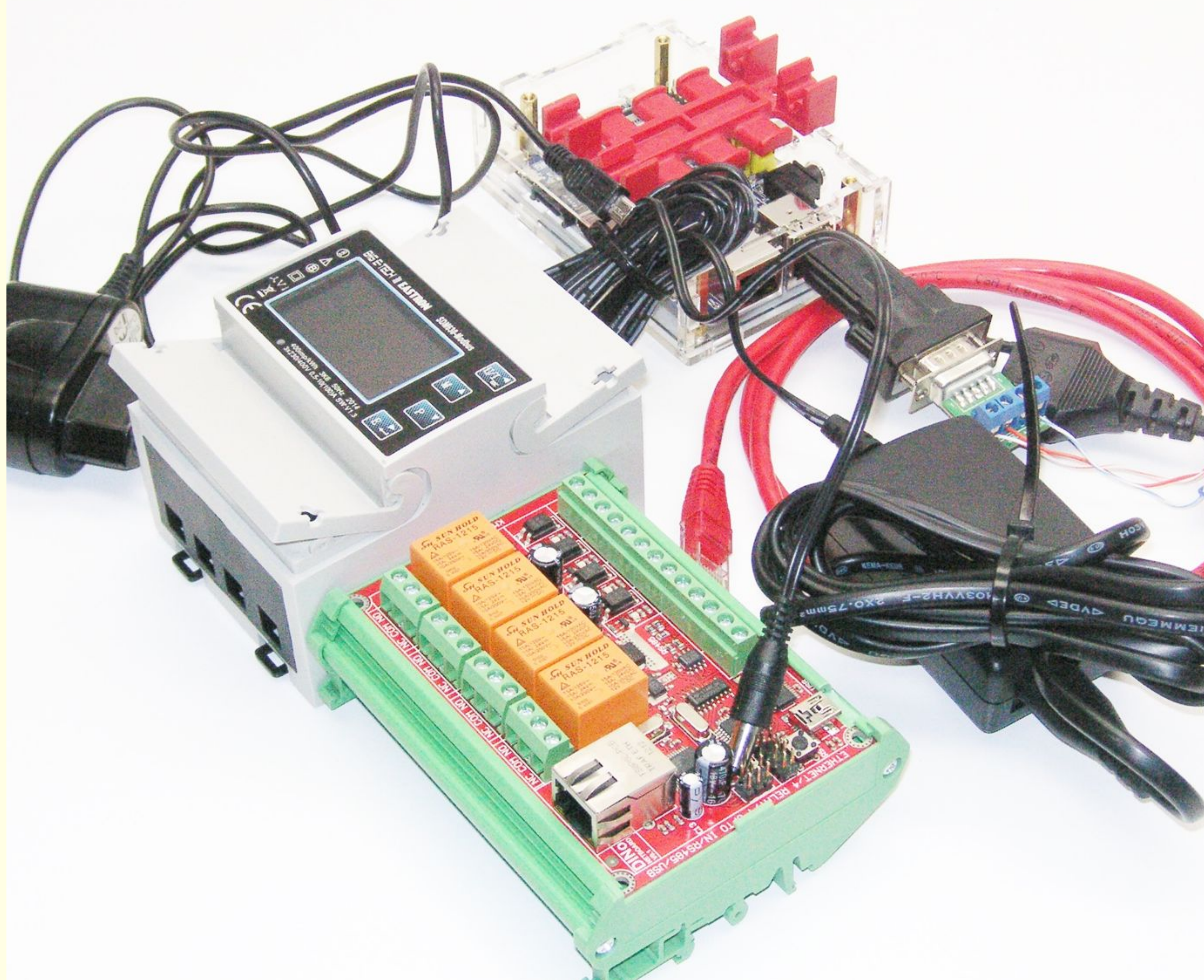
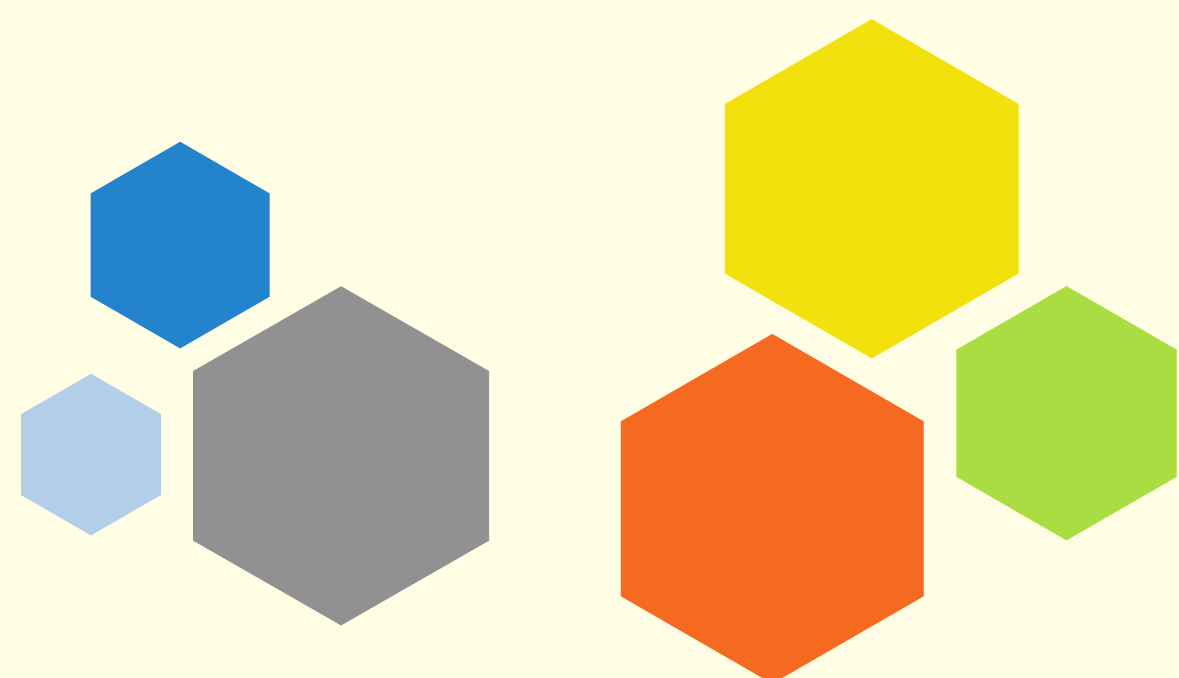


Why it is froody



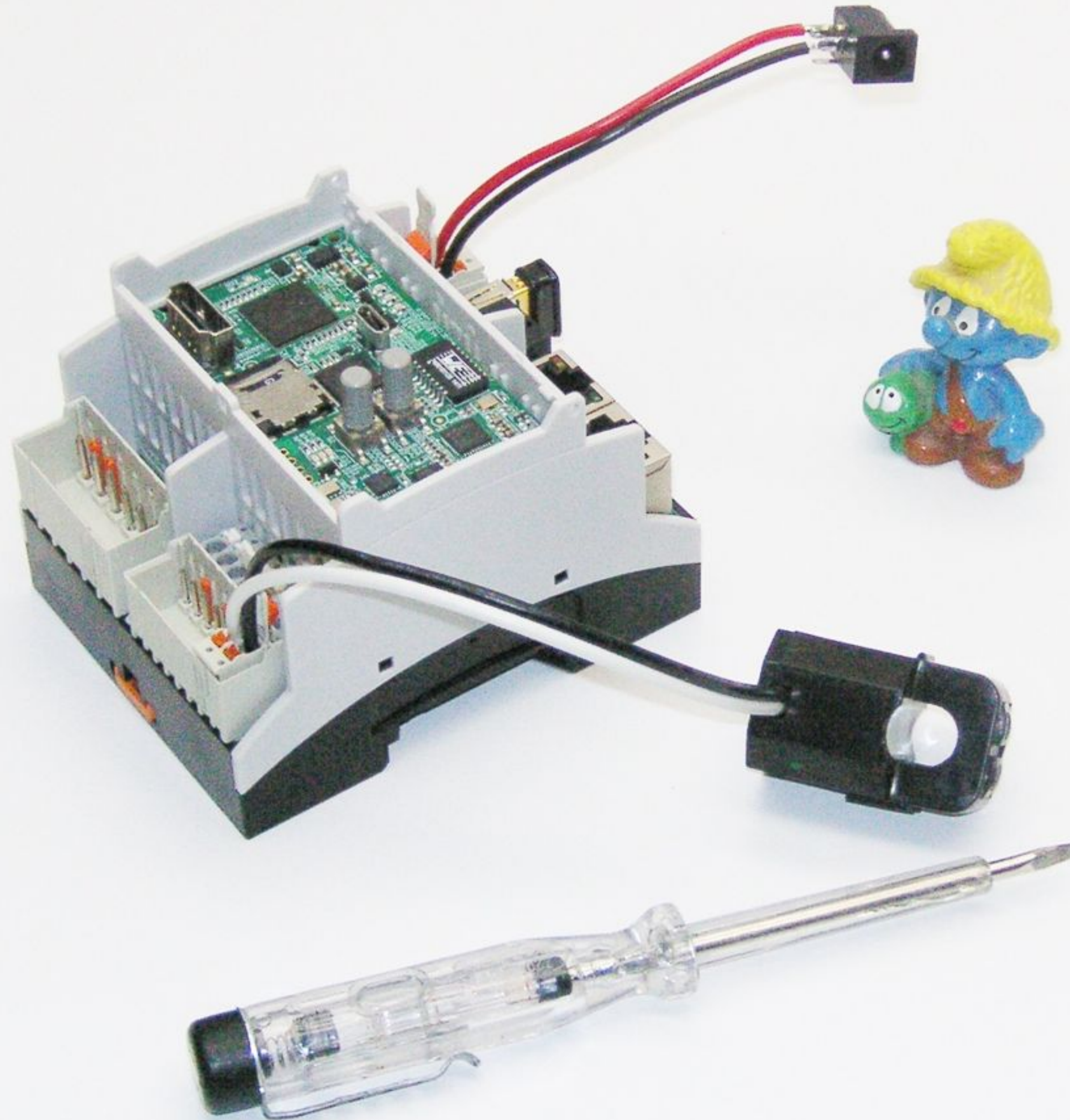
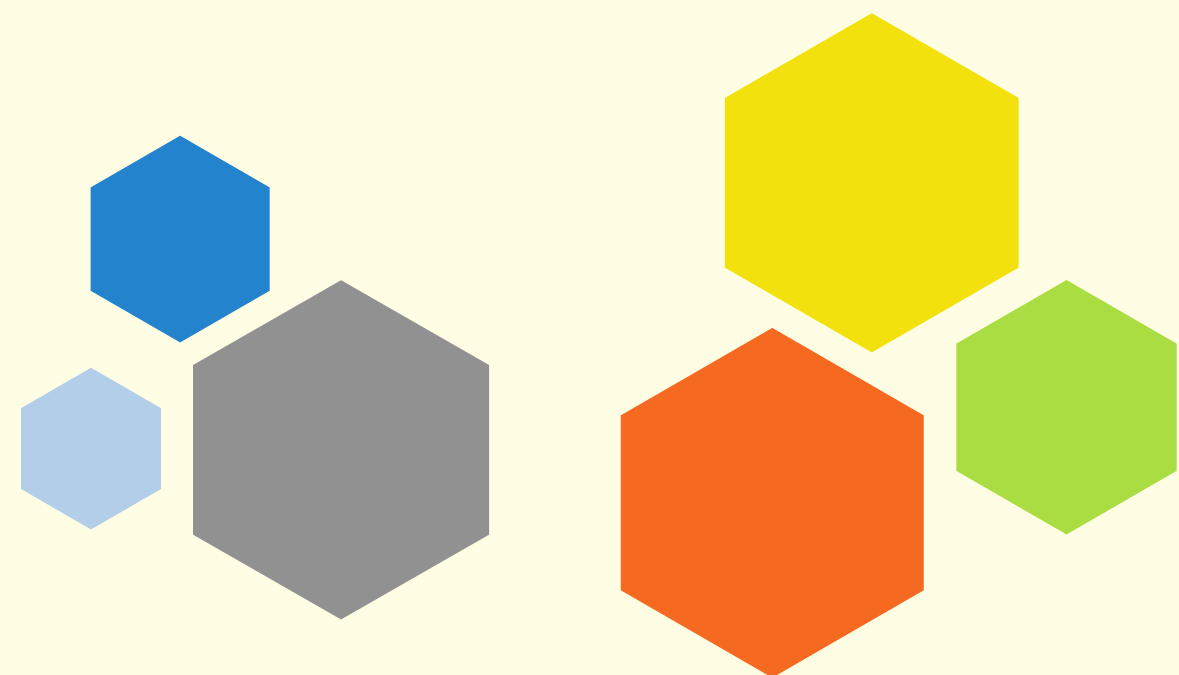


Why it is froody



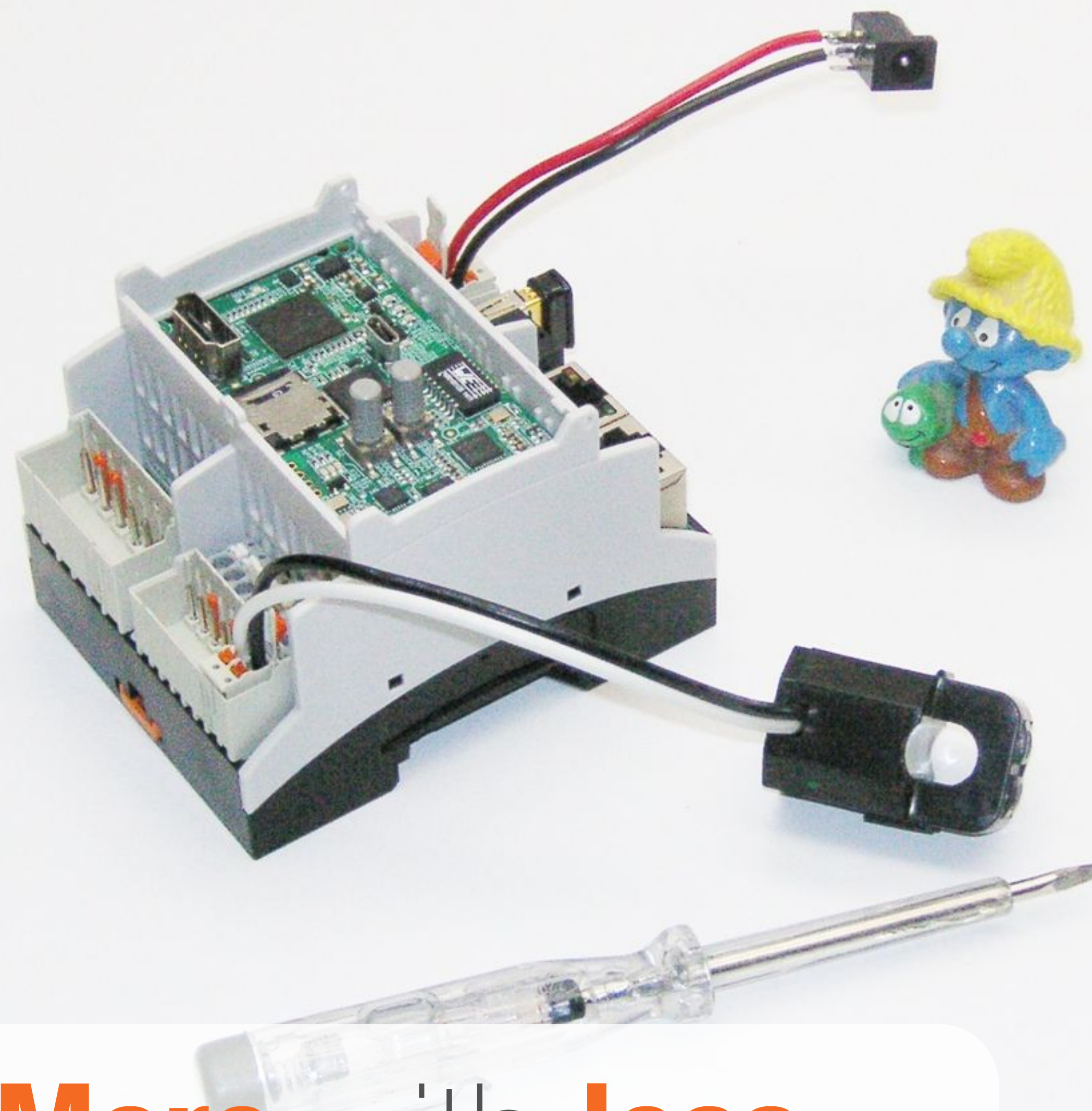


Why it is froody





Why it is froody



More with **less...**

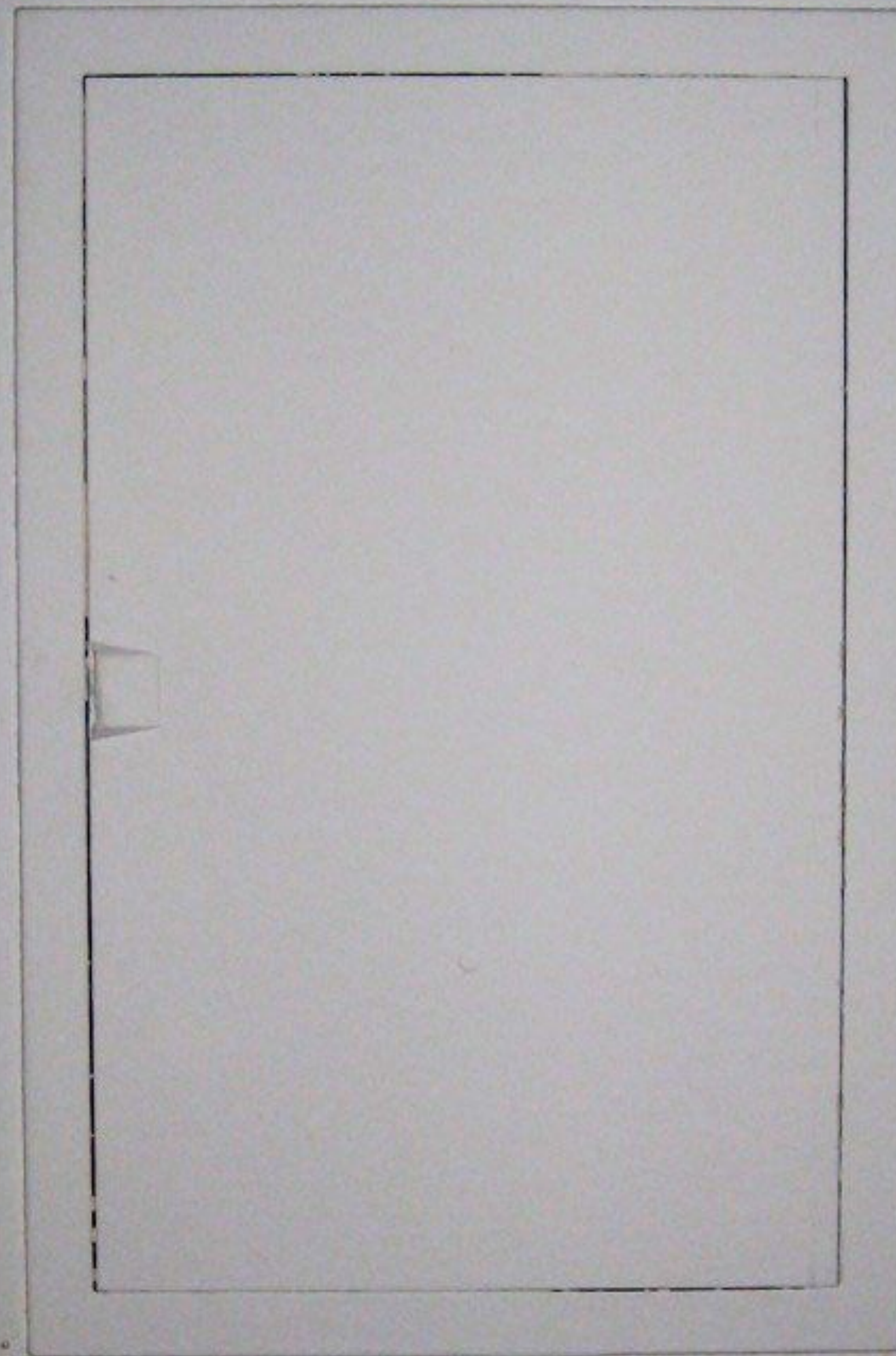
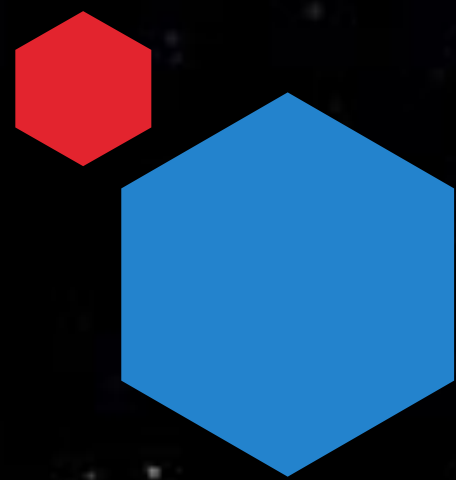


Reality rules

The laws of the universe do not care about human theories!

