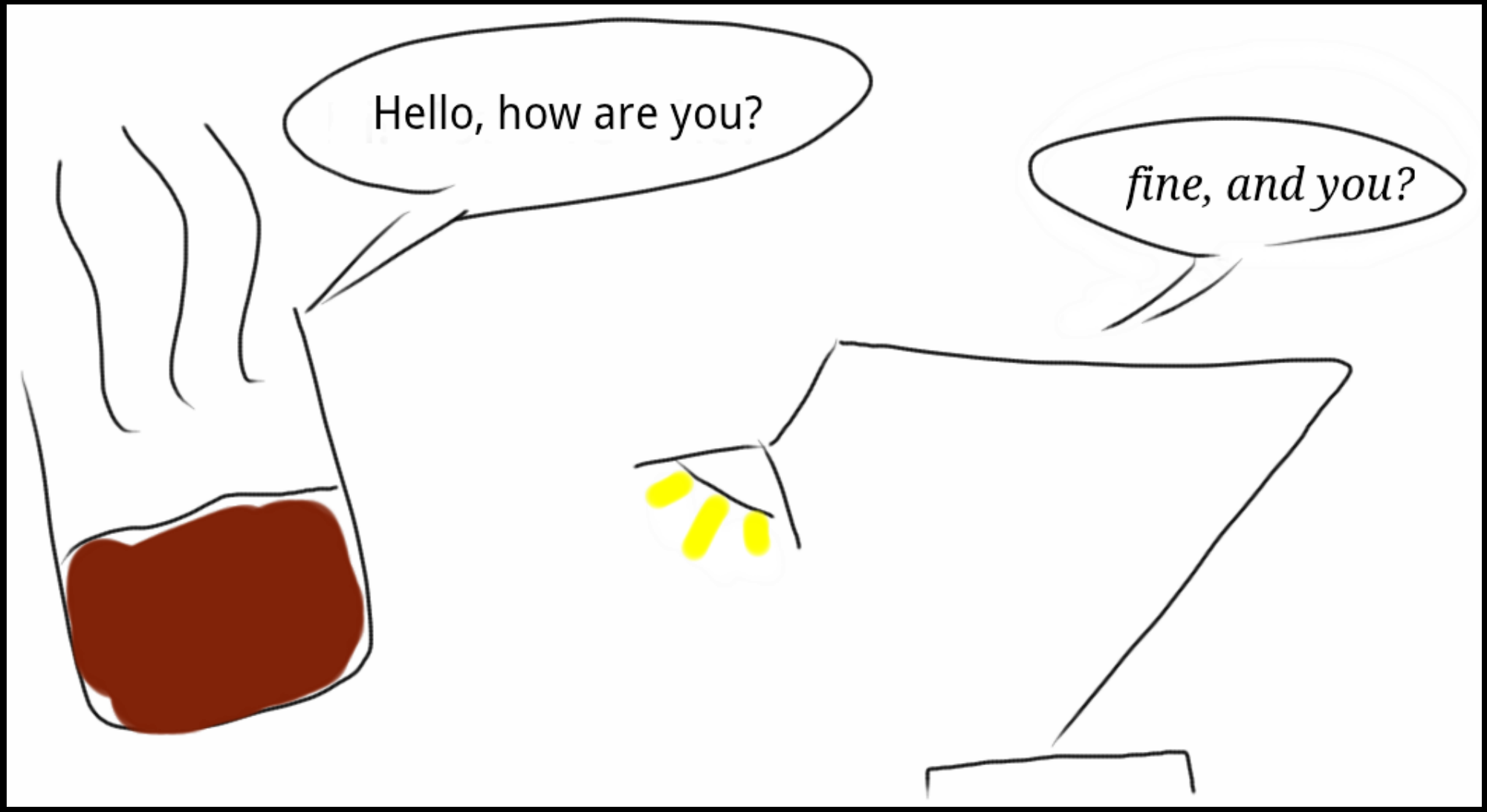
Lua as a common language for the IoT

Dipl.-Ing. Andre Riesberg, Nogs GmbH - Lua Workshop Moskow September 2014



Agenda

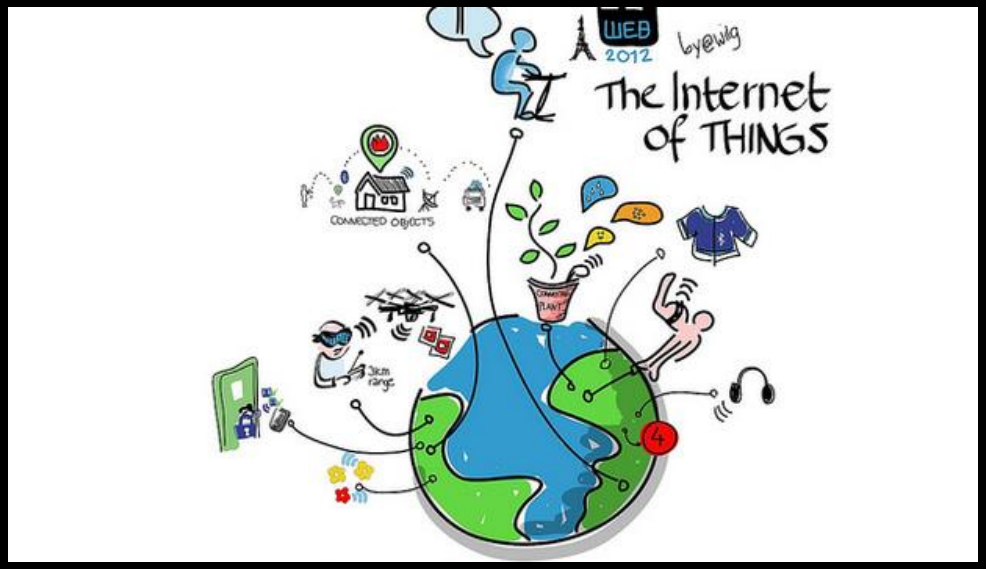
1. **Smart objects in the Internet of Things**
2. Babylonian confusion in the IoT world
3. Are smart objects really smart today?
4. How nodes can get savvy by means of Lua
5. Nogs - a new IoT framework and communication ecosystem