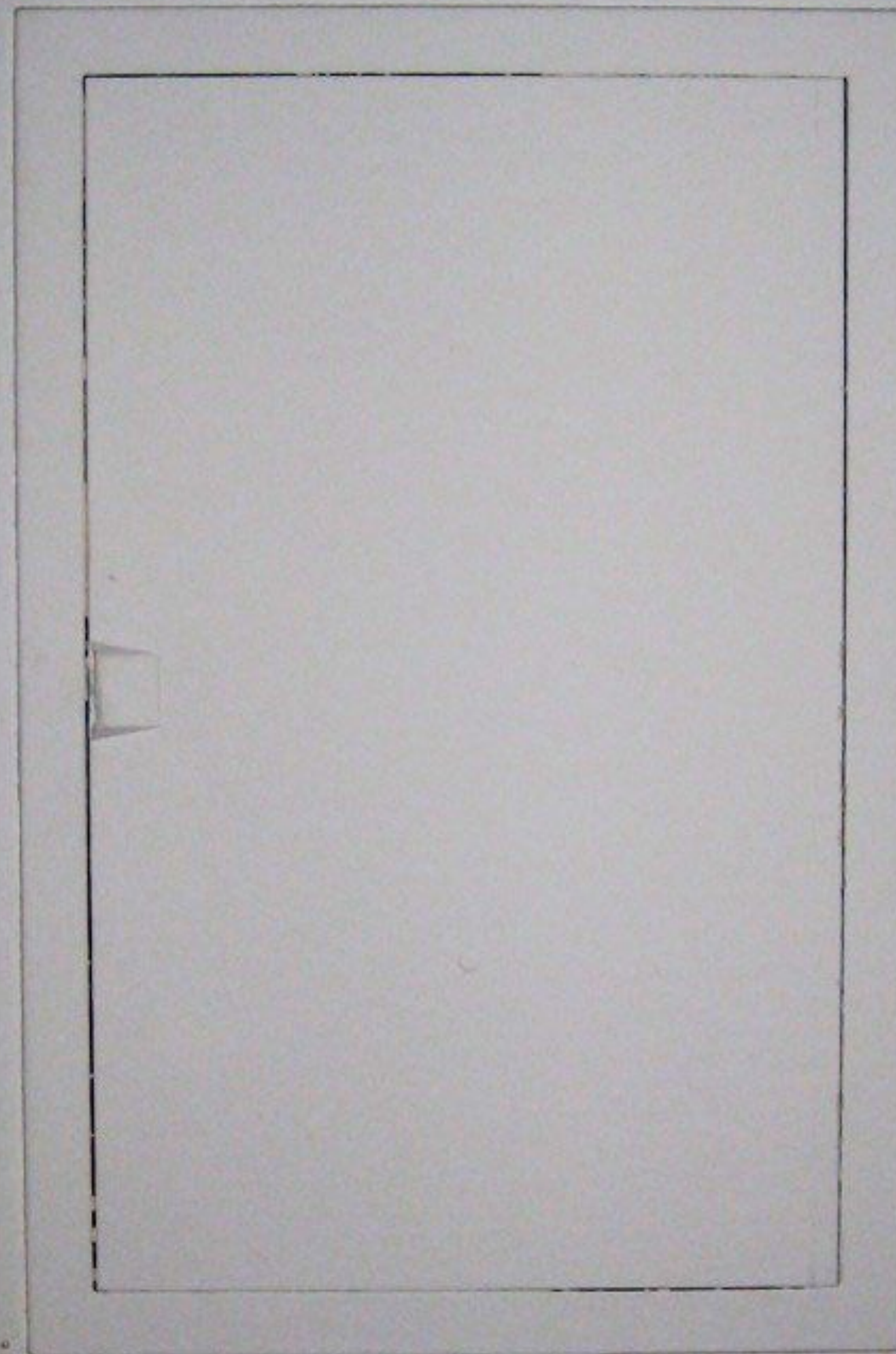
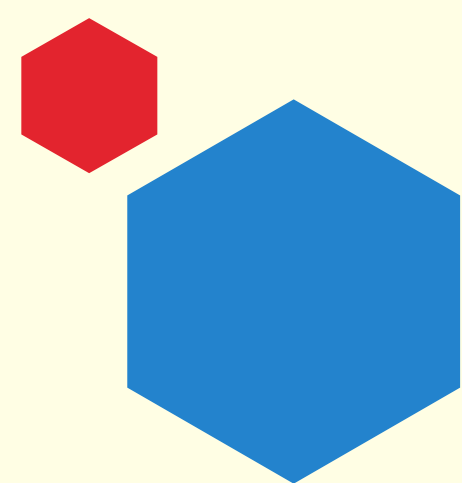


Reality rules



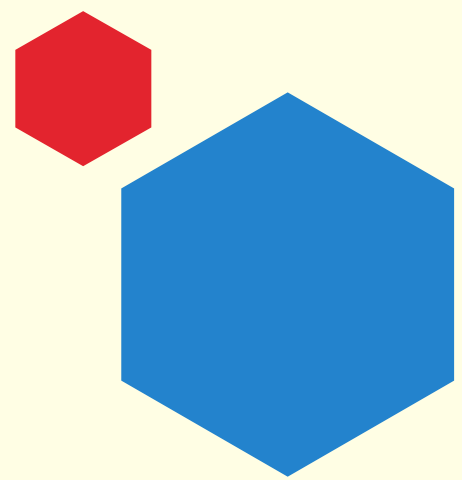


Reality rules





Reality rules

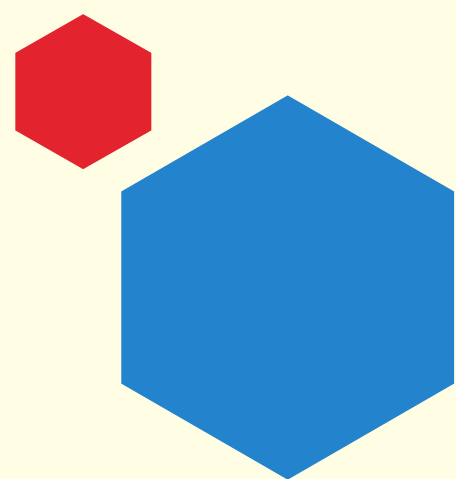


There is never
enough free space





Reality rules

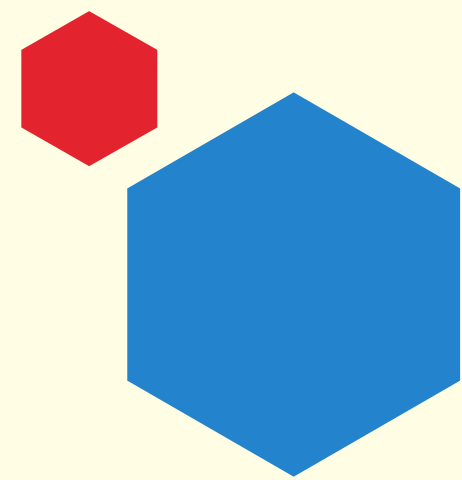


The future is here
to stay!





Reality rules



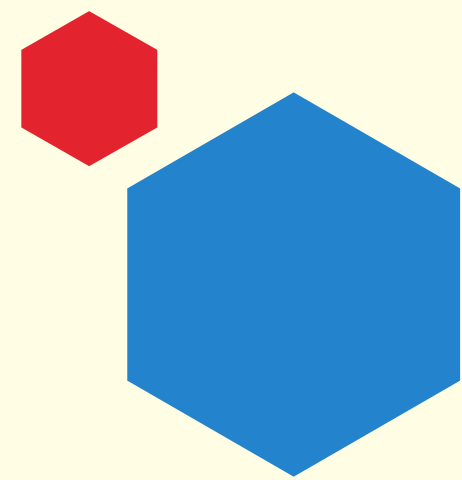
Decentralized is ...
decentralized?

80 GW_p

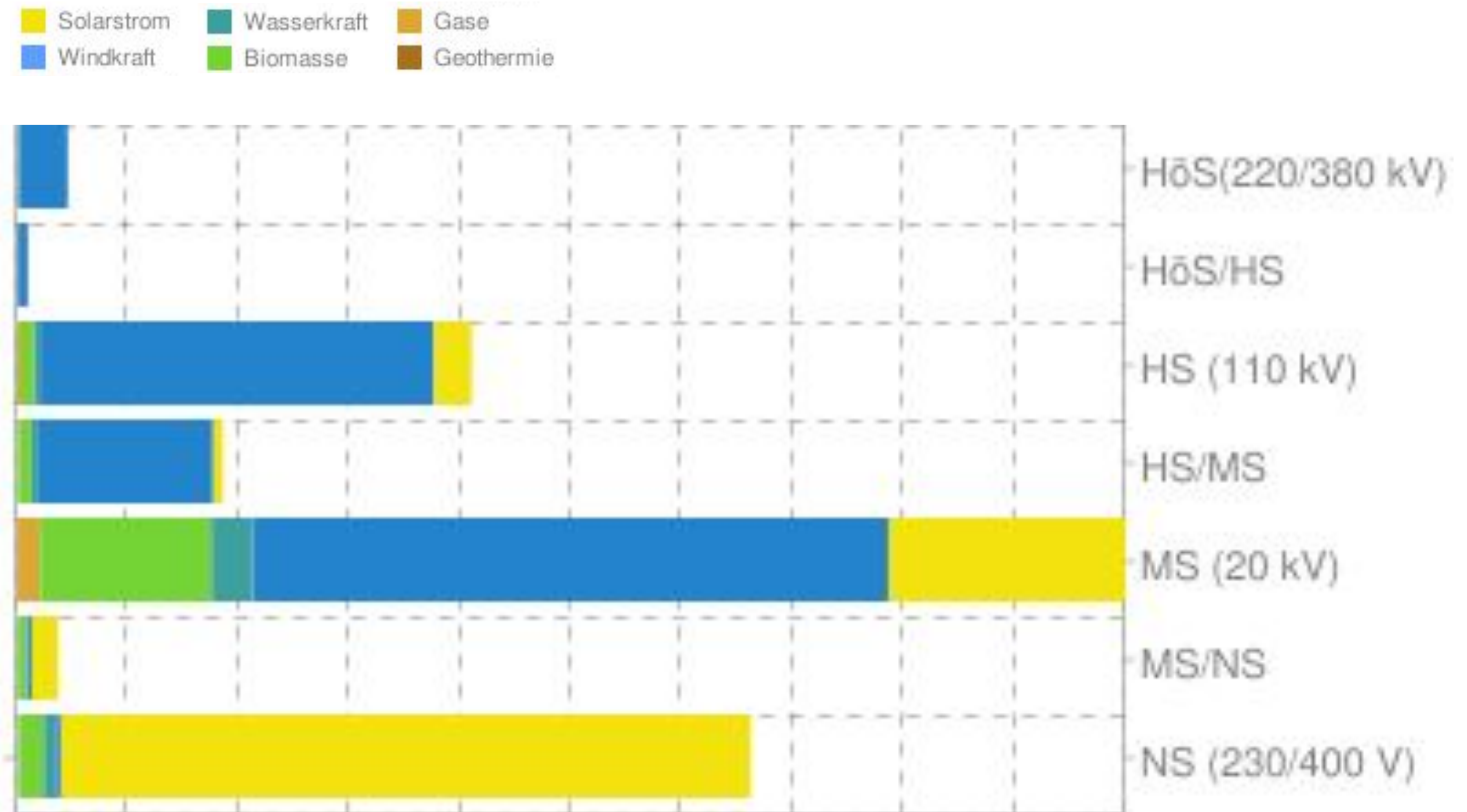
renewable power plants (Germany, 2014)



Reality rules



Decentralized is ...
decentralized?

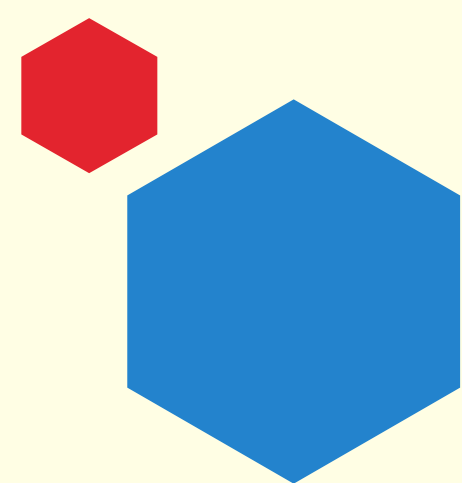


www.energymap.info: Power in kW_p

ca. 80 GW_p renewable power plants (Germany, 2014)

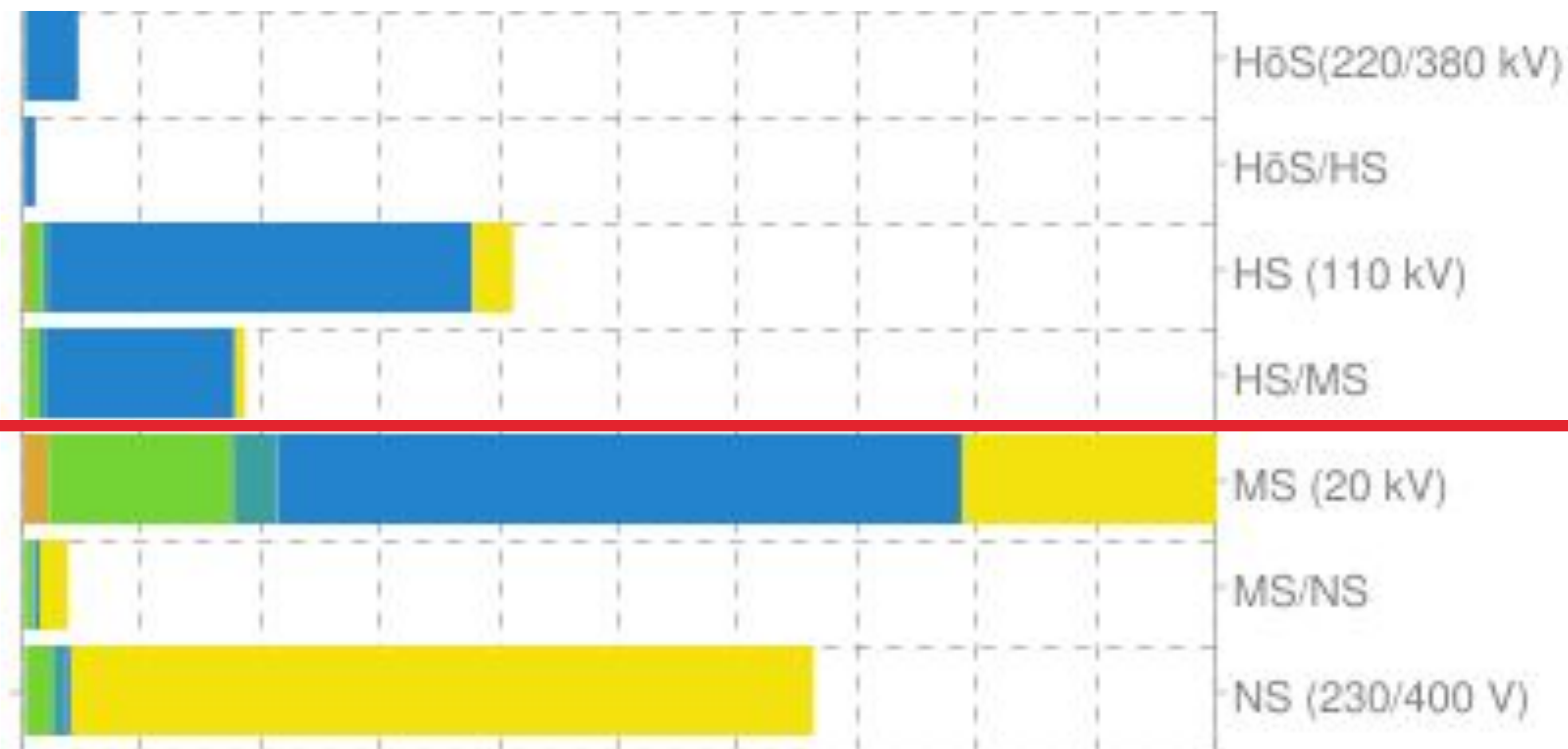


Reality rules



Decentralized is ...
decentralized?

Solarstrom Wasserkraft Gase
Windkraft Biomasse Geothermie



www.energymap.info: Power in kW_p

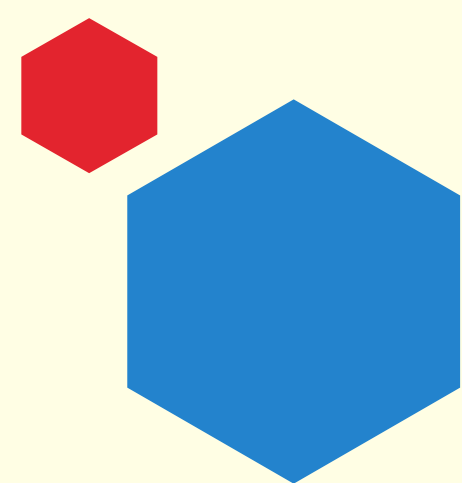
30 %

70 %

ca. 80 GW_p renewable power plants (Germany, 2014)

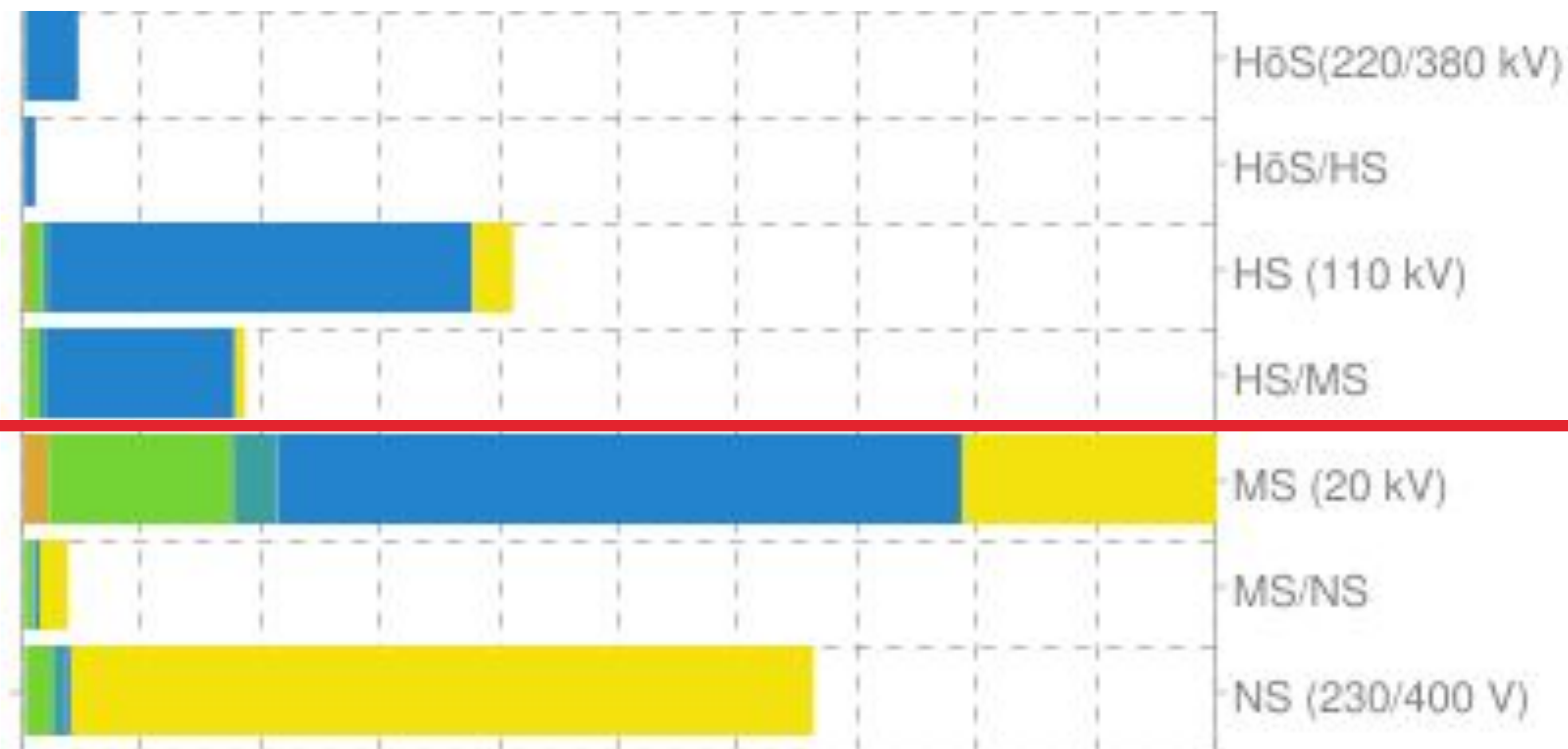


Reality rules

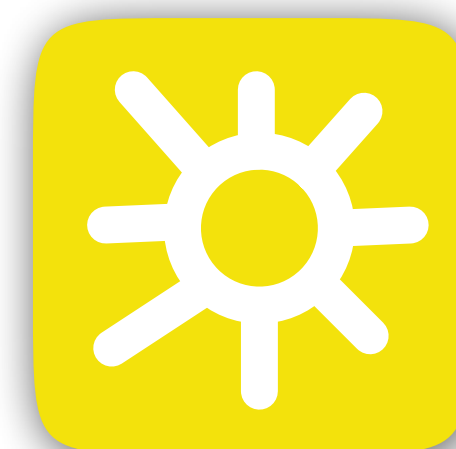


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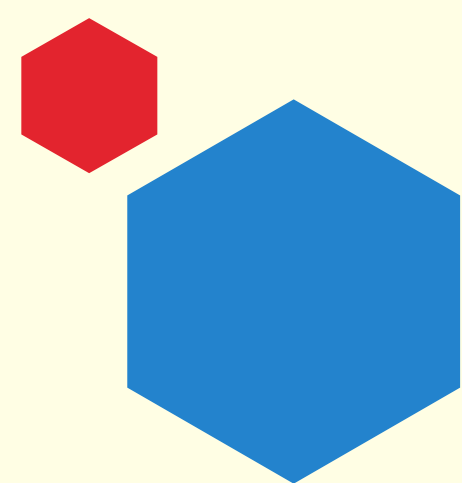


95 %

ca. 80 GW_p renewable power plants (Germany, 2014)

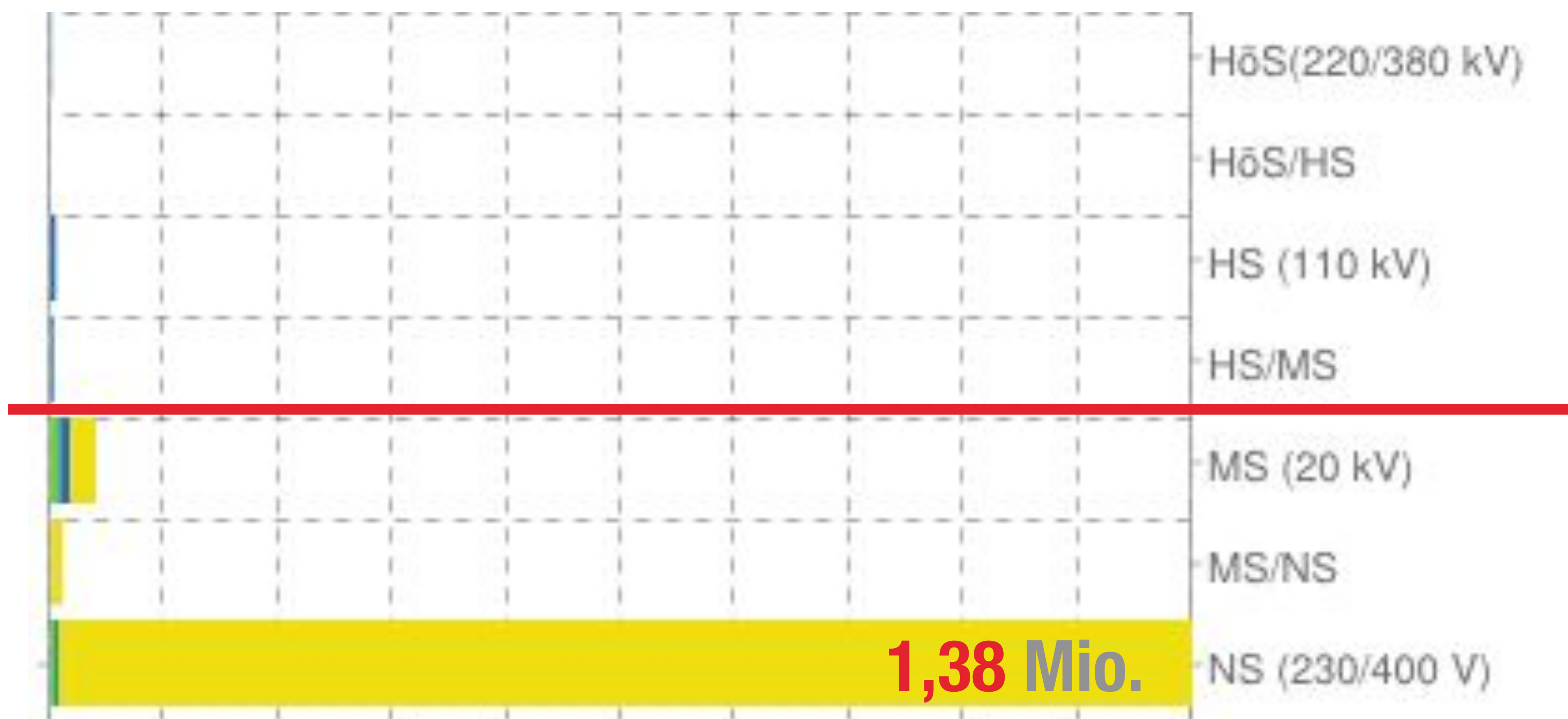


Reality rules



Decentralized is ...
decentralized?

Solarstrom Wasserkraft Gase
Windkraft Biomasse Geothermie



www.energymap.info: Unit count



95 %

1,45 Mio. renewable power plants (Germany, 2014)



Bundesministerium
für Wirtschaft
und Energie

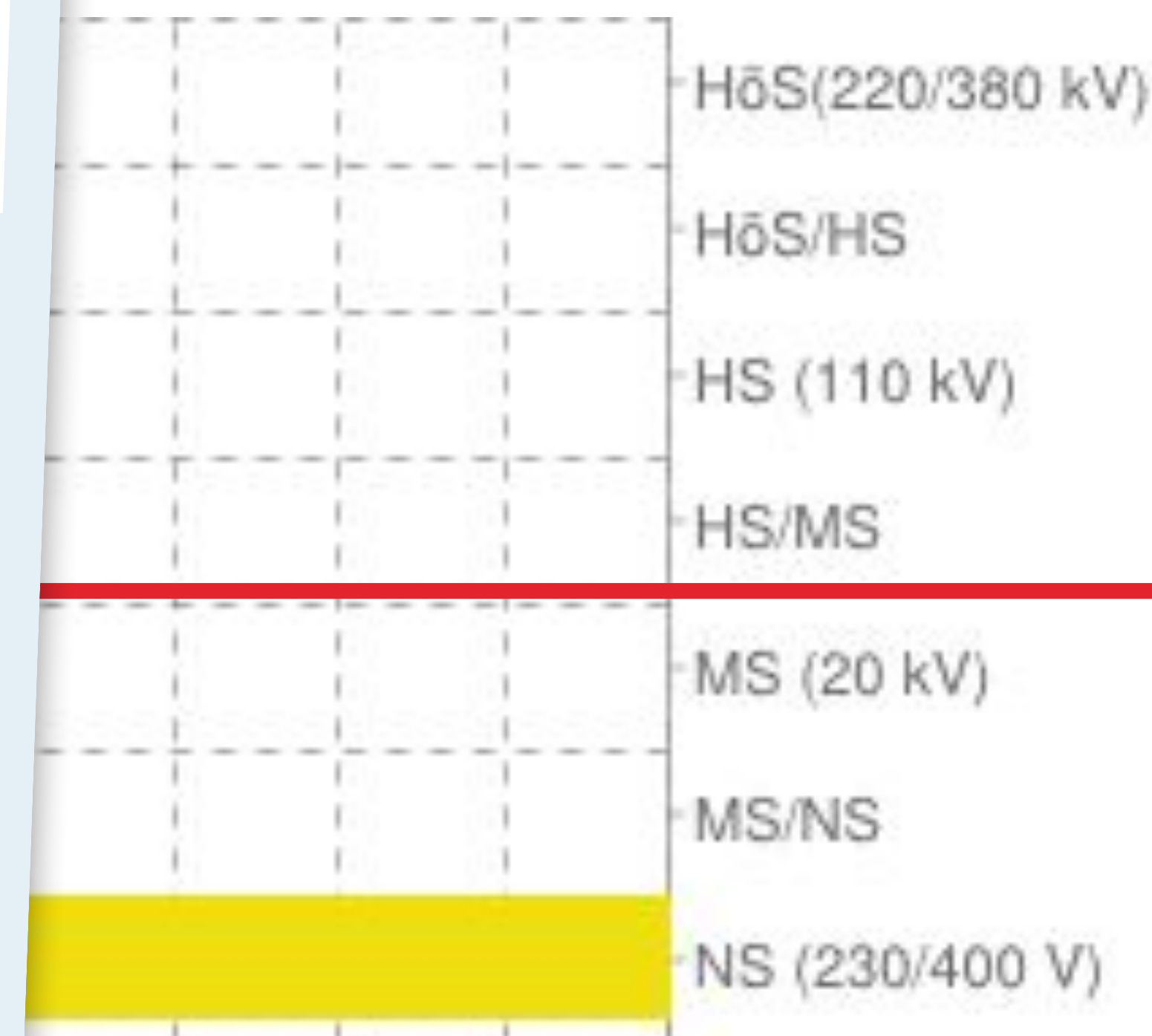
Baustein für die Energiewende: 7 Eckpunkte für das „Verordnungspaket Intelligente Netze“

I. Die Notwendigkeit eines energiewendetauglichen Smart Metering

Die fluktuierende Stromerzeugung aus erneuerbaren Energien stellt besondere Anforderungen an das Stromversorgungssystem. Dieses muss zur Netz- und Marktintegration der Erneuerbaren stets ausreichend Kapazitäten und Flexibilitäten zum Ausgleich oder zur Abnahme des volatilen erneuerbaren Stroms bereithalten. Zusammengehalten wird ein solches System von intelligenten Netzen, die nicht nur Strom transportieren und verteilen, sondern stets auch das notwendige Gleichgewicht zwischen Erzeugung und Verbrauch sicherstellen müssen. Die hohen Anforderungen hat nicht zuletzt die im September 2014 veröffentlichte BMWi Verteilernetzstudie aufgezeigt.

Kommunikation wird zu einer Grundanforderung solcher intelligenten Netze. Deshalb ist es erforderlich, dass Erzeugungsanlagen, steuerbare Lasten sowie insbesondere Eigenerzeugung mit Eigenverbrauch und alle diejenigen, die Flexibilität anbieten bzw. von variablen Tarifen profitieren wollen, sichere standardisierte Kommunikationsverbindungen nutzen können. So kann gewährleistet werden, dass insbesondere Netzbetreiber, Lieferanten, Vermarkter, Dienstleister und Bilanzkreisverantwortliche zeitnah über zuverlässige Informationen verfügen, die nicht nur Prognosen auf Basis von Schätzungen, Vorjahreswerten oder unpräzisen Standardlastprofilen sind. Zur Gewährleistung von Datenschutz und Datensicherheit muss die erforderliche Datenkommunikation im intelligenten Netz geregelt werden. Von der notwendigen Kommunikationsinfrastruktur sollten auch andere Sparten (wie z. B. Gas, Wasser, Heizwärme und sog. Mehrwertdienste) profitieren können. Allein dadurch sind Kosteneinsparungen, Effizienz- und Komfortgewinne möglich. Mit den richtigen Schritten kann Deutschland hier, wie bei der Energiewende insgesamt, ein Vorreiter sein.

Versehen mit dem Schutzprofil des Bundesamts für Sicherheit in der Informationstechnik (BSI) ist...



95 %

ower plants (Germany, 2014)



Bundesministerium
für Wirtschaft
und Energie

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Versehen mit dem Schutzprofil des Bundesamts für Sicherheit in der Informationstechnik (BSI):

s to build a

Grid

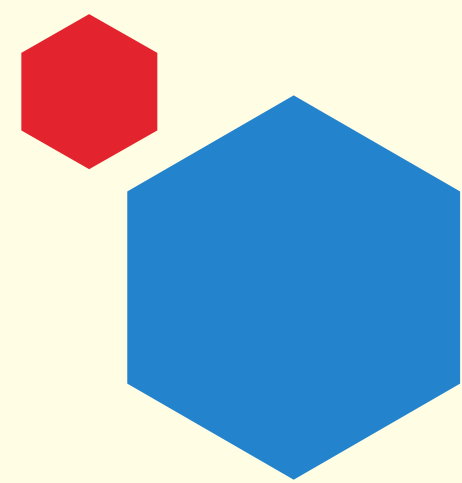
install

Meters

power plants (Germany, 2014)



Reality rules



The solution is to build a

Smart Grid

and install

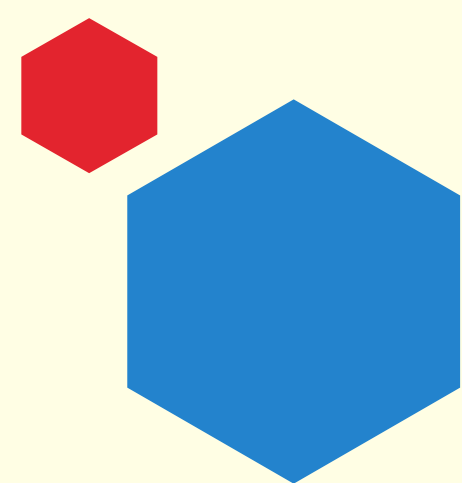
Smart Meters



1,45 Mio. renewable power plants (Germany, 2014)



Reality rules



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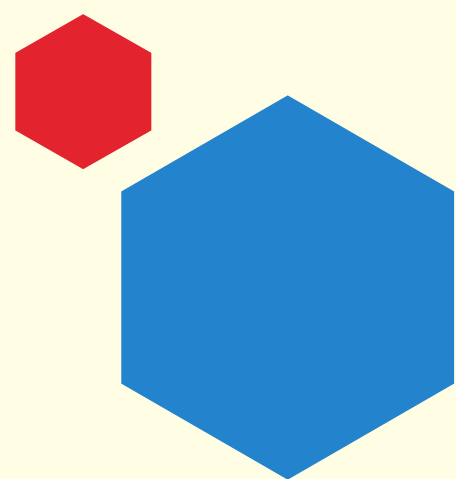
Smart Meters



30 Mio. ? power plants (Germany, 2014) **2030** ?



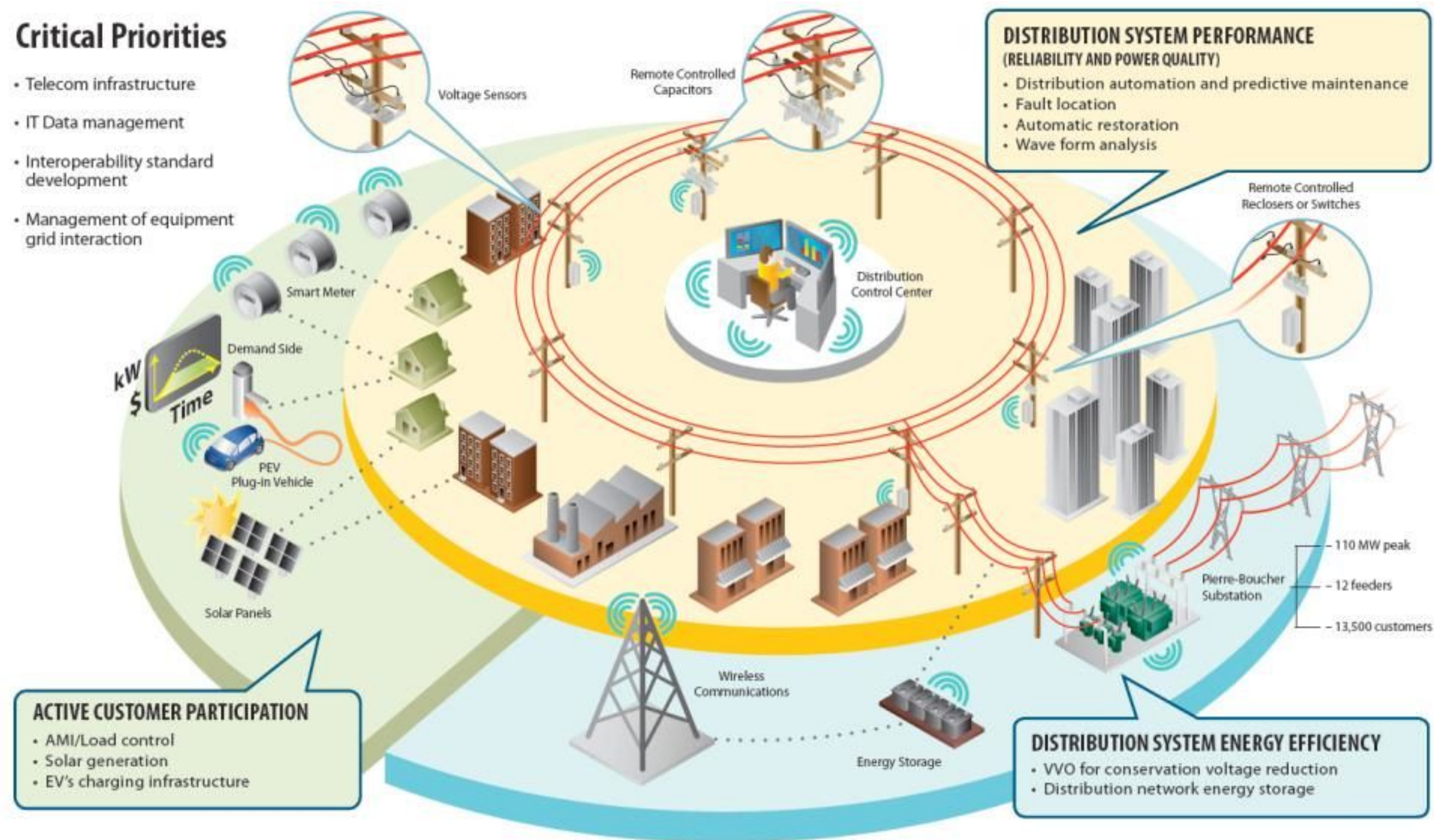
Reality rules



... even if all
buzzwords are in place

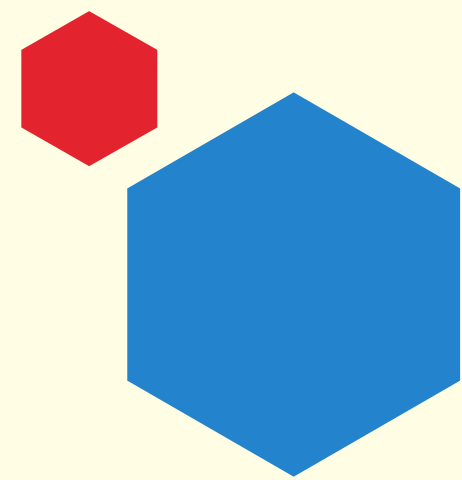
Critical Priorities

- Telecom infrastructure
- IT Data management
- Interoperability standard development
- Management of equipment grid interaction





Reality rules



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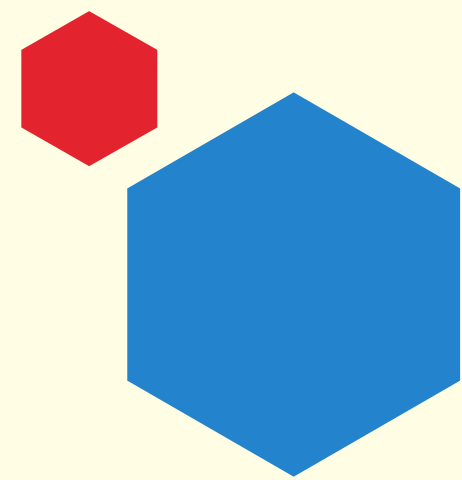
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Reality rules



All buzzwords are
in place

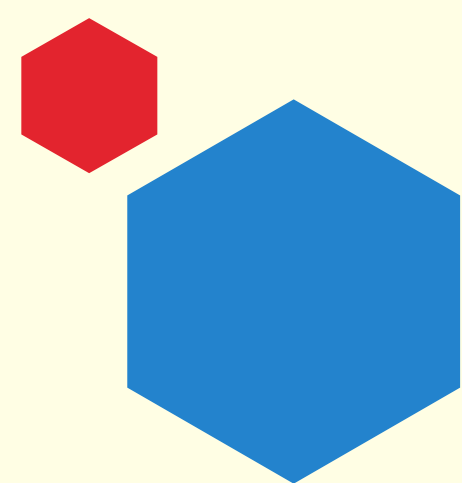
The all mighty “puppet master”