Smart Objects connect Digital and Real World

- The digital revolution of the 21st century will be much, much lager than previous two digital revolutions of personal computers and the internet
- We are now facing the digital revolution of the 21st century: Smart objects in the intenet of things, that interconnect the digital world with the physical world
- A smart object is a small mircoelectronic device that consists of a communication device, typically low power radio, a small mircoprocessor and a sensor and/or actuator.

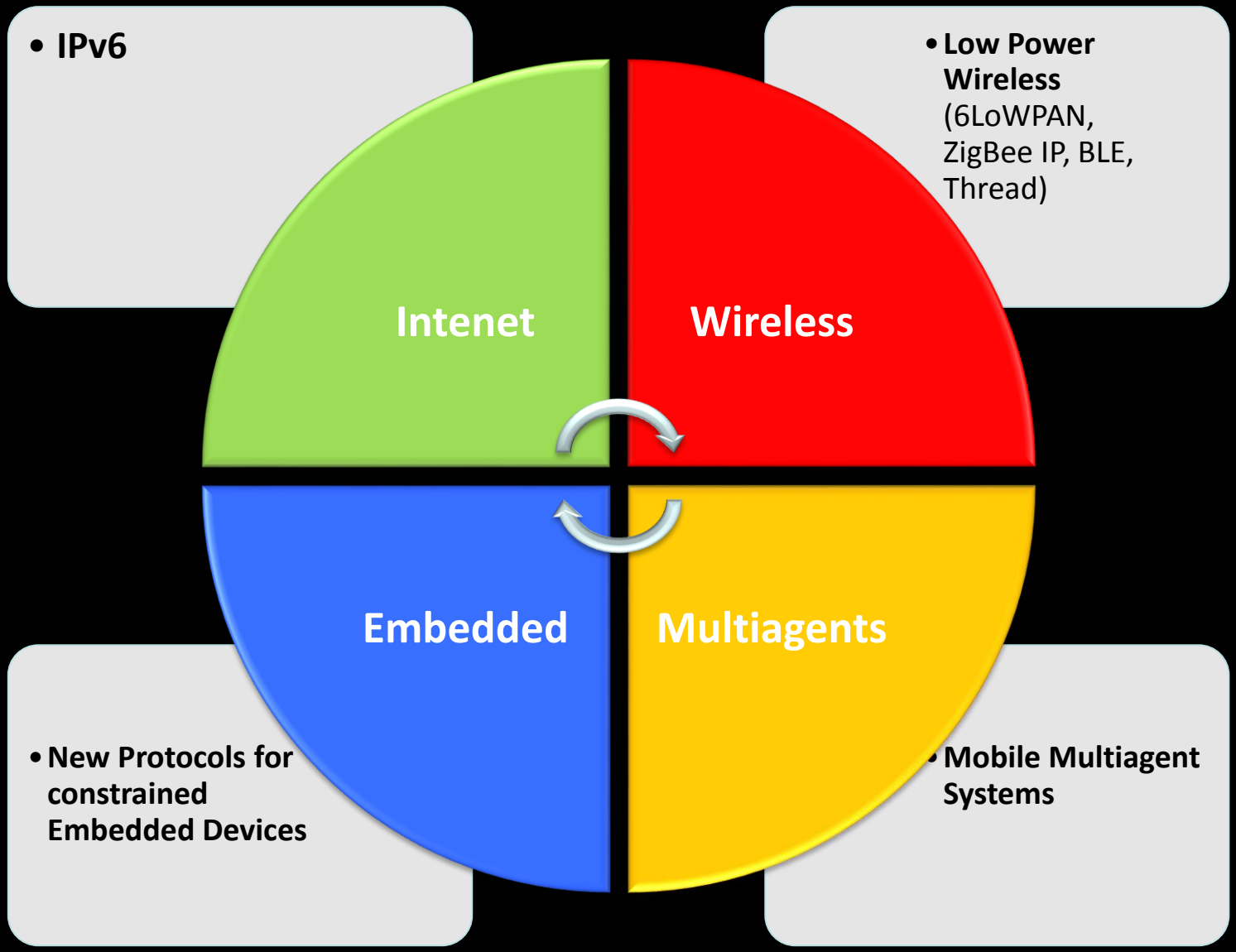
Credits: Jean Phlippe Vasseur Adam Dunkels