Distribution Control Center



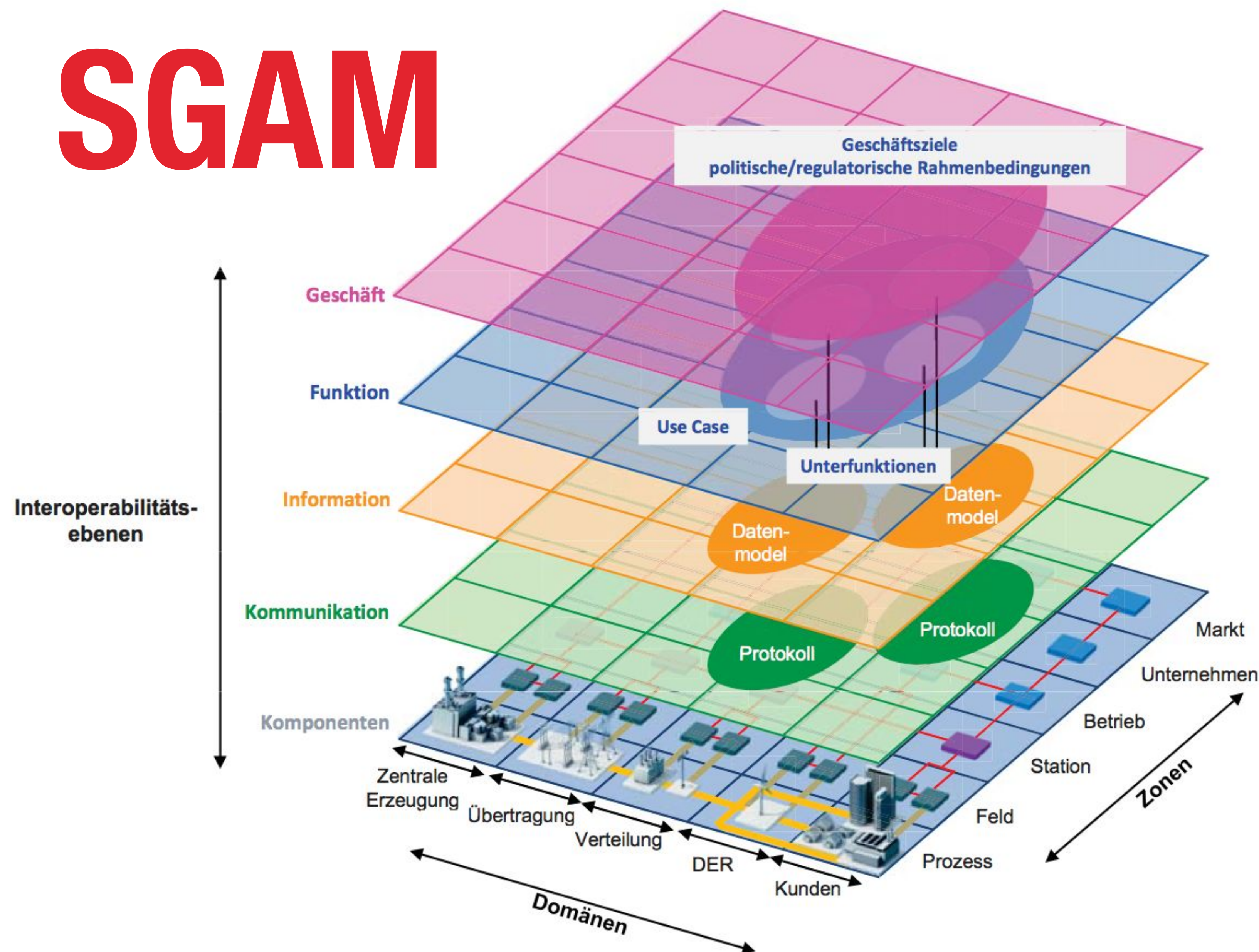


Reality rules



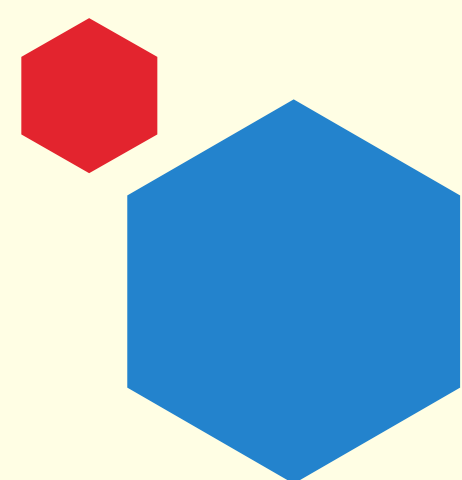
... even if all
buzzwords are in place

SGAM

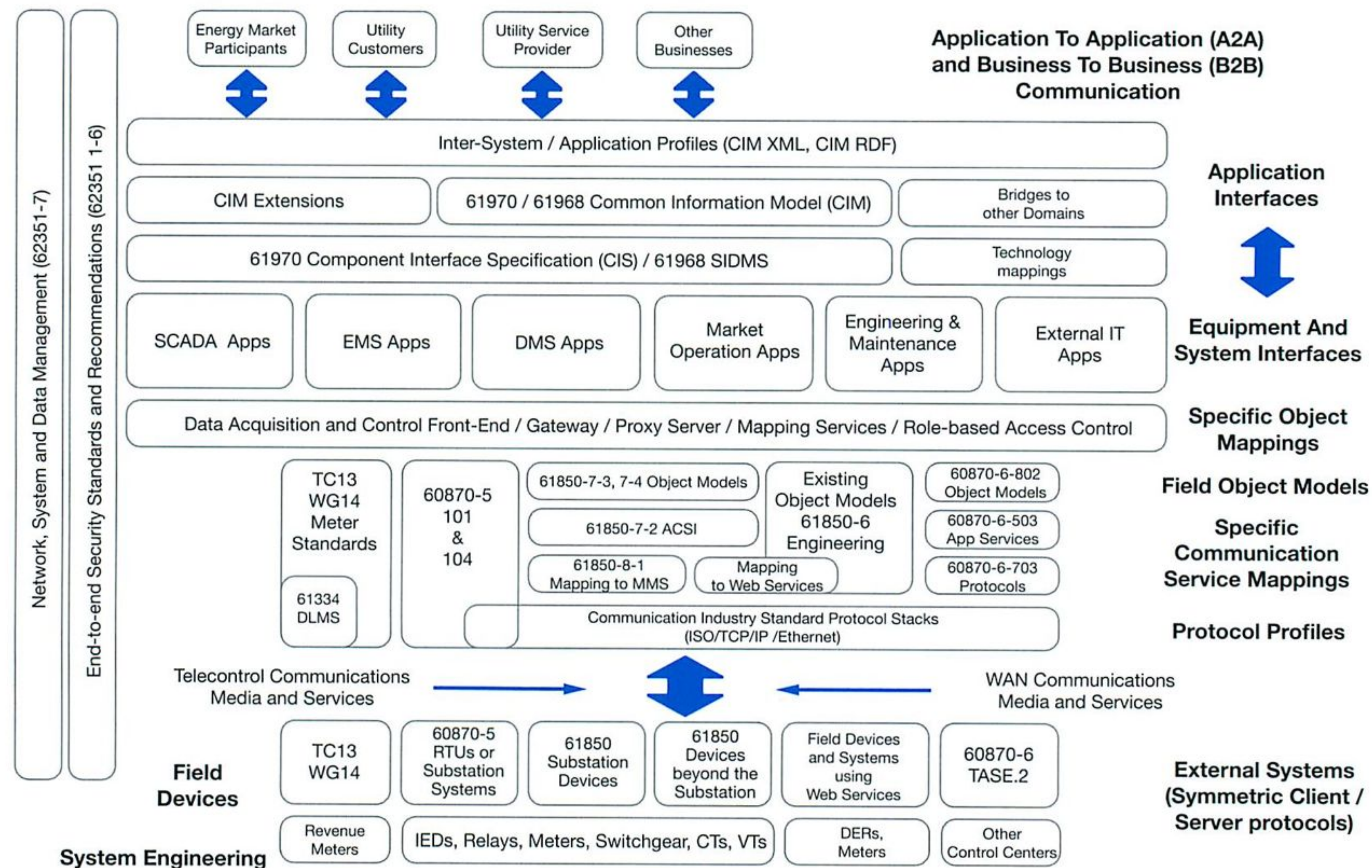




Reality rules

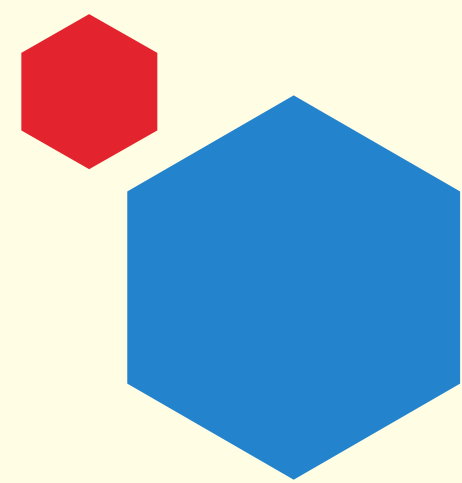


... even if all buzzwords are in place





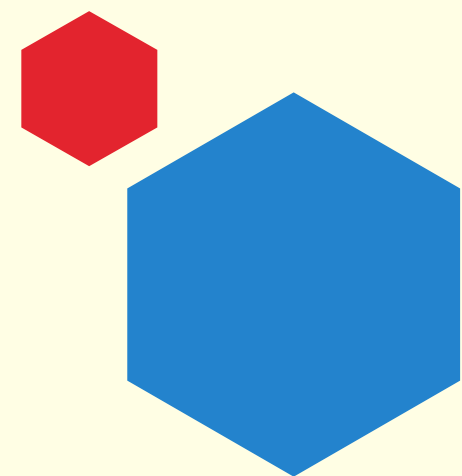
Reality rules



Systems **fail**
due to their own
complexity!



Reality rules



Deutscher Bundestag

17. Wahlperiode

Drucksache 17/5672

27. 04. 2011

Bericht

des Ausschusses für Bildung, Forschung und Technikfolgenabschätzung
(18. Ausschuss) gemäß § 56a der Geschäftsordnung

Technikfolgenabschätzung (TA)

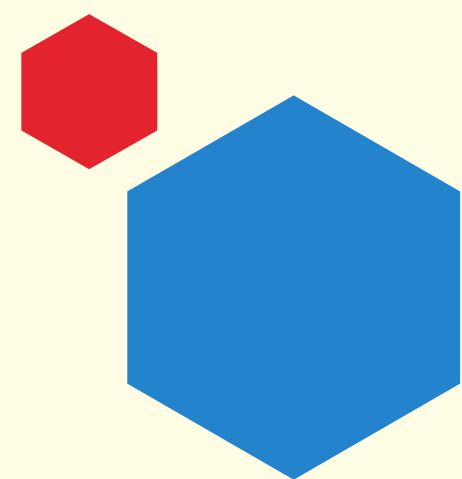
TA-Projekt: Gefährdung und Verletzbarkeit moderner Gesellschaften –
am Beispiel eines großräumigen und langandauernden Ausfalls
der Stromversorgung

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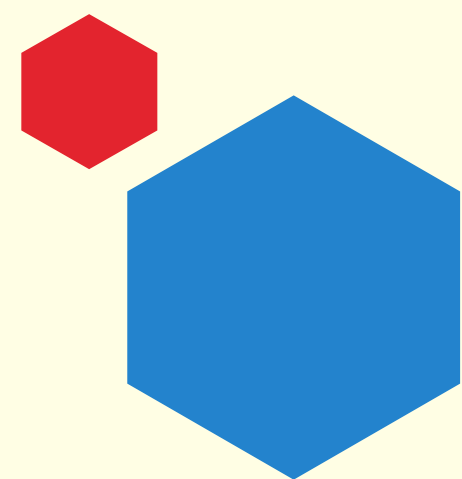
Communication

Reality rules





Reality rules



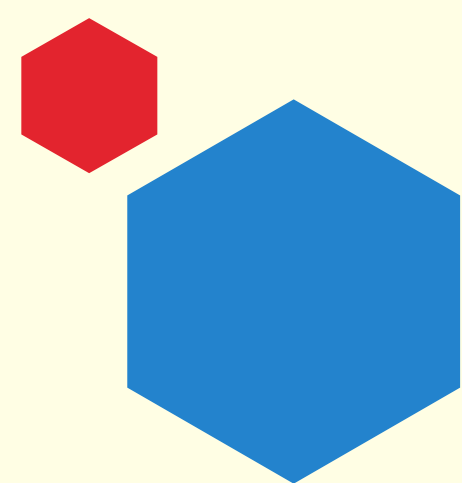
Communication

requires

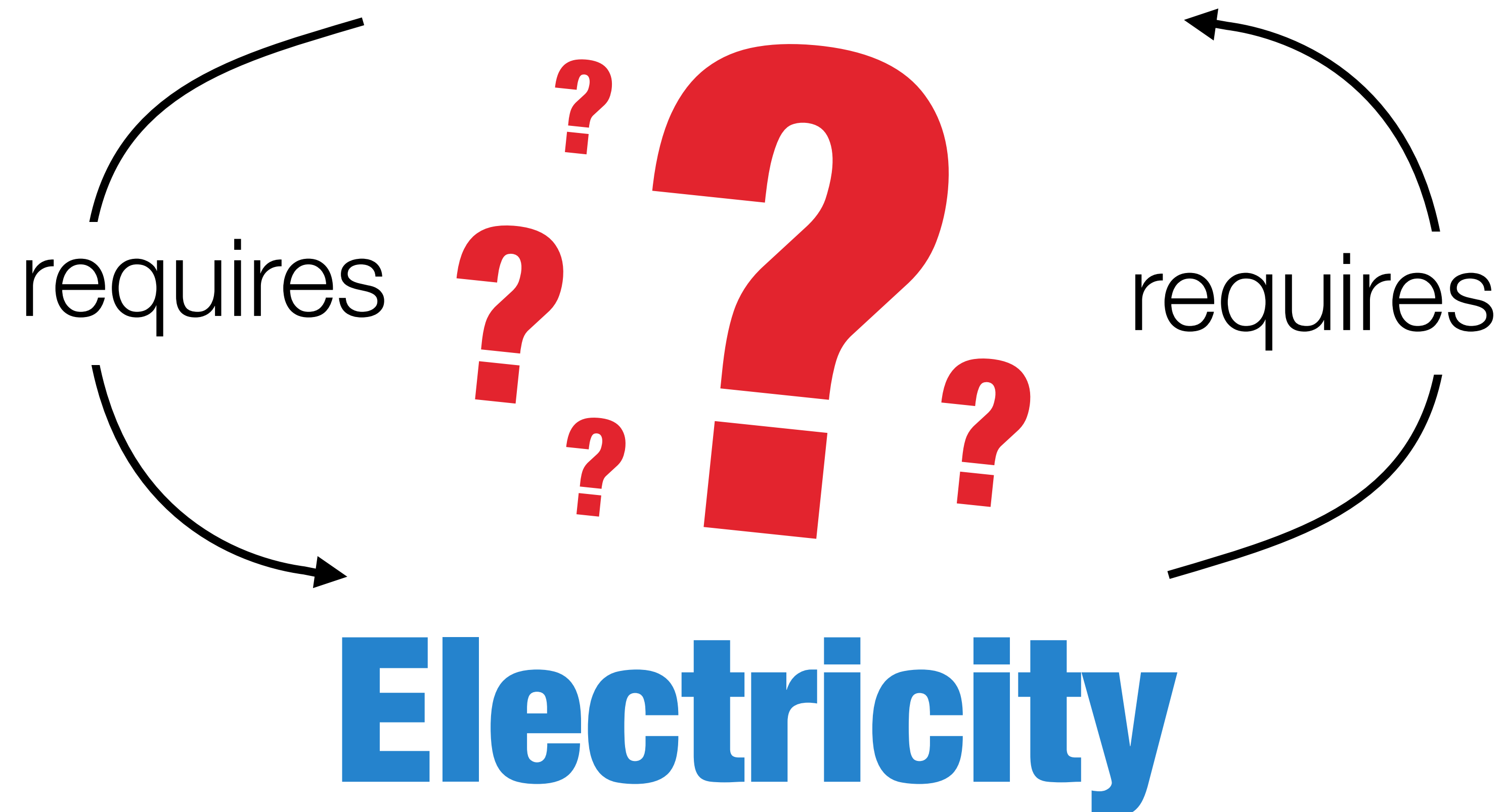
Electricity



Reality rules

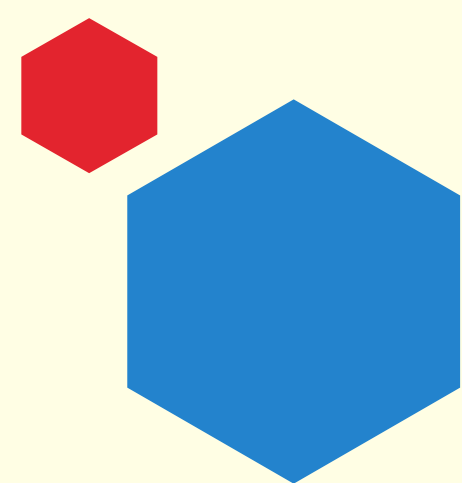


Communication



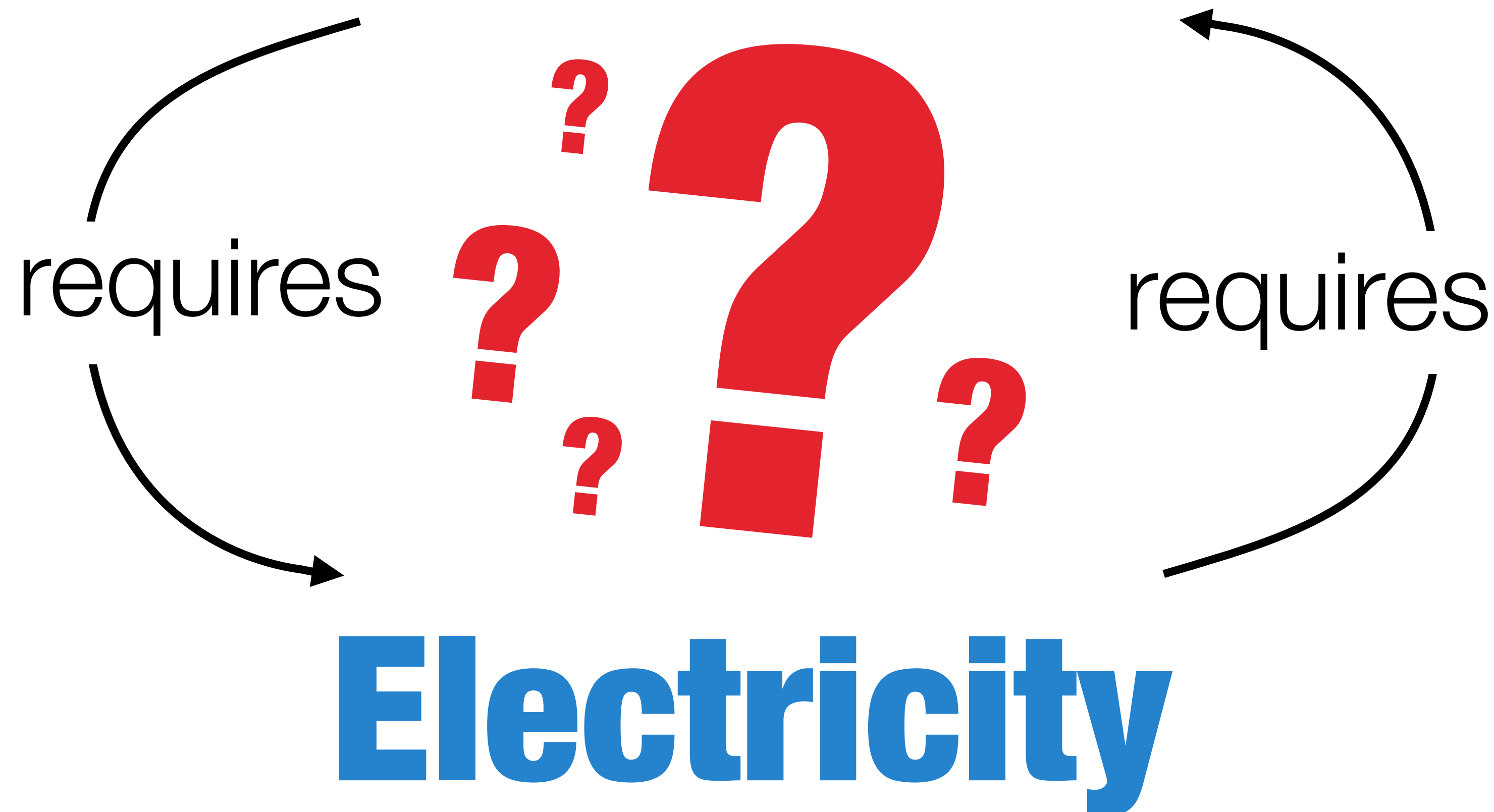


Reality rules



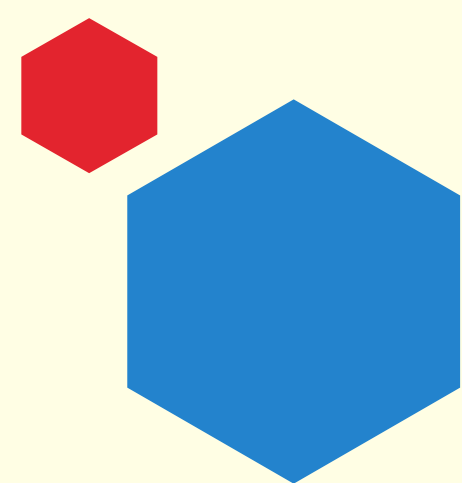
Do not shoot yourself
into the foot

Communication



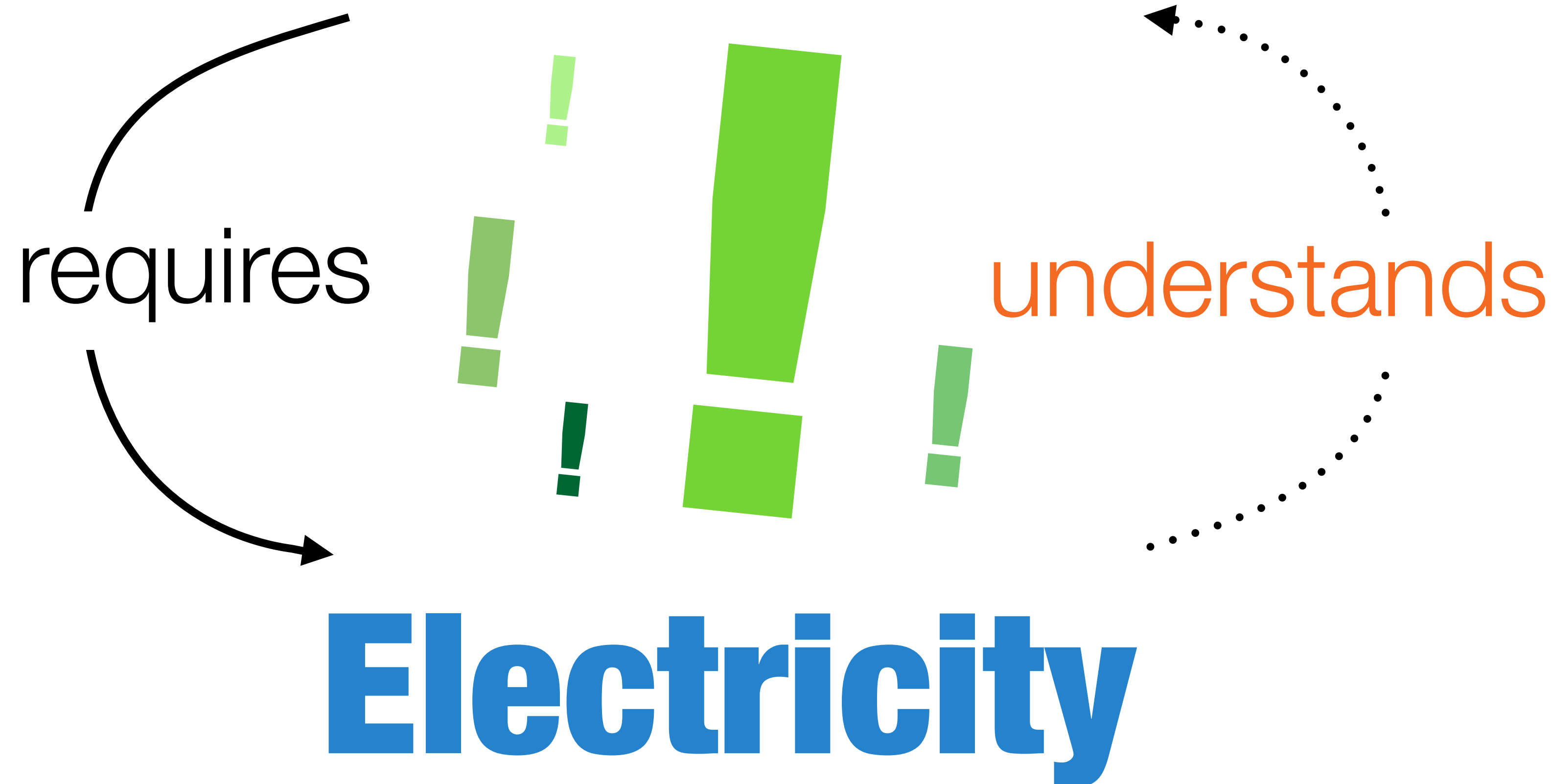


Reality rules



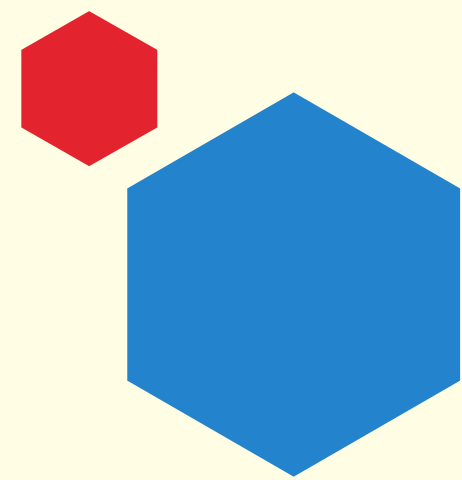
Do not shoot yourself
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Communication





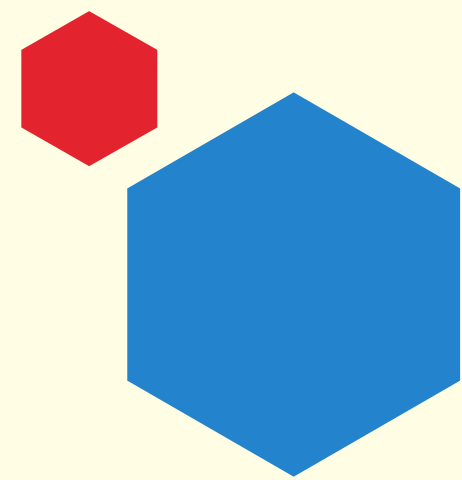
Reality rules



Solid **solutions**
are **simple!**



Reality rules



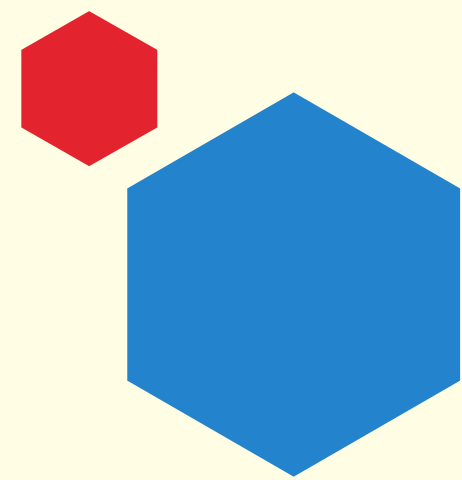
Weather



Weather forecast

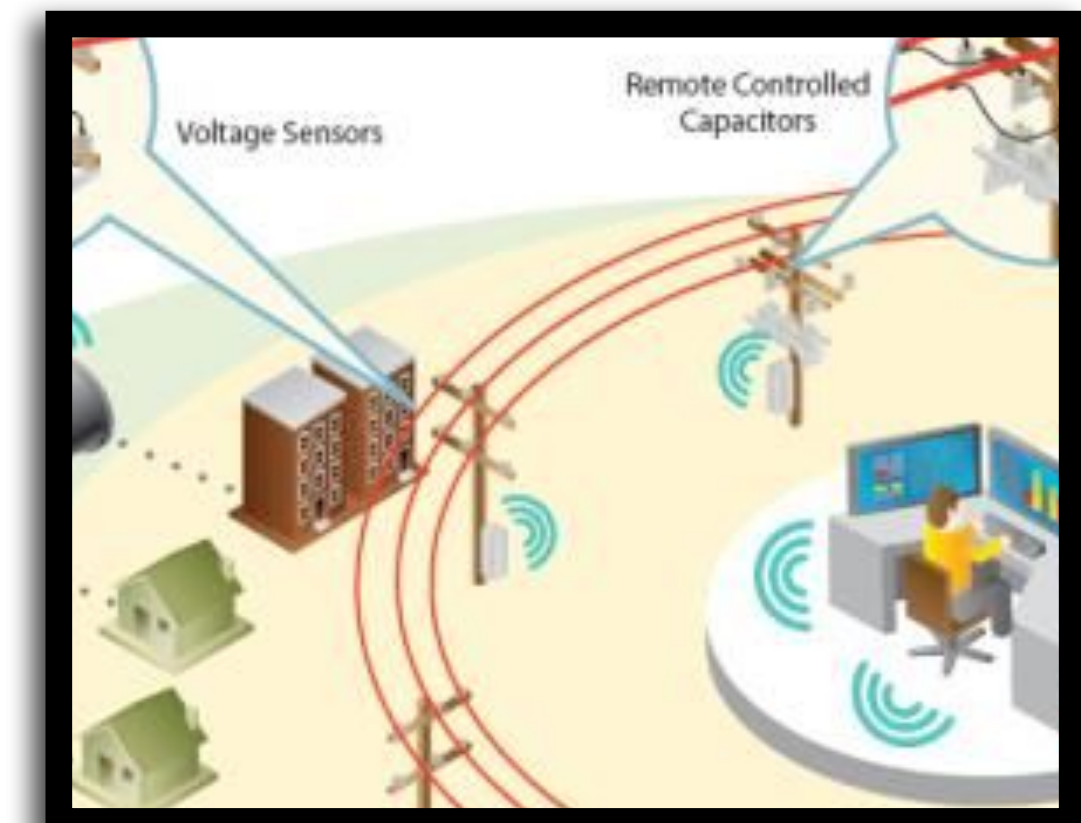
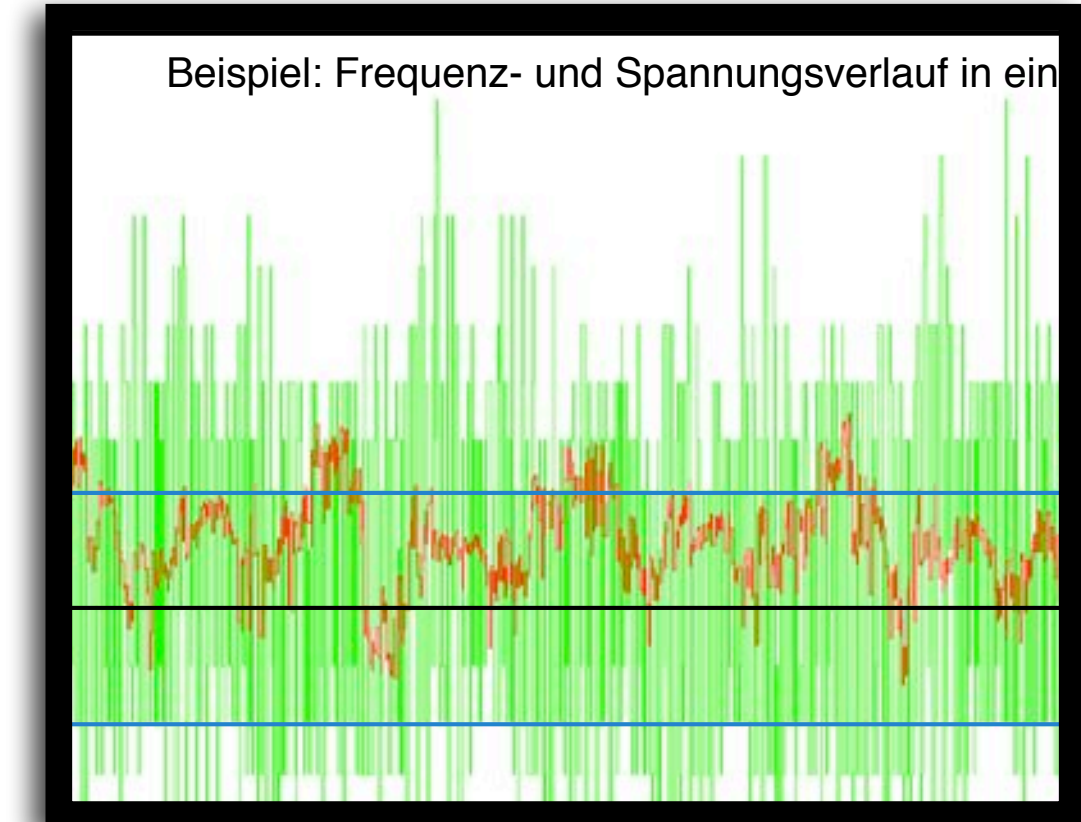


Reality rules



... theory helps.

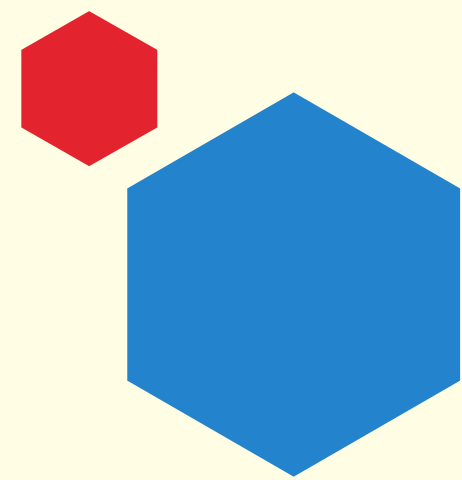
Weather



Weather forecast



Reality rules



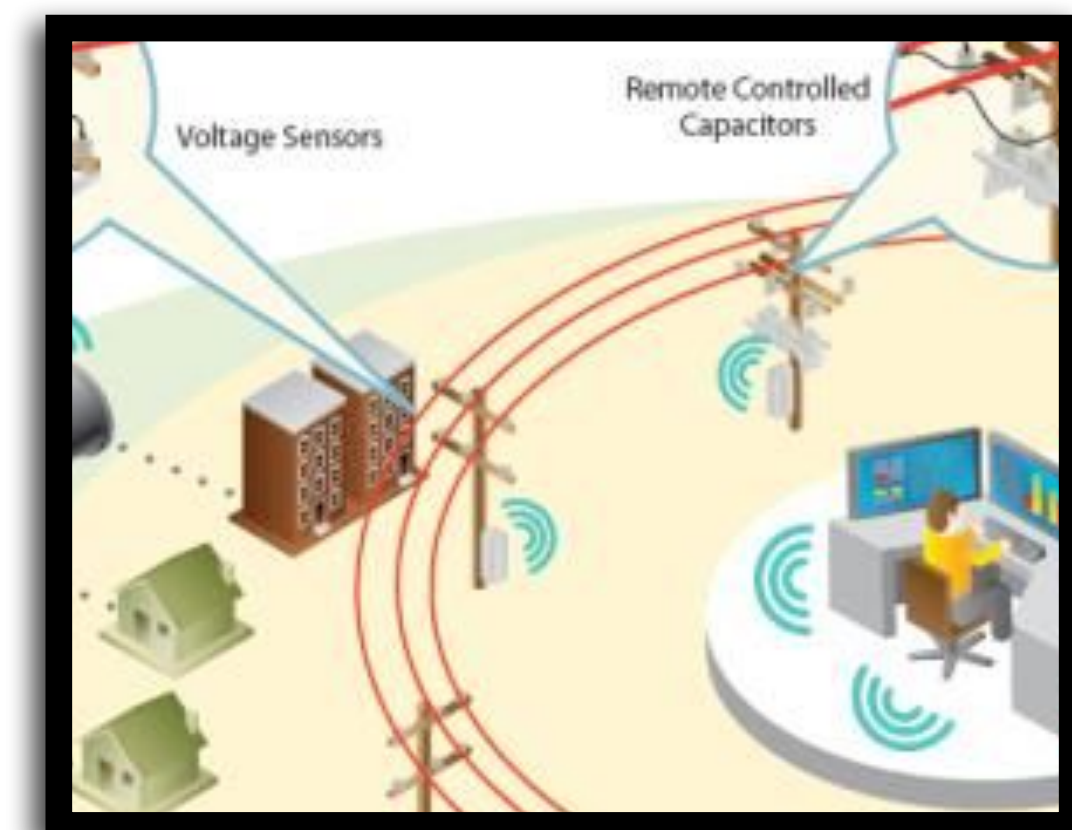
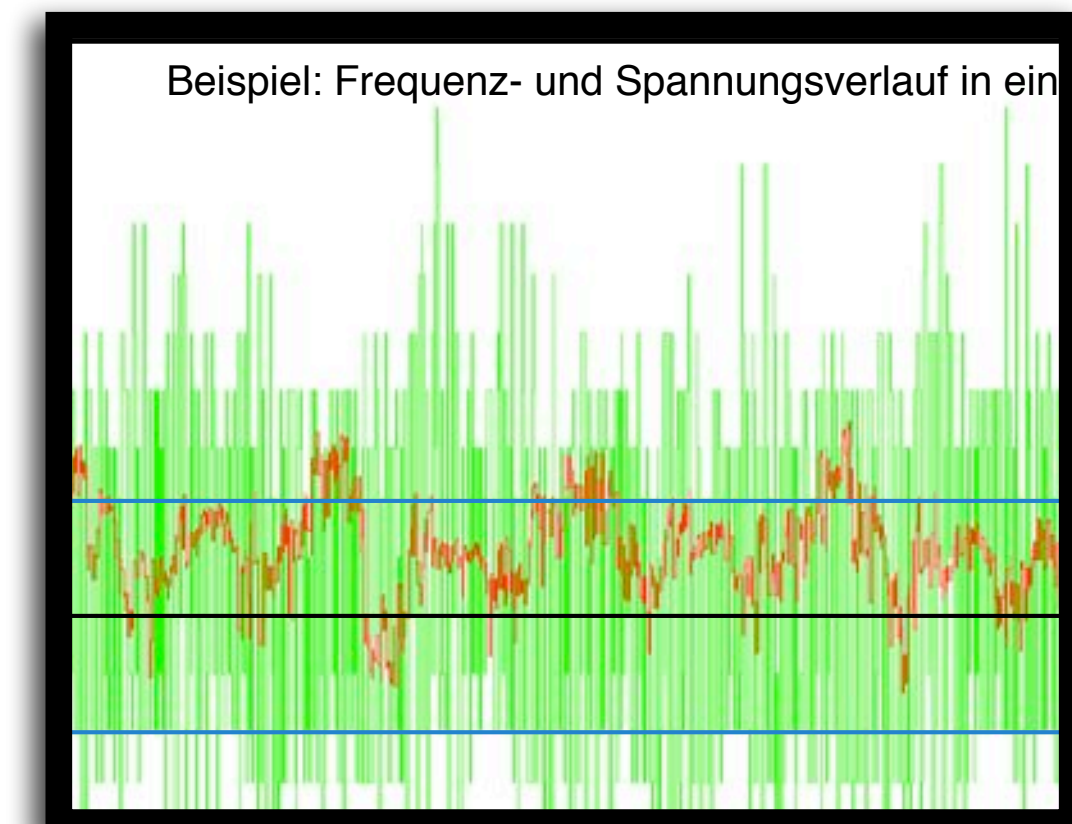
... theory helps.

Weather

**Renewable
Grid Code**

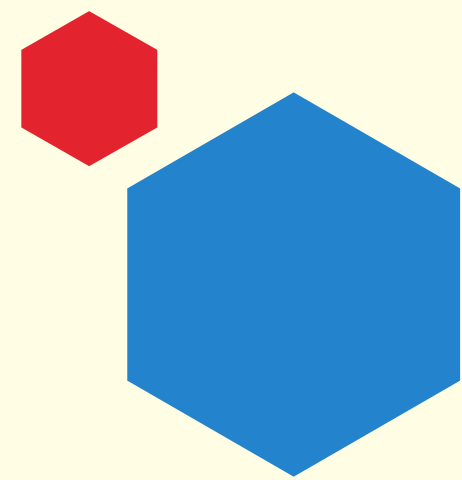
**Smart Grid
Communication**

Weather forecast





Reality rules



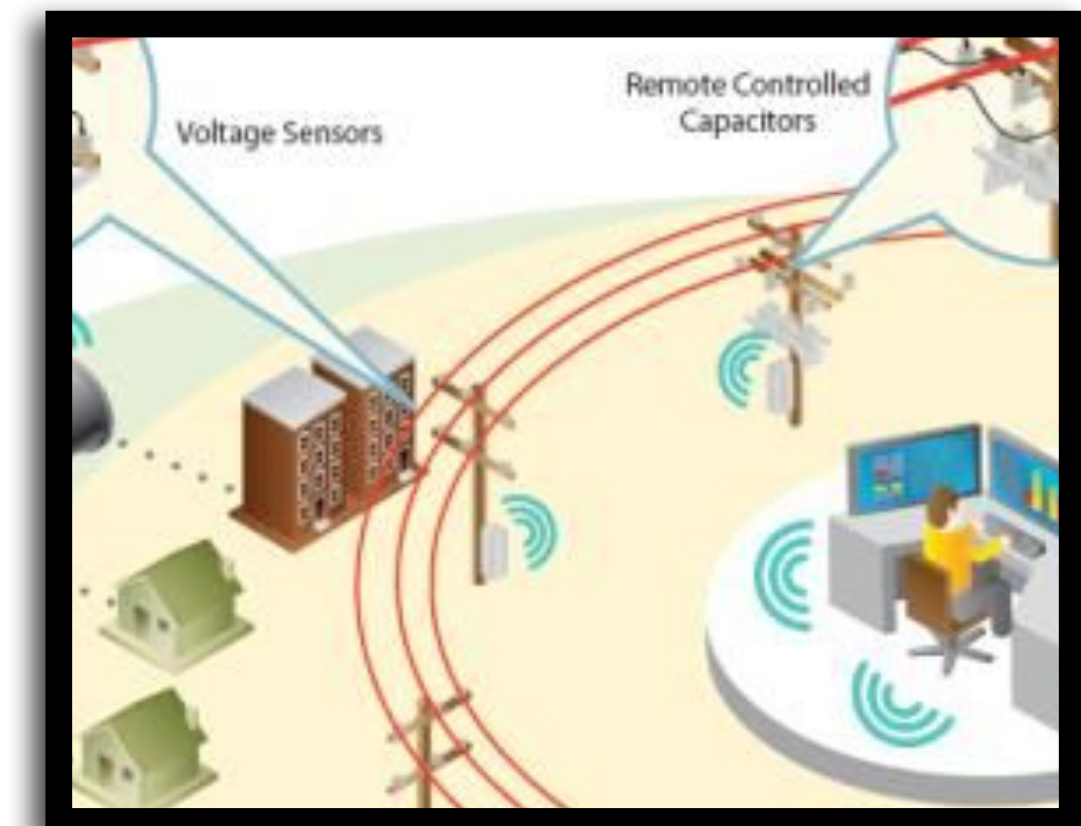
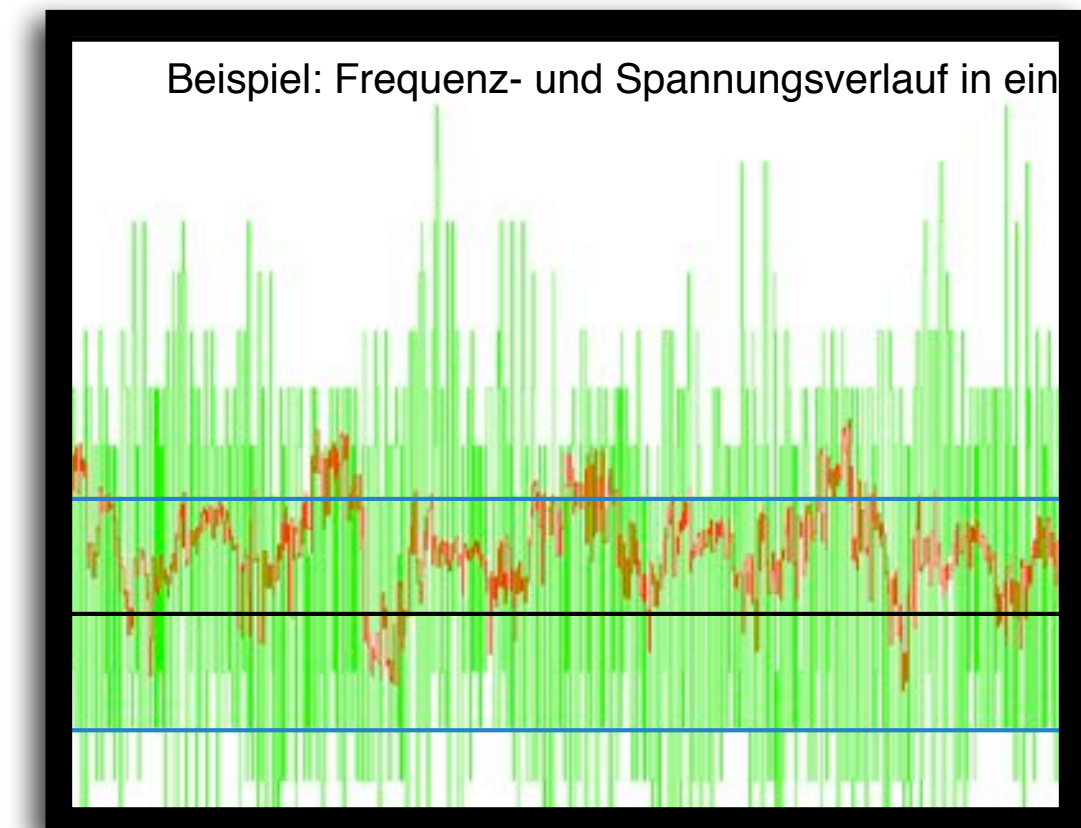
... theory helps.