Internet of Things changing Automation Paradigm

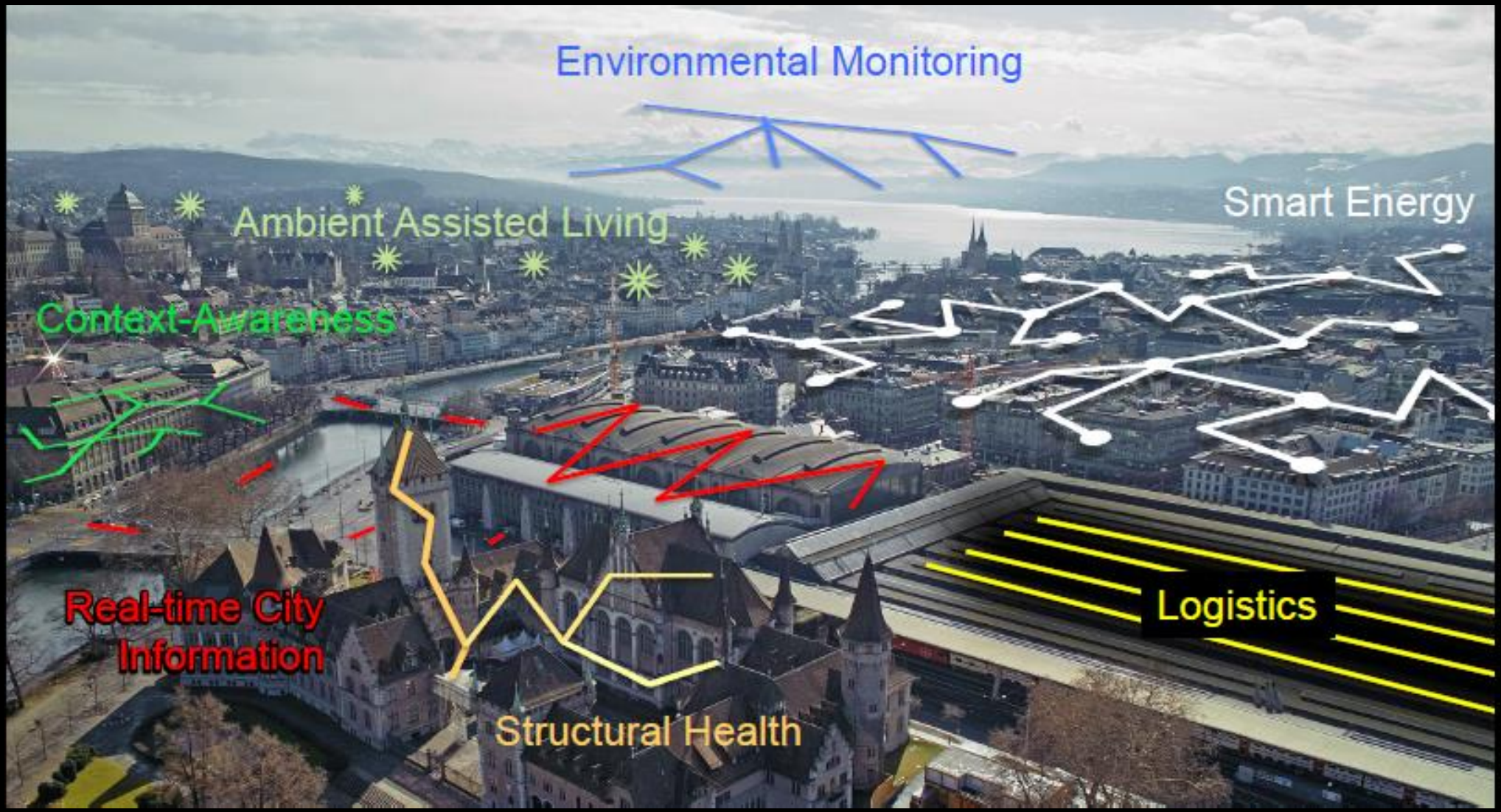


- The "Internet of Things" (IoT) is describing billions of embedded devices that are communicating with each other through Internet technology without involving human beings directly
- In the automation context, the IoT means the shift from centralized and hierarchical control towards cooperative, distributed networks and control structures
- Formerly passive sensors (simple objects) become active players (smart objects) in networks and are enhanced with the capability for computation and decision making.