We must have a

**Renewable
Grid Code**

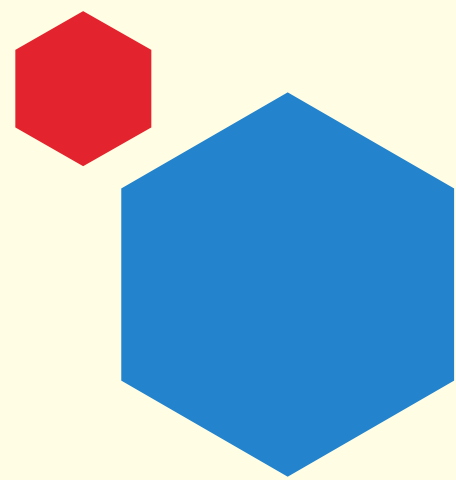
**Smart Grid
Communication**

could be helpful.

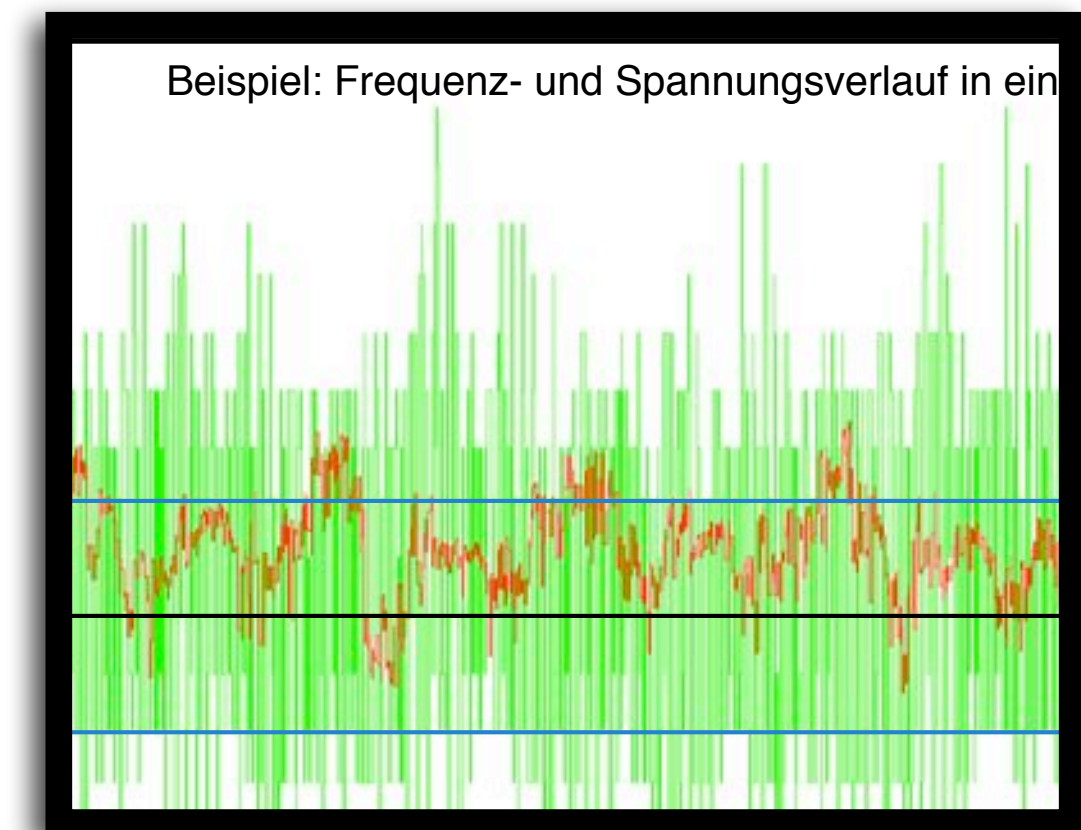




Reality rules

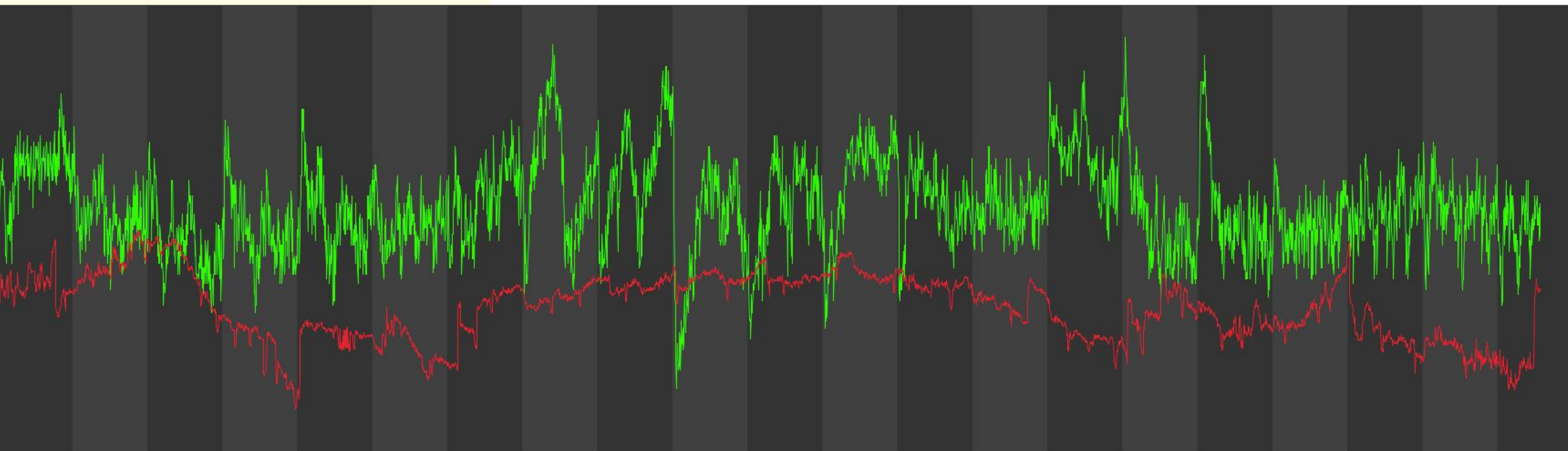


Renewable Grid Code



Voltage
Local balance

Frequency
Global balance

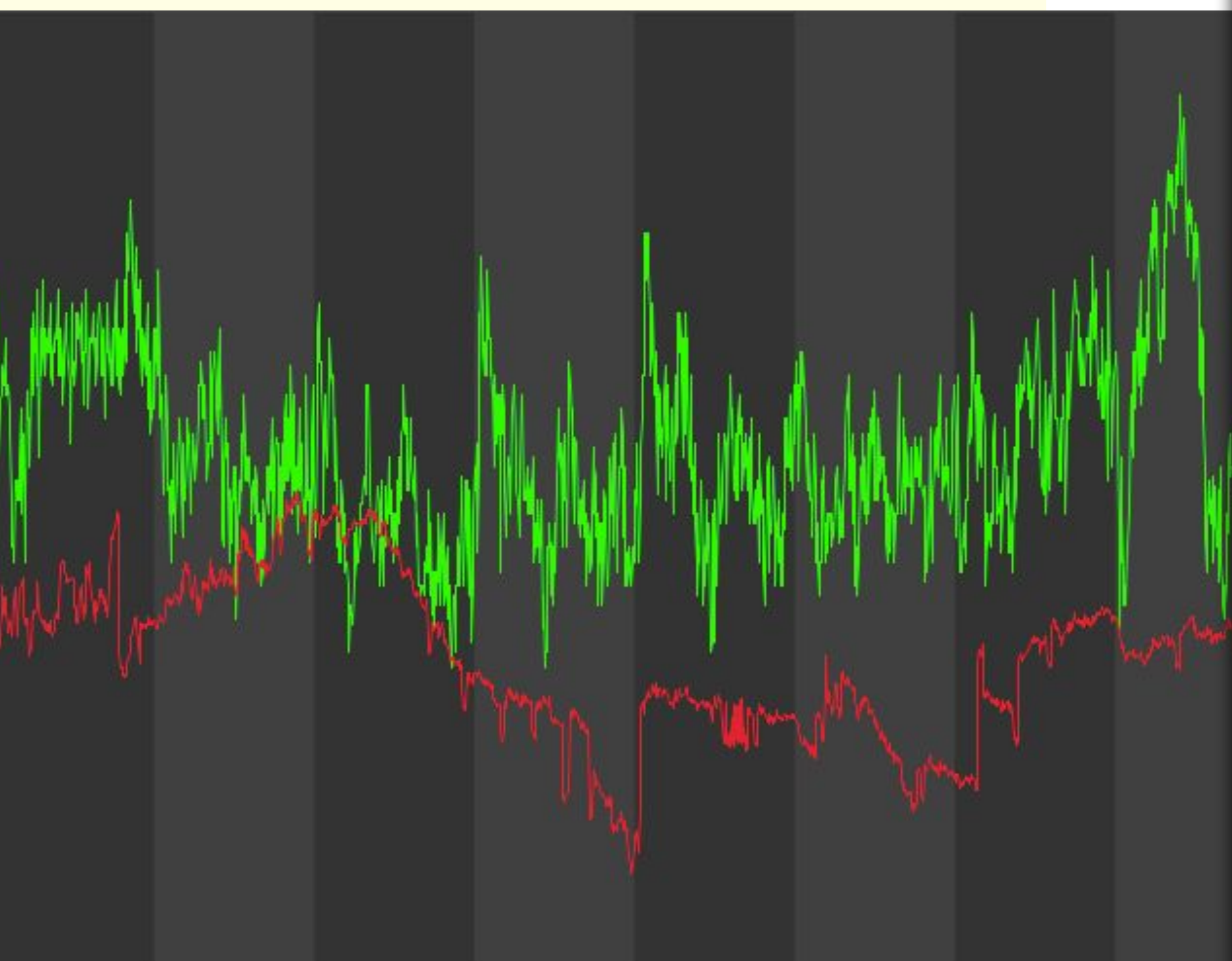


Voltage

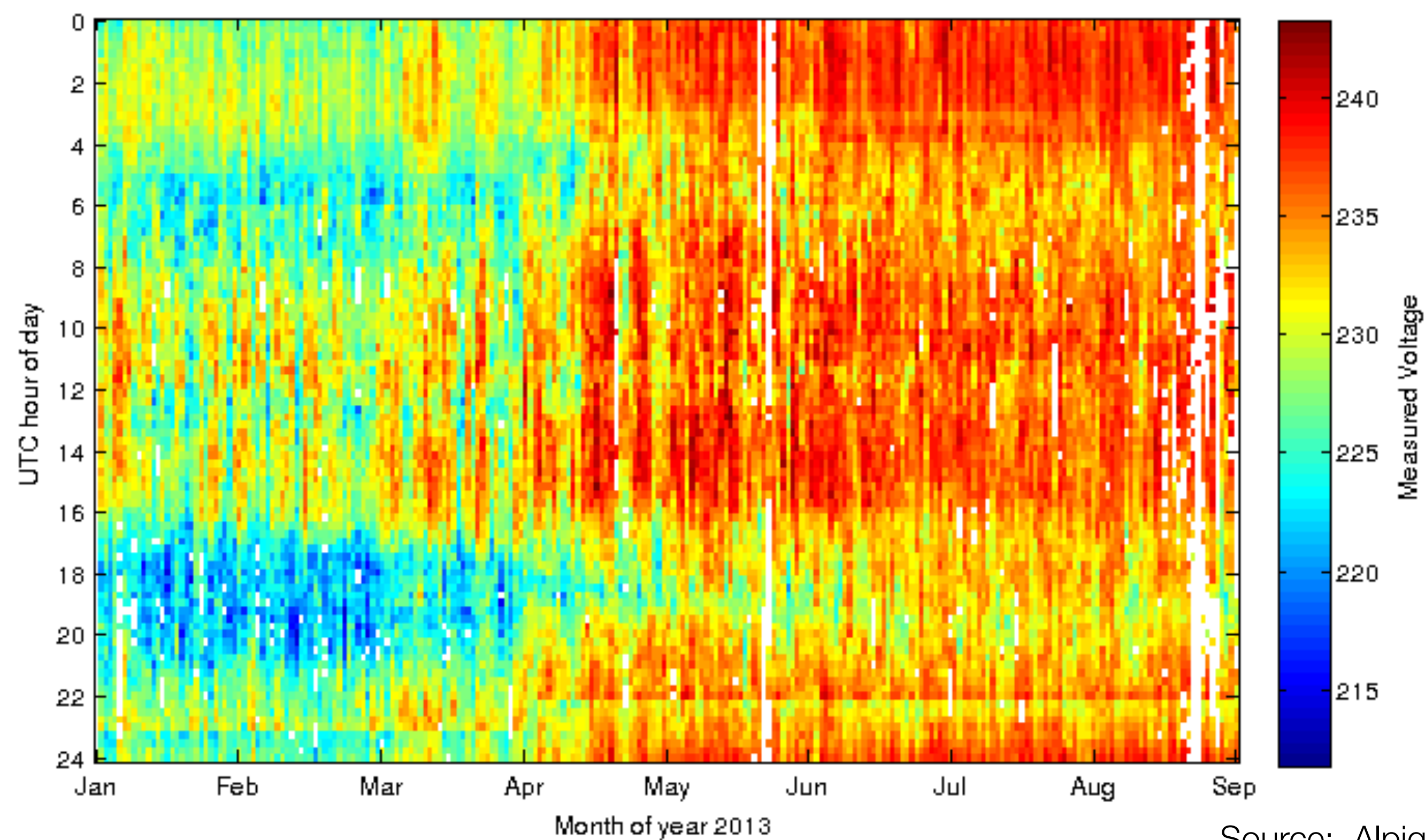
Local balance

Frequency

Global balance



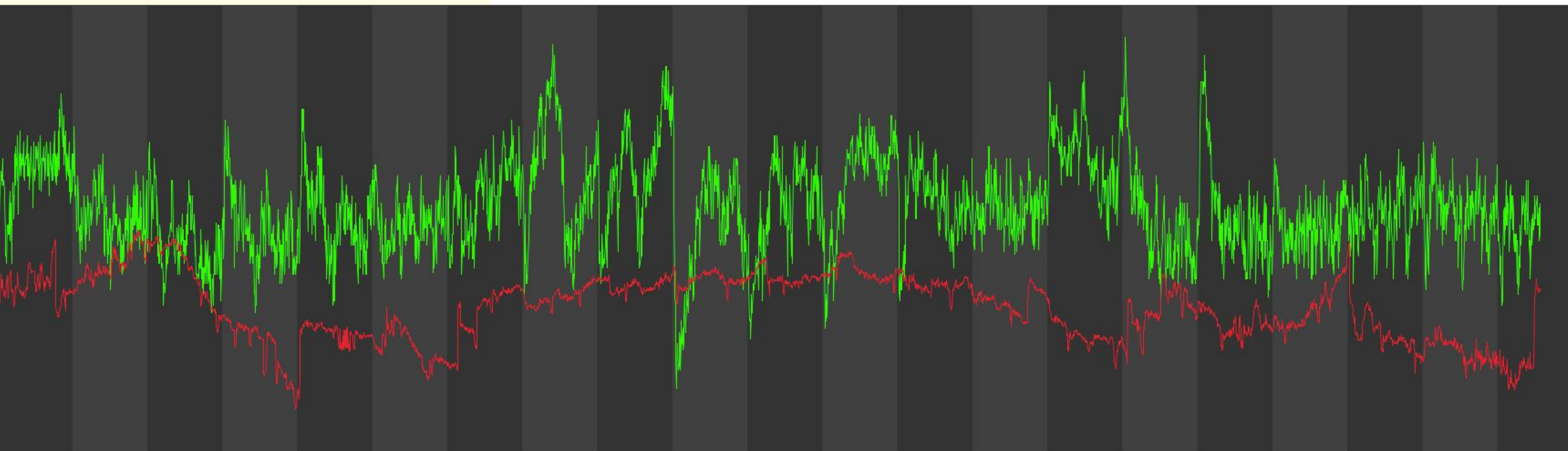
Daily and seasonal patterns of grid voltage



Source: Alpiq Intec

Voltage
Local balance

Frequency
Global



Voltage

Local balance

Frequency

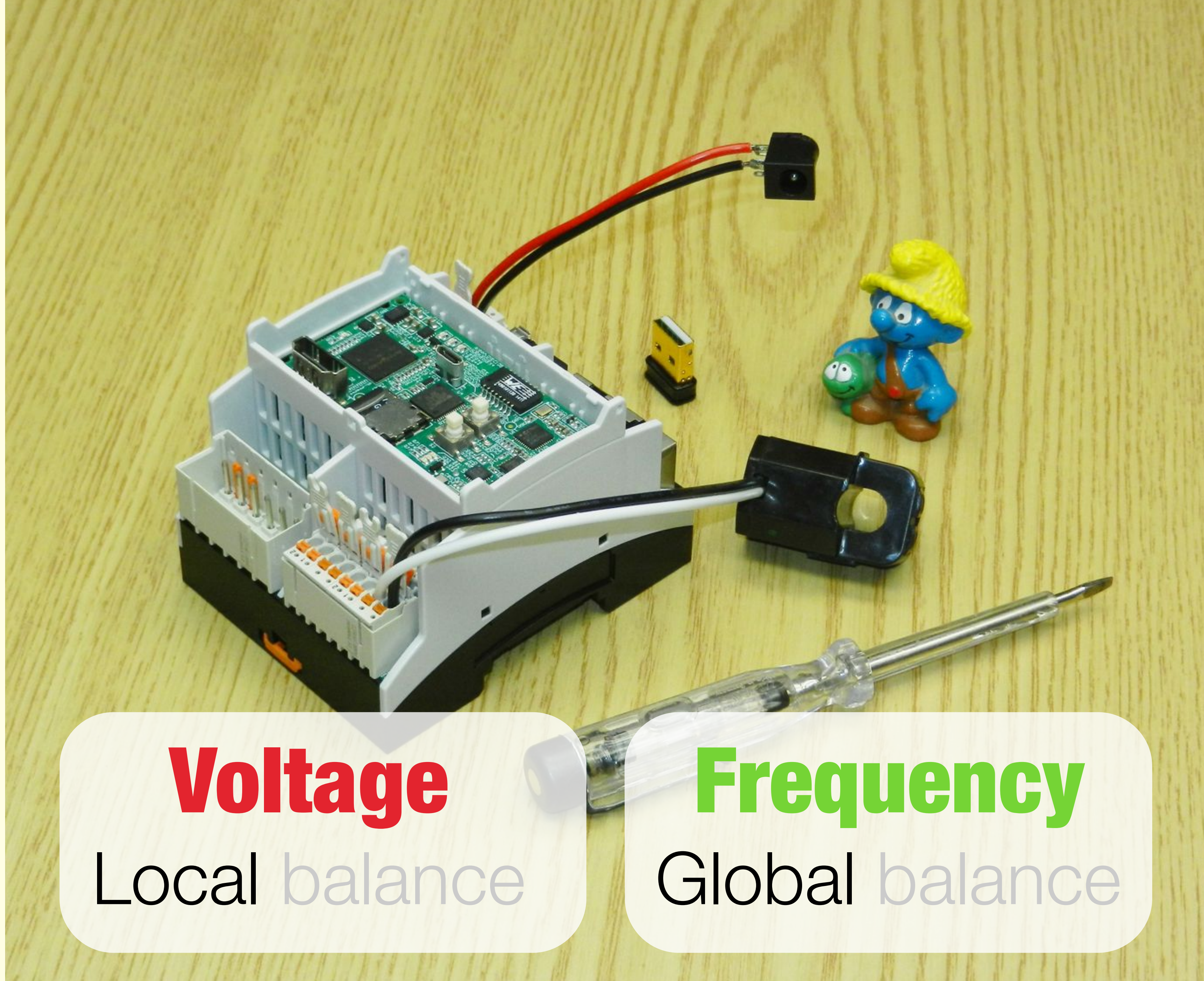
Global balance



Yes ... it can!

Voltage
Local balance

Frequency
Global balance

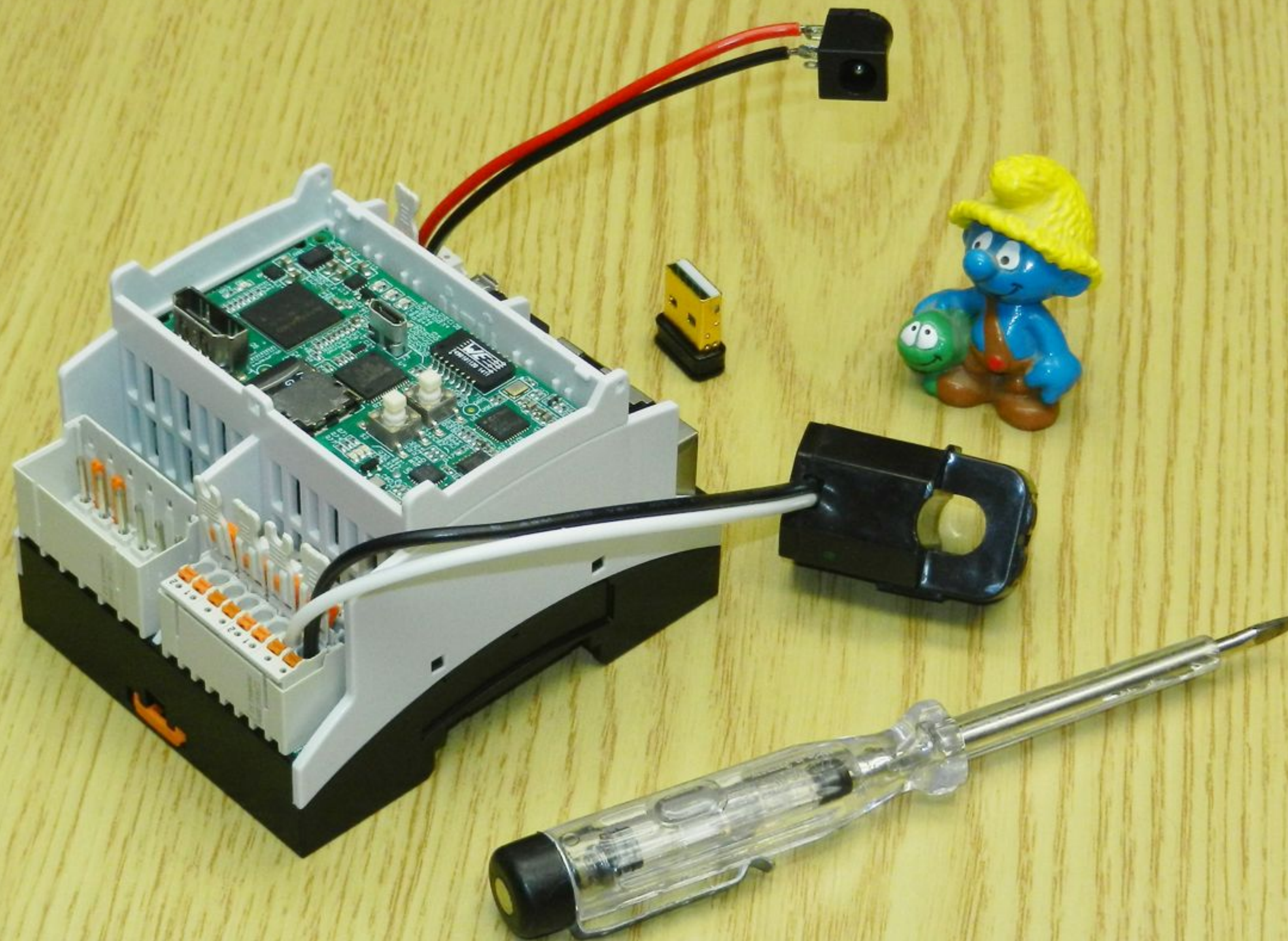




Yes ... it can!

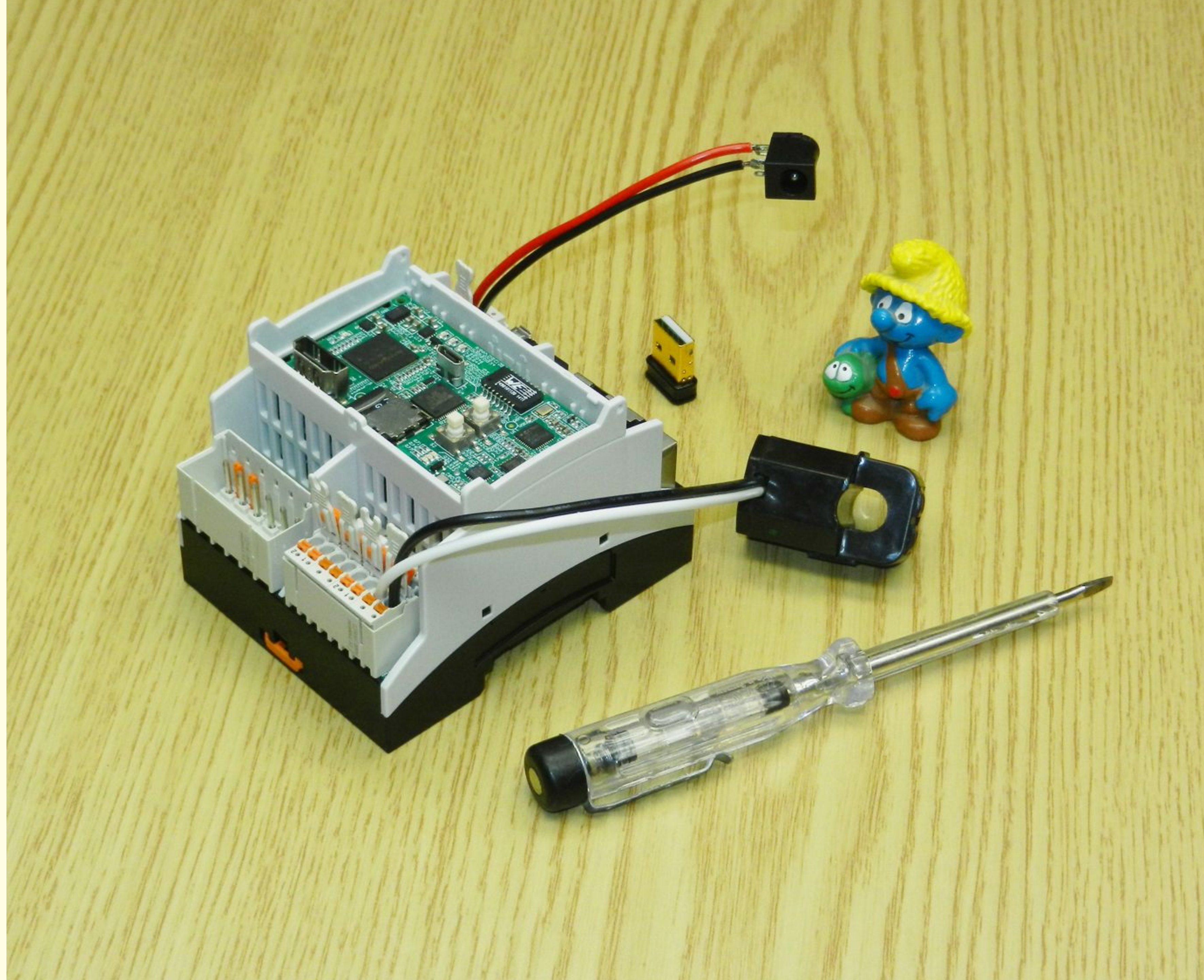
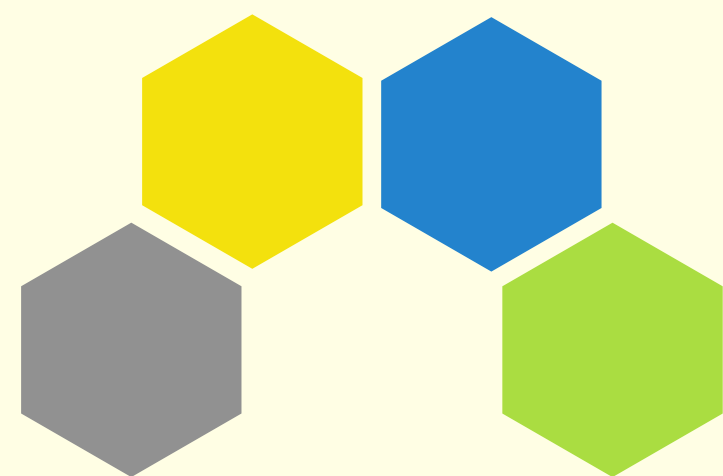


Yes ... it can!



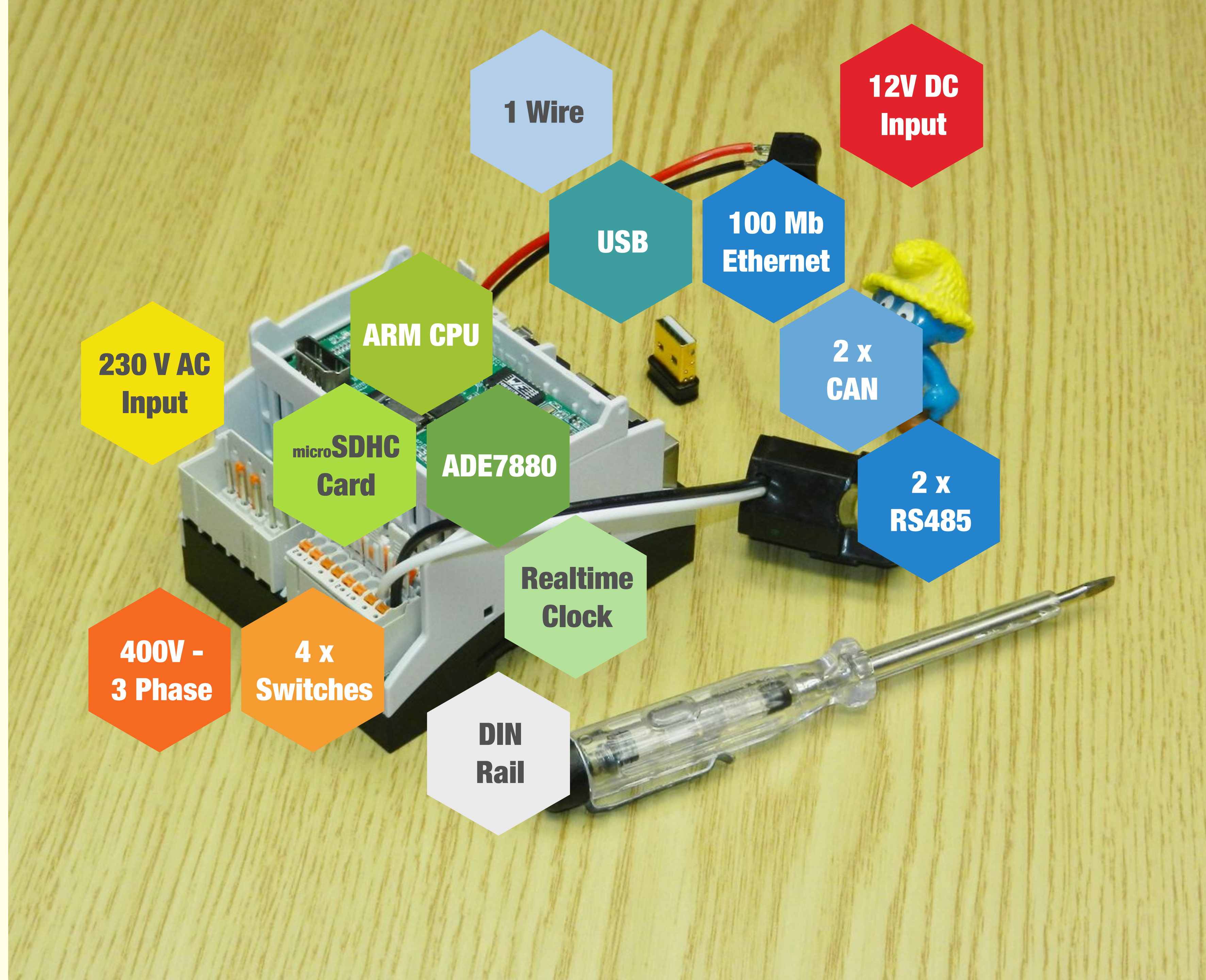
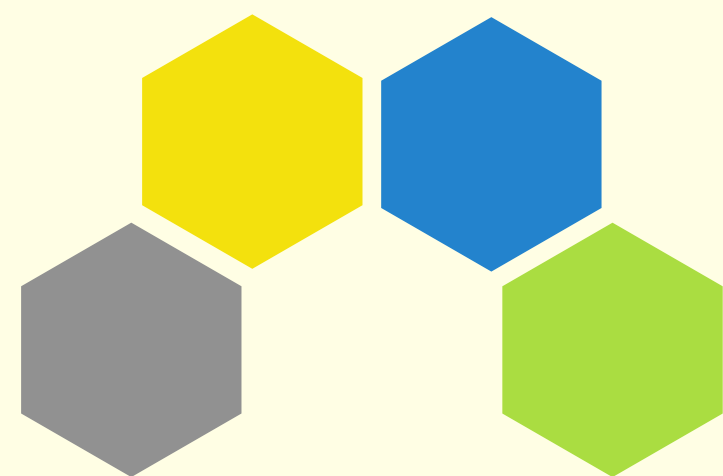


Yes ... it can!



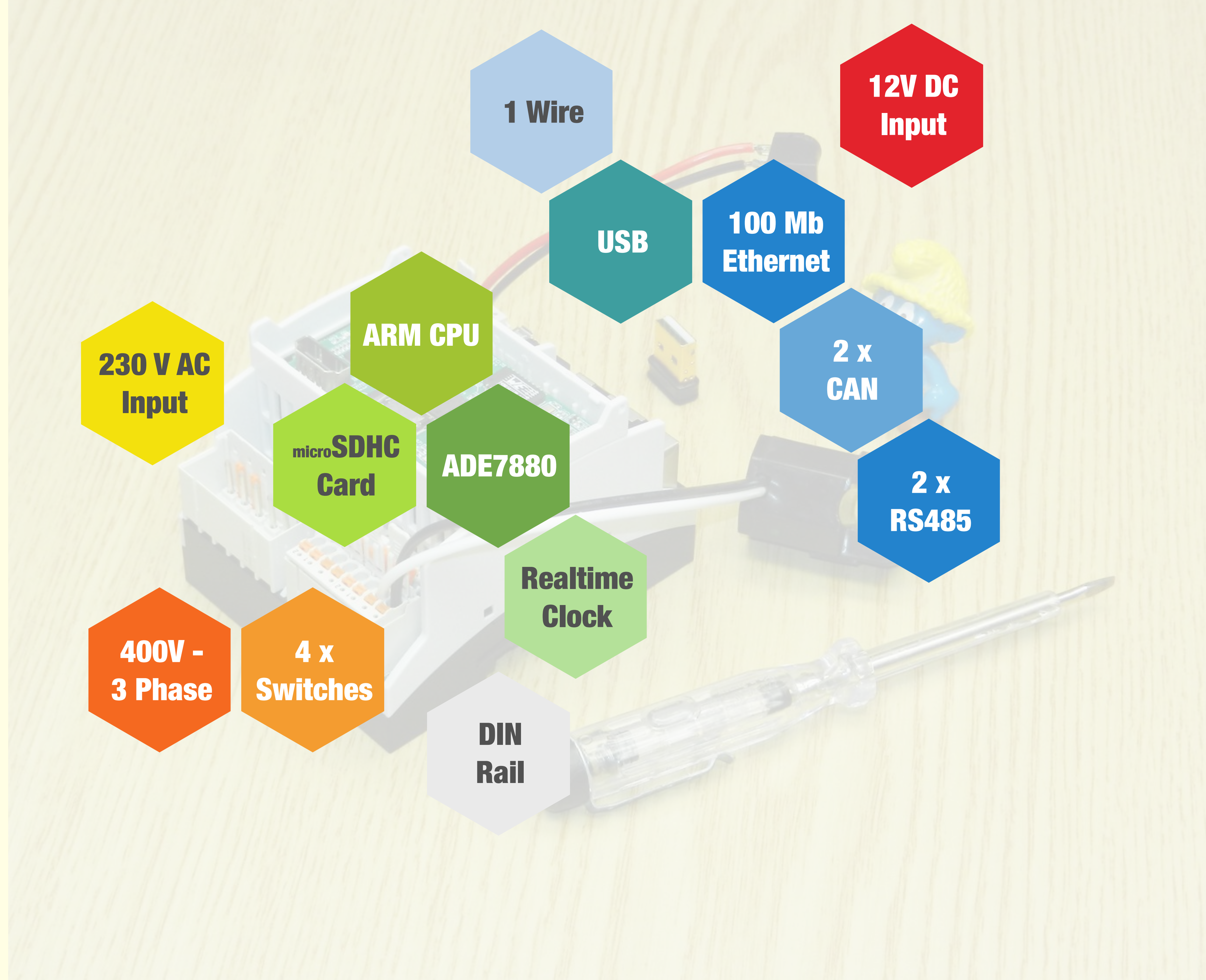
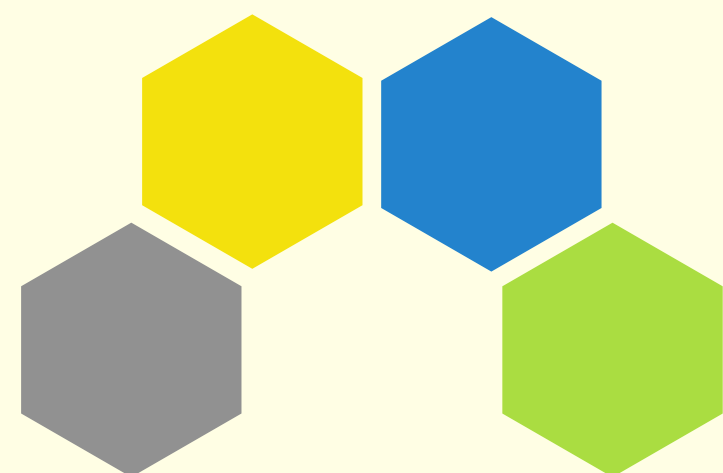


Yes ... it can!



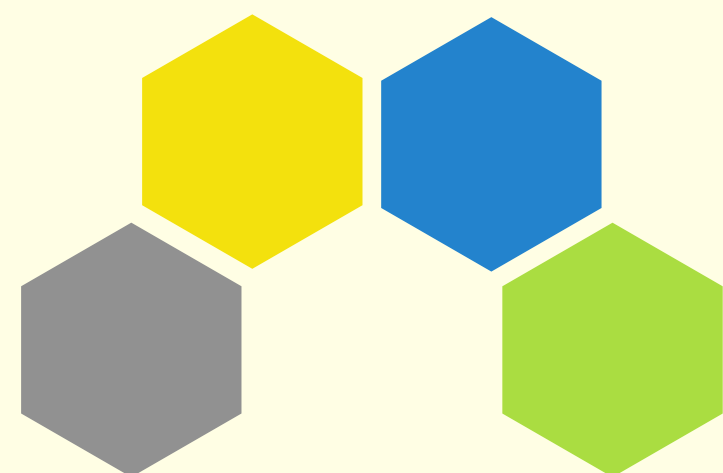


Yes ... it can!



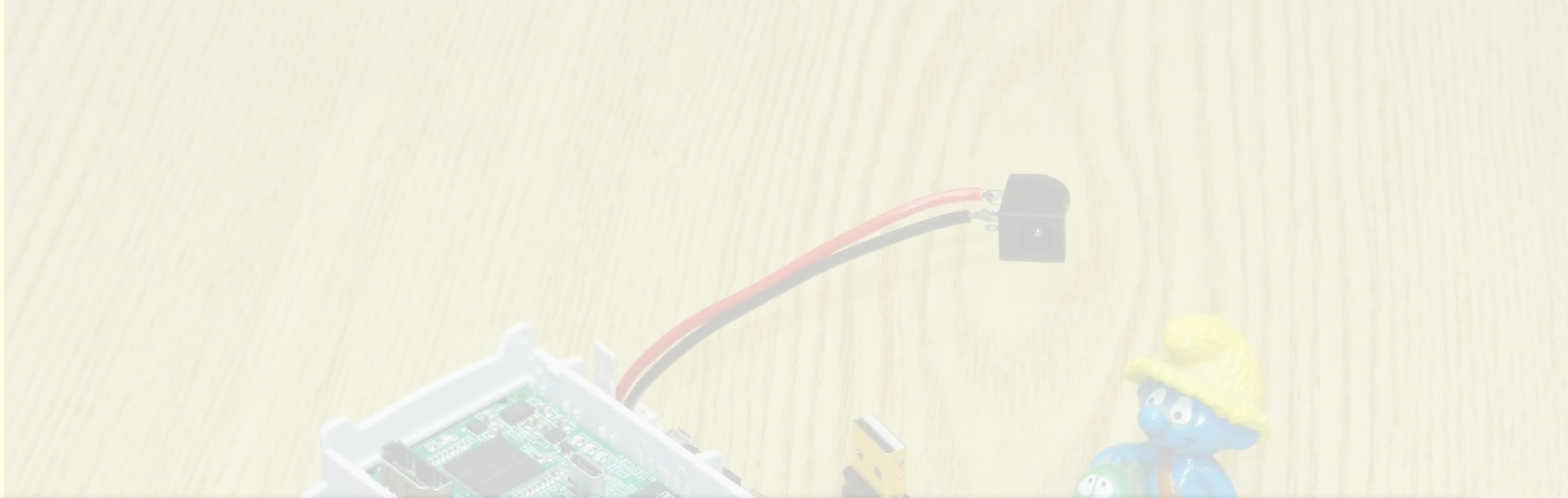


Yes ... it can!





Yes ... it can!