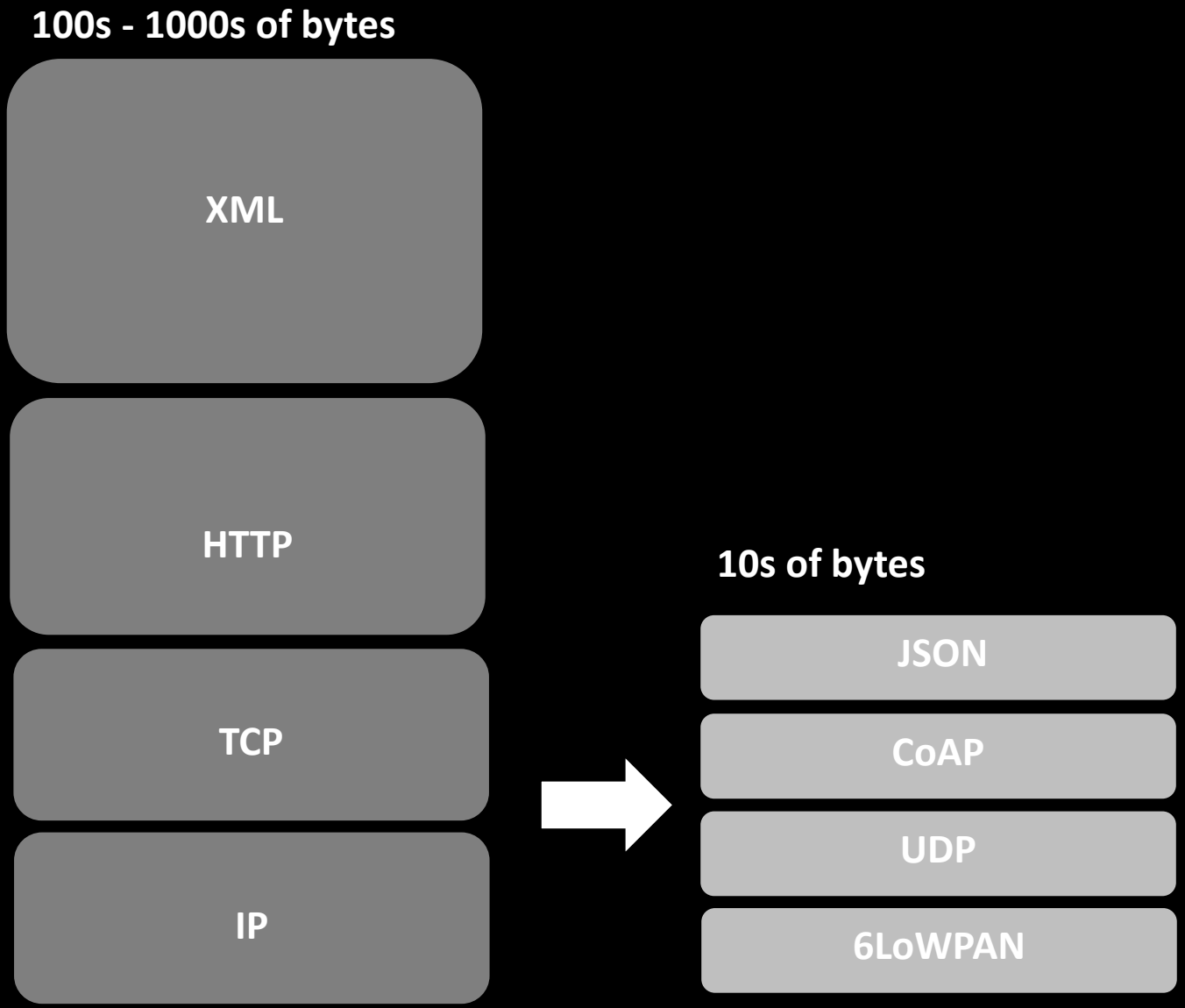
Enabeling Technologies



Wireless Sensor Networks



Protocols for constrained Embedded Devices



Credits: Zach Shelby

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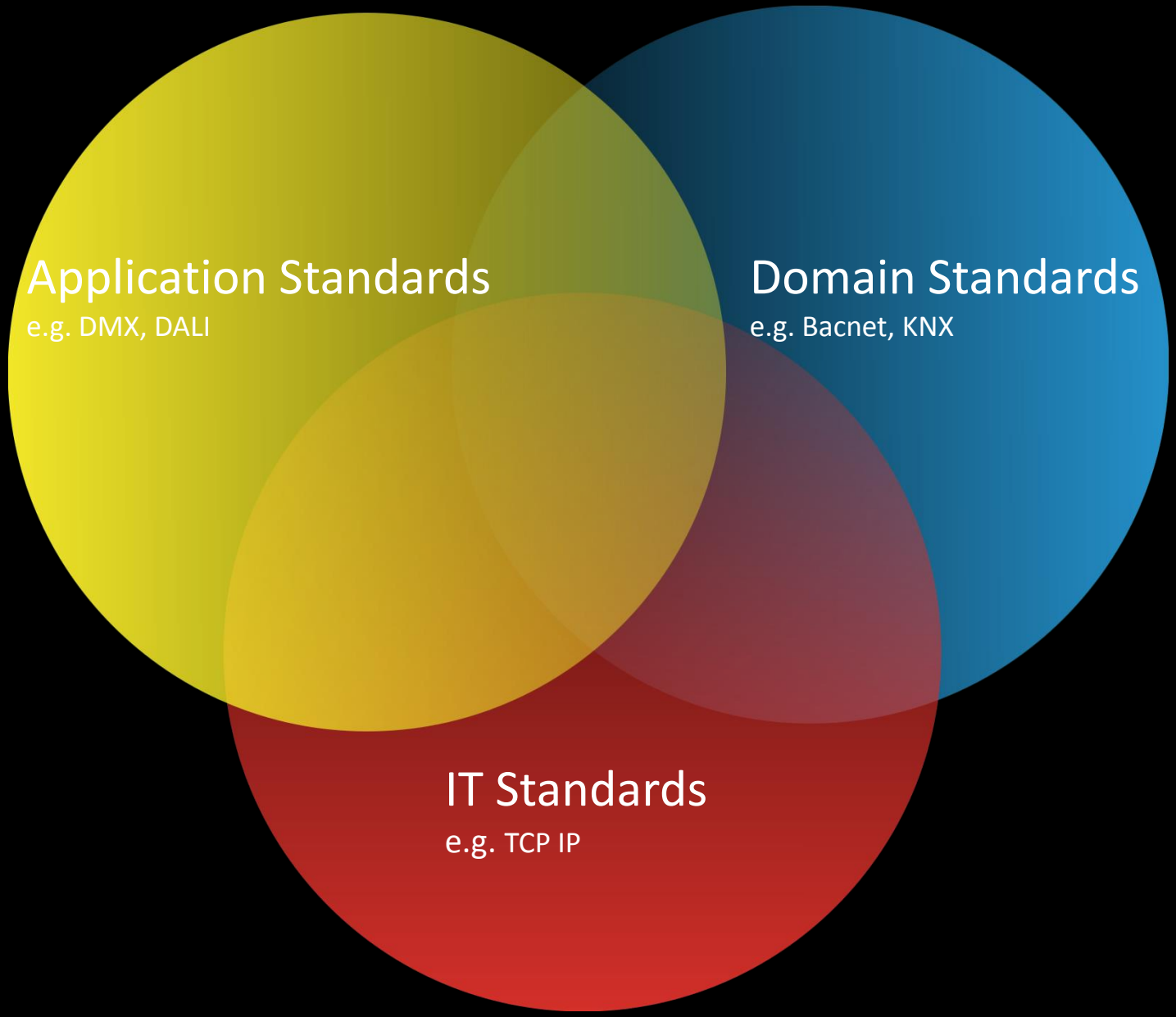
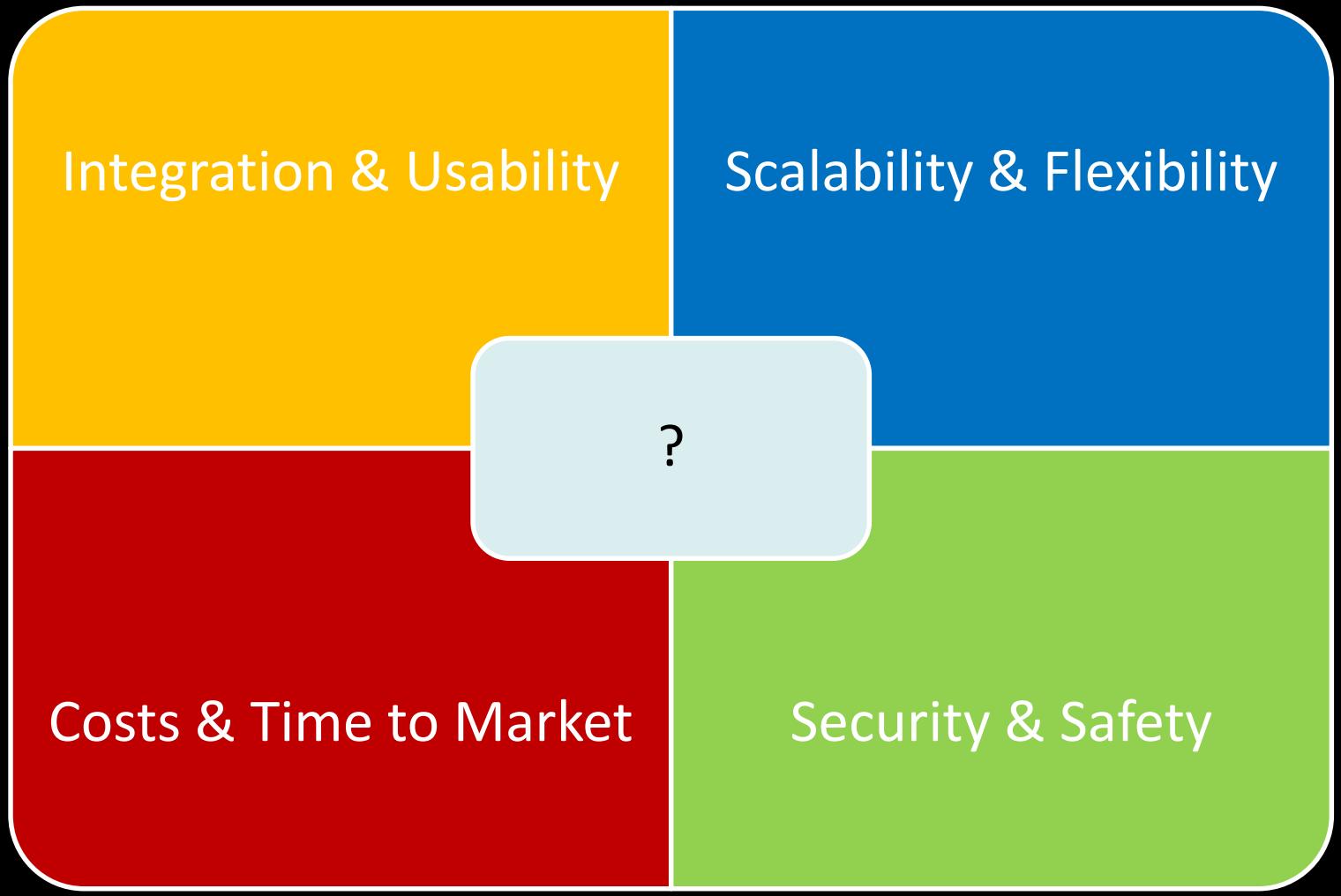
Clash of Technologies



Magic Square for Embedded System Development



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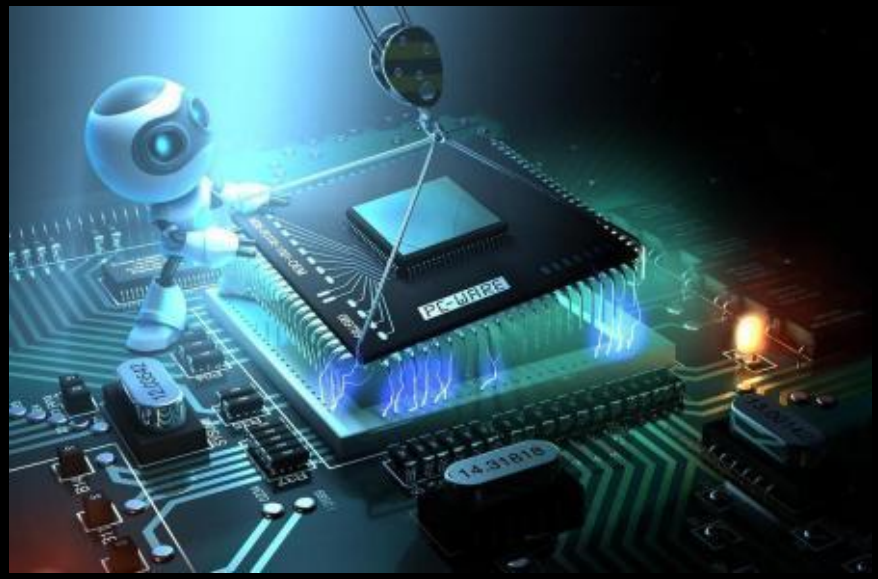
Embedded today



- Firmware / software updates
- Only predictable content
- Difficult to handle multiple protocols
- No consistent development platform
- Platform independent visualisation?