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Protocol

[HTTP](#)[GIT](#)[RSYNC](#)

Location

<https://www.kernel.org/pub/><https://git.kernel.org/><rsync://rsync.kernel.org/pub/>

Latest Stable Kernel:

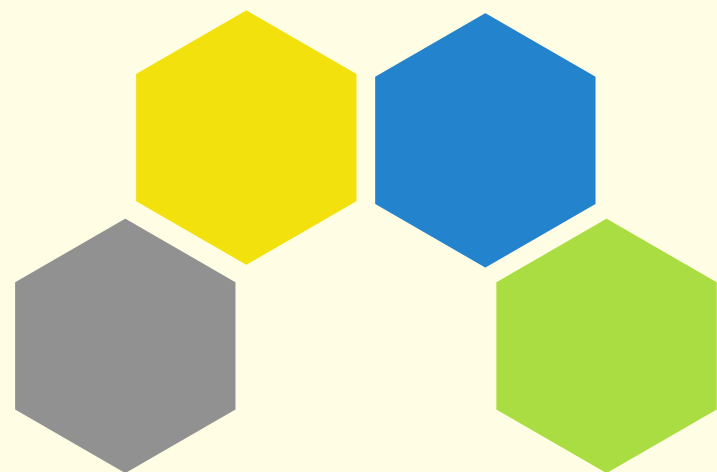


4.0.4

mainline:	4.1-rc6	2015-06-01	[tar.xz]	[pgp]	[patch]	[view diff]	[browse]	
stable:	4.0.4	2015-05-17	[tar.xz]	[pgp]	[patch]	[inc. patch]	[view diff]	[browse]
stable:	3.19.8 [EOL]	2015-05-11	[tar.xz]	[pgp]	[patch]	[inc. patch]	[view diff]	[browse]
longterm:	3.18.14	2015-05-20	[tar.xz]	[pgp]	[patch]	[inc. patch]	[view diff]	[browse]
longterm:	3.14.43	2015-05-17	[tar.xz]	[pgp]	[patch]	[inc. patch]	[view diff]	[browse]
longterm:	3.12.43	2015-05-20	[tar.xz]	[pgp]	[patch]	[inc. patch]	[view diff]	[browse]
longterm:	3.10.79	2015-05-17	[tar.xz]	[pgp]	[patch]	[inc. patch]	[view diff]	[browse]



Yes ... it can!



babelbee | OpenWrt Barrier Breaker r35052 | Load: 2.71 2.03 1.67 Changes: 0

Status **System** Network Statistics Logout

System Administration Software Startup Scheduled Tasks Time Synchronisation Mount Points LED Configuration Relay Configuration

Backup / Flash Firmware Reboot

Flash operations

Actions **Configuration**

Backup / Restore

Click "Generate archive" to download a tar archive of the current configuration files. To reset the firmware to its initial state, click "Perform reset" (only possible with squashfs images).

Download backup:

Reset to defaults:

To restore configuration files, you can upload a previously generated backup archive here.

Restore backup: no file selected

Flash new firmware image

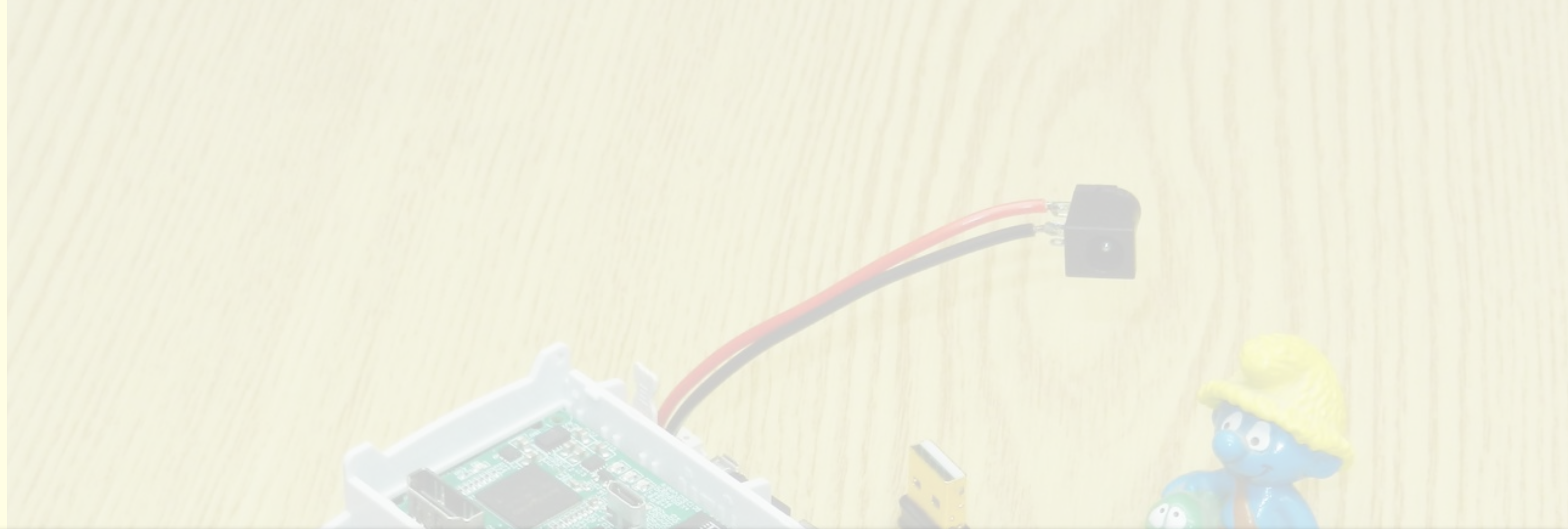
Upload a sysupgrade-compatible image here to replace the running firmware. Check "Keep settings" to retain the current configuration (requires an OpenWrt compatible firmware image).

Keep settings: ☒

Image: no file selected

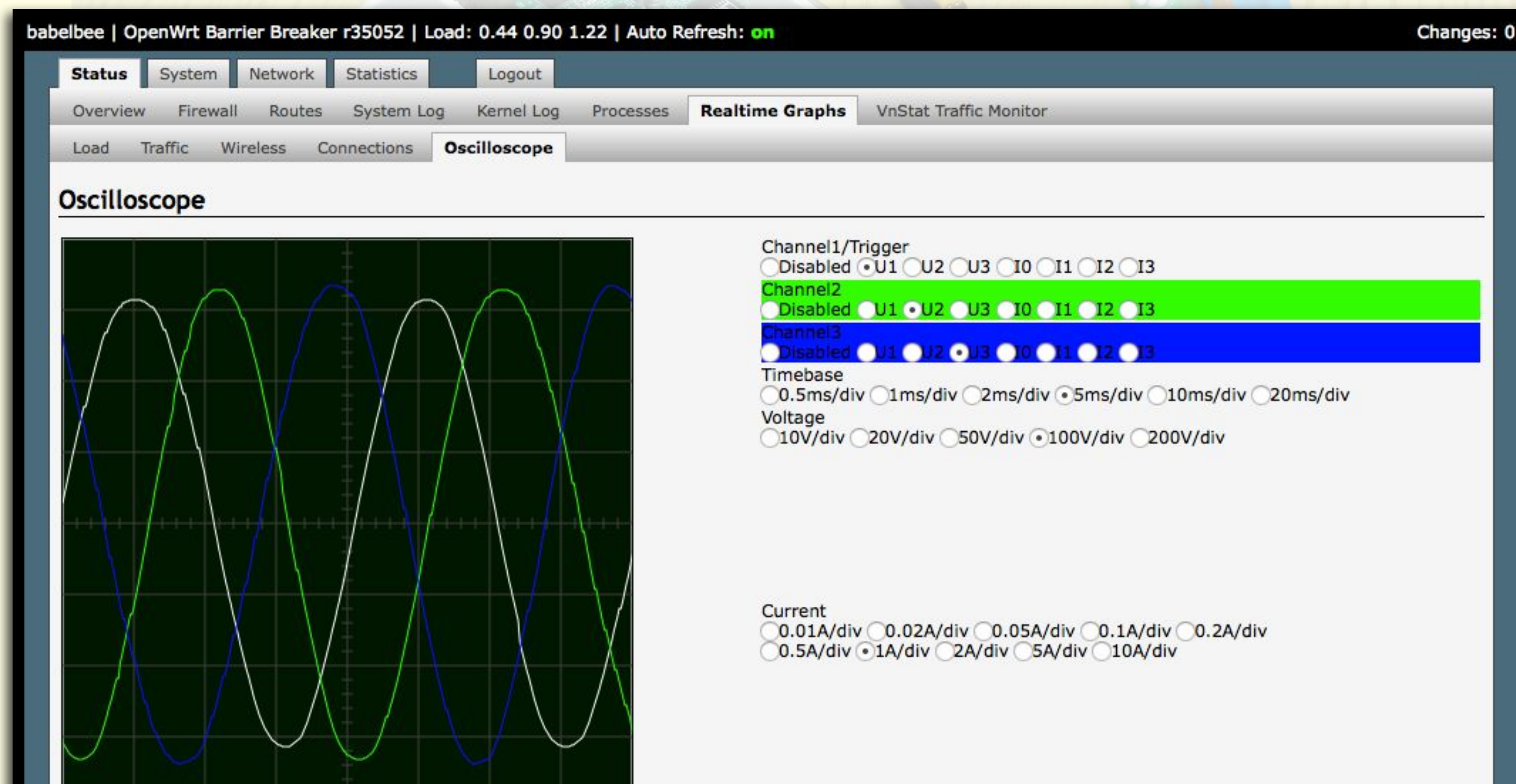


Yes ... it can!



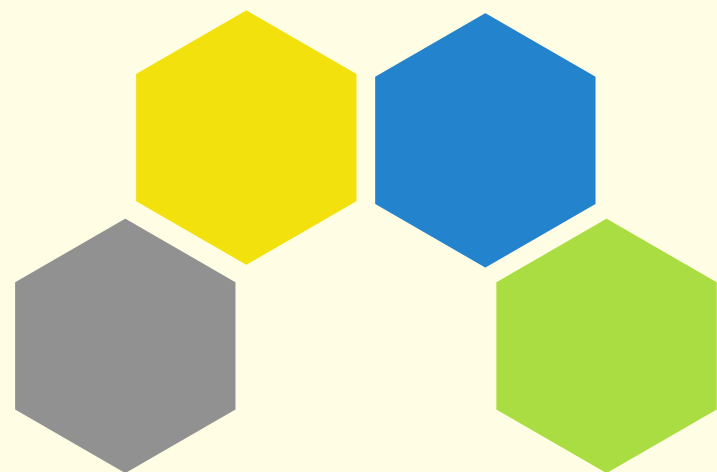


Yes ... it can!





Yes ... it can!



About

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❖ What is Lua?

Lua is a powerful, fast, lightweight, embeddable scripting language.

Lua combines simple procedural syntax with powerful data description constructs based on associative arrays and extensible semantics. Lua is dynamically typed, runs by interpreting bytecode for a register-based virtual machine, and has automatic memory management with incremental garbage collection, making it ideal for configuration, scripting, and rapid prototyping.

❖ Where does Lua come from?

❖ Why choose Lua?

Lua is a proven, robust language

Lua has been used in many industrial applications (e.g., Adobe's Photoshop Lightroom), with an emphasis on embedded systems (e.g., the Ginga middleware for digital TV in Brazil) and games (e.g., World of Warcraft and Angry Birds). Lua is currently the leading scripting language in games. Lua has a solid reference manual and there are several books about it. Several versions of Lua have been released and used in real applications since its creation in 1993. Lua featured in HOPL III, the Third ACM SIGPLAN History of Programming Languages Conference, in June 2007. Lua won the Front Line Award 2011 from the Game



Yes ... it can!



GitHub repository page for **babelbee / openwrt**, forked from `openwrt-mirror/openwrt`.

Mirror of the OpenWRT repository <http://openwrt.org/> — Edit

33,059 commits 3 branches 0 releases 2 contributors

branch: **babelbee_new** **openwrt / +**

This branch is 30 commits ahead, 1379 commits behind `openwrt-mirror:master` Pull Request Compare

Fixed can interfaces

cp15 authored on Mar 19 latest commit `db36173a2f`

<code>config</code>	config: disable kernel tracing on uml	4 months ago
<code>docs</code>	docs: update remaining references to functions.sh	3 years ago
<code>include</code>	fix typo	4 months ago
<code>package</code>	Add and activated an updated canutils package, which now points to th...	3 months ago
<code>scripts</code>	scripts: fix getver git dir check	4 months ago

Code

- Pull requests 0
- Wiki
- Pulse
- Graphs
- Settings

HTTPS clone URL

`https://github.com/babe`

You can clone with [HTTPS](#), [SSH](#), or [Subversion](#)



Yes ... it will!



IBR-DTN

A modular and lightweight implementation of the bundle protocol.

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Wiki | [Timeline](#) | [View Tickets](#) | [Search](#)

wiki: [WikiStart](#)

[Start Page](#) | [Index](#) | [History](#)

Welcome to the IBR-DTN Project

This implementation of the bundle protocol [RFC5050](#) is designed for embedded systems like the [RouterBoard 532A](#) or [Ubiquiti RouterStation Pro](#) and can be used as framework for DTN applications.

The module-based architecture with miscellaneous interfaces, makes it possible to change functionalities like routing or storage of bundle just by inheriting a specific class.

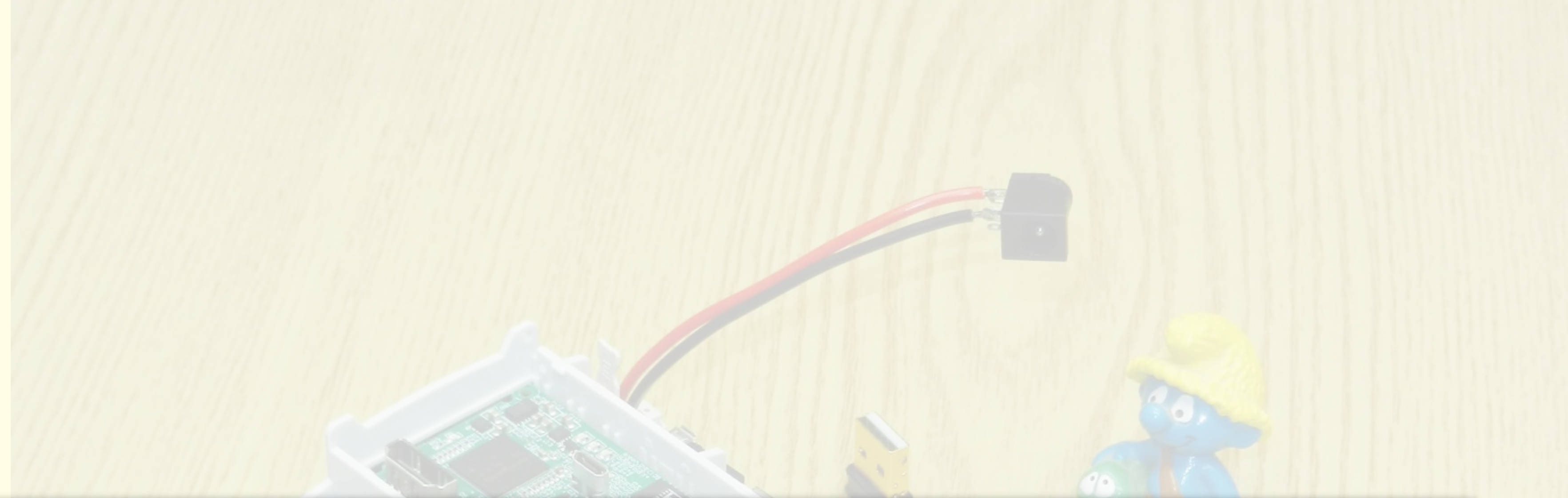
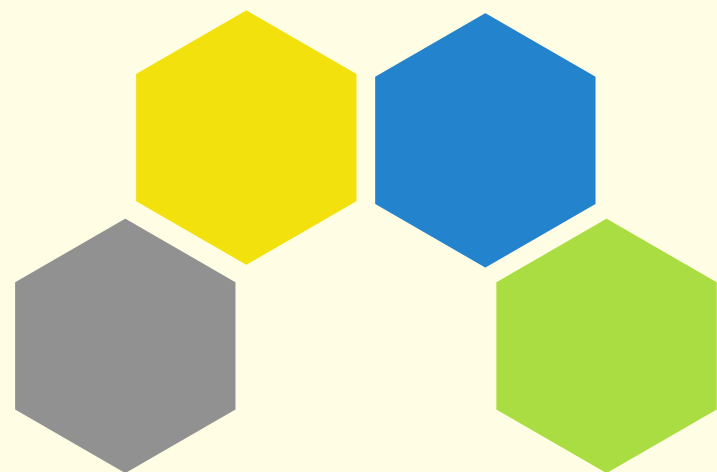
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Software

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Yes ... it will!



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Standard for Connecting Electric Components of Light Electric Vehicles

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www.energybus.org -> [Basics](#) -> What is EnergyBus

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[Why EnergyBus](#)

[Function](#)

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[Vision-Reality-Future](#)

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[Booklet](#)

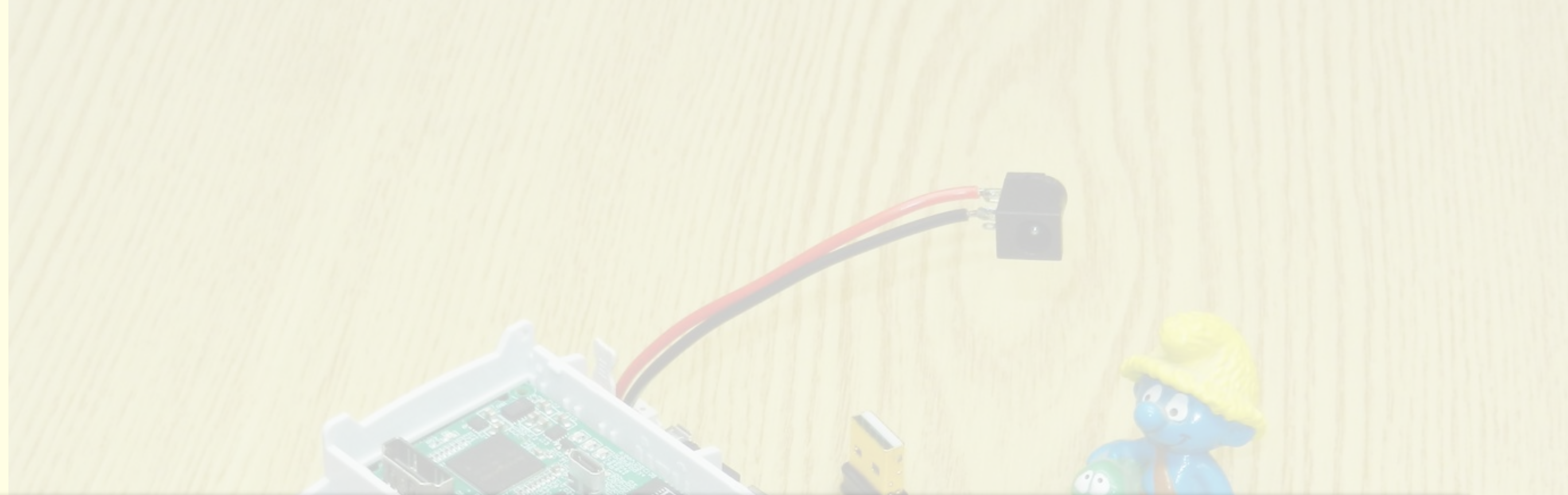
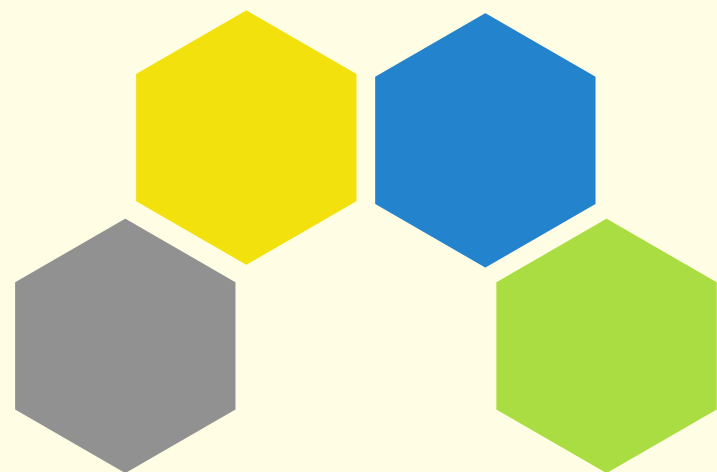
What is EnergyBus

EnergyBus is an open standard for all electrical components of Light-Electric-Vehicles (LEVs). It aims to improve compatibility and safety of LEVs and consists of a cutting-edge connector family and the respective communication protocol. EBS will be available to all EnergyBus members in spring 2011.





Yes ... you can!



```
BusyBox v1.19.4 (2013-04-01 23:03:47 CEST) built-in shell (ash)
Enter 'help' for a list of built-in commands.
```

```
-----
|_| W I R E L E S S   F R E E D O M
-----
```

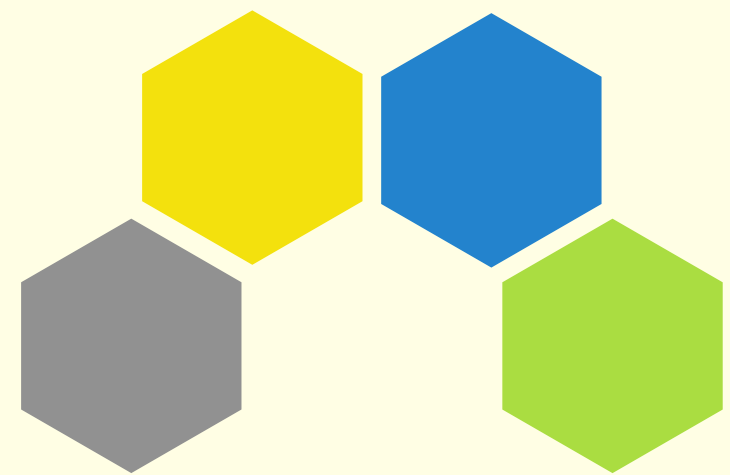
```
-----
BARRIER BREAKER (Bleeding Edge, r35052)
-----
```

```
* 1/2 oz Galliano      Pour all ingredients into
* 4 oz cold Coffee     an irish coffee mug filled
* 1 1/2 oz Dark Rum    with crushed ice. Stir.
* 2 tsp. Creme de Cacao
```

```
-----
root@babelbee:~#
```




Yes ... you can!



Crowdfunding starting soon...





Babelbee



**Open
Source**

**Electric
Power**

**Monitor-
ing**

**Manage-
ment**

Babelbee

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