Highly changeable world

- New requirements at any time
- New types of smart objects
  e.g. wearables
- New communication protocols
  e.g. Thread
- Innovation in front-end devices
  e.g. Tizen
- New nodes pop up.

Let‘s start here …

Synchronized fireflies

Imagine all nodes would use the same unified way of communication among each other …

… and the way how they communicate is exchanging apps [executable save code] …

… and even sensor nodes are able to run such apps.

And think further …

Bird flocking

Let‘s assume everything could be an app: programm, data & communication …

… even the simple on/off command could be an app which destroys itself after it‘s executed …

… and wouldn‘t it be great if these apps could be executed on the fly?

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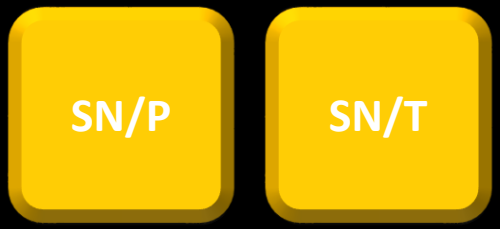
Basics

- Lua as a language for embedded
  5.2 -> 5.3
- Platform independed software development
- Open Source MIT
- Classification of nodes depending on Lua capabilties
  hardware constrains.

Type of Nodes



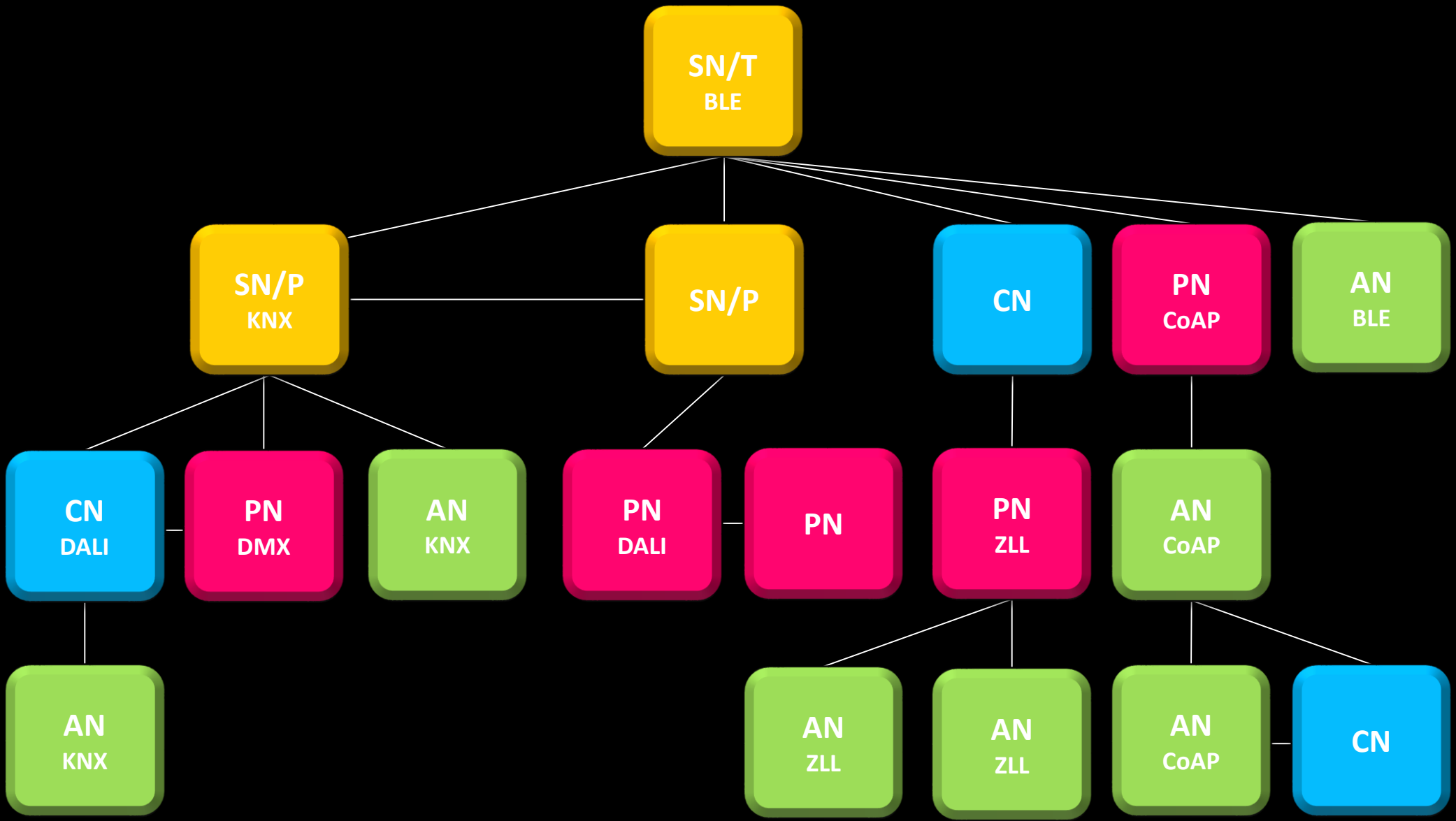
Permanent Smart Nodes
Temporary Smart Nodes both with GUI

Clever Nodes with Lua VM

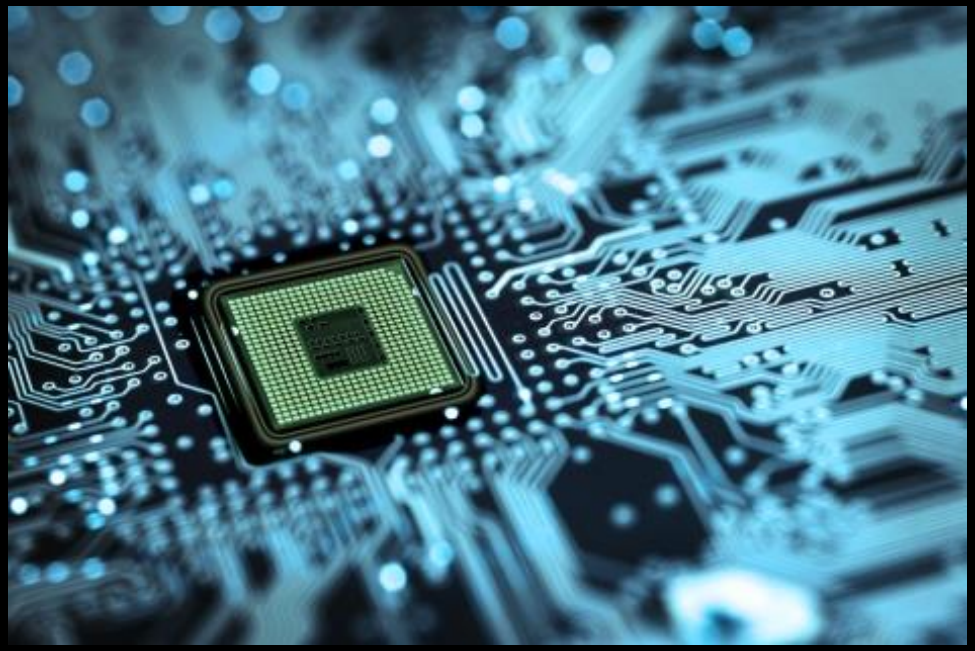
Primitve Nodes single line interpreting

Alien Nodes to connect with software gateway.

Typical Topology

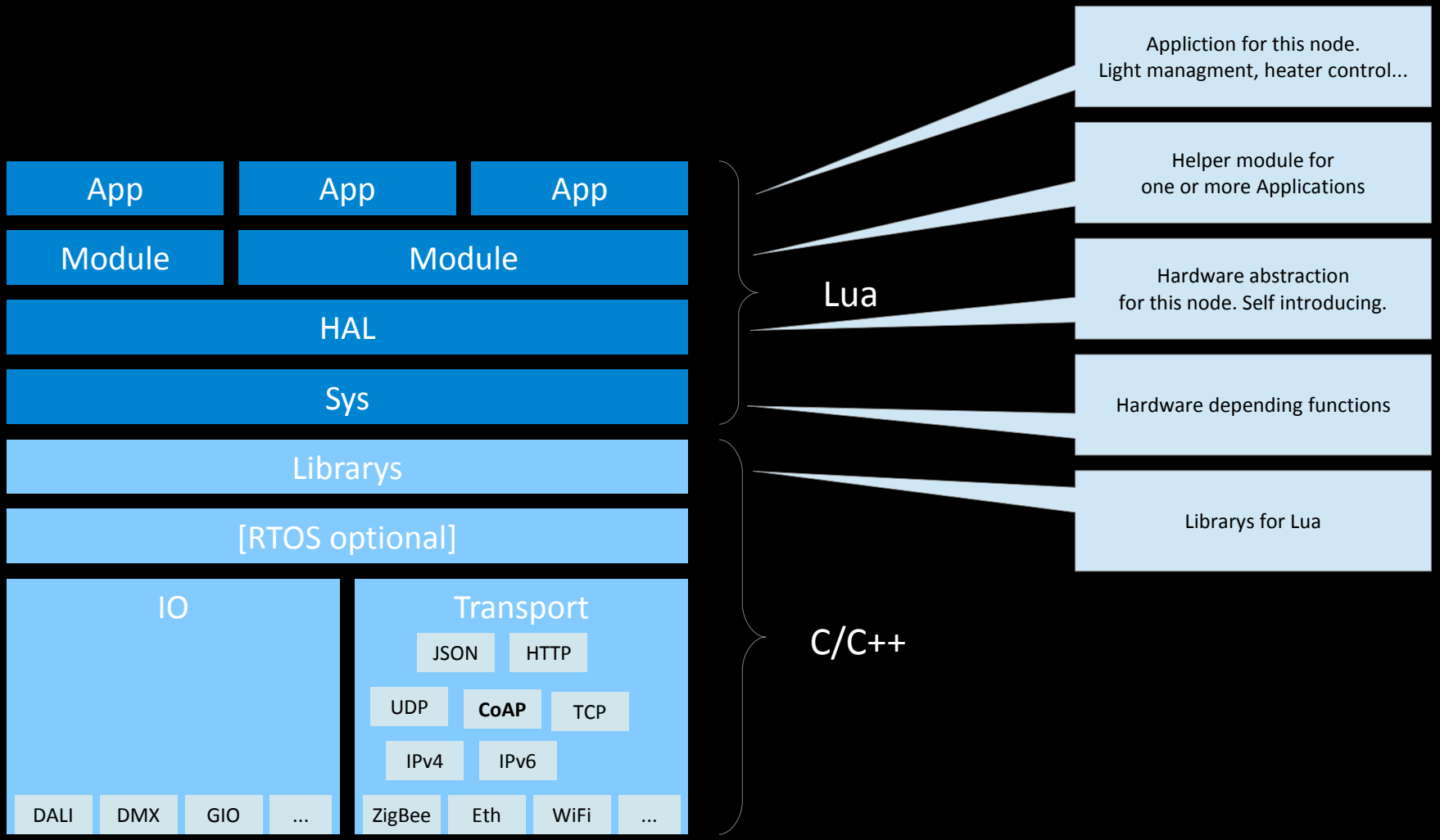


How to do Apps for Embedded?



- Standardized software layers for for different types of nodes
  hardware independent
- Unified communication between tasks & devices
  independent from protocols.

Nogs CN Platform



Dynamic coding as a communication principle

- Clever nodes as a new class of smart objects running a Lua VM
- Those nodes exchange objects where Lua represents data or functions
- These objects are executed on the fly.

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Communication Concept

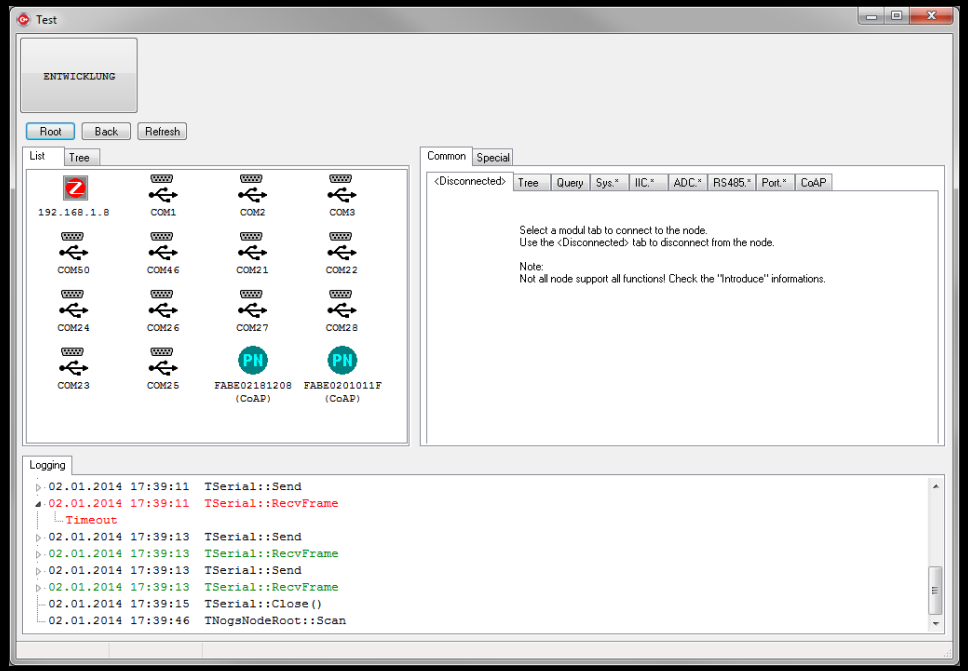
```
function Setup(ipAddress)
    timers.add(
        10,
        coroutine.create(
            function()
                local myJoin = join.udp.new(ipAddress,join.coap.PORT)
                myJoin.chain = join.chain.new{join.coap.json.con}
                while true do
                    myJoin:con(
                        '["ow.getTemp()"]',
                        function(recv, timerTotalTime)
                            if recv then
                                local table = json.decode(recv)
                                if table then
                                    for key, value in pairs(table) do
                                        dataBase[key] = tonumber(value)
                                    end
                                else
                                    -- Error handling
                                end
                            else
                                -- Error handling
                            end
                        end
                    )
                    while myJoin:isBusy() do coroutine.yield() end
                end
            end
        )
    )
end
```

- Distributed system
- Loose couplings
- Event driven with closers
- Security levels
  depending on requirements.

Security

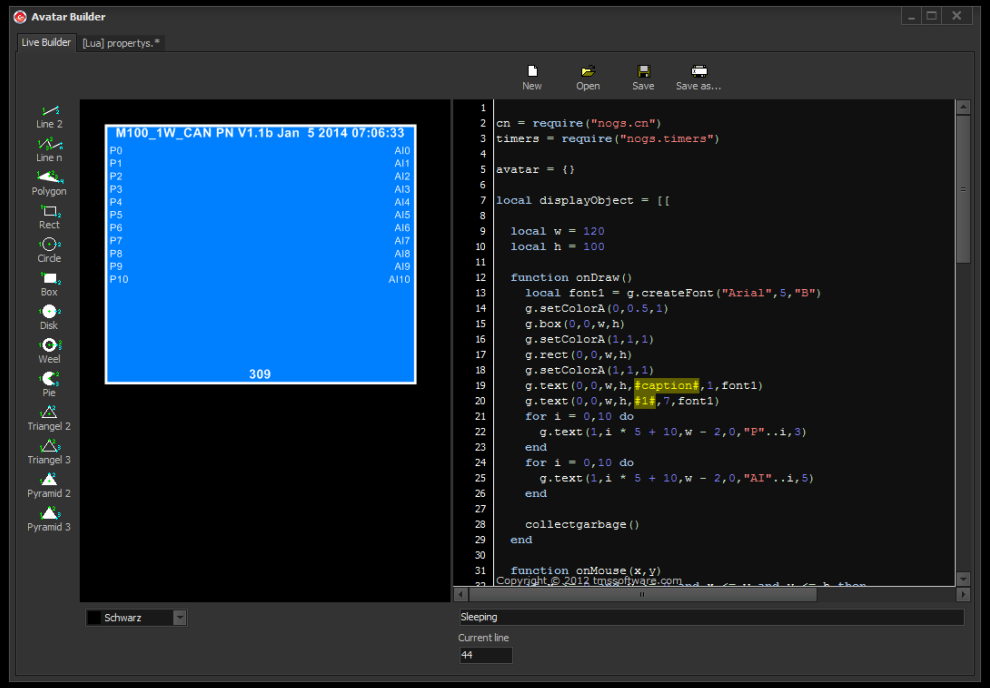
- All hardware with encryption chip
  „Nogs inside“ requirement
- Authentication of apps
- Special mechanisms
  e.g. for man in the middle & overload attacs
- Bare metal supervisor
  e.g. for APT-infection
- Encryption option
  above protocol level.

Unified Communication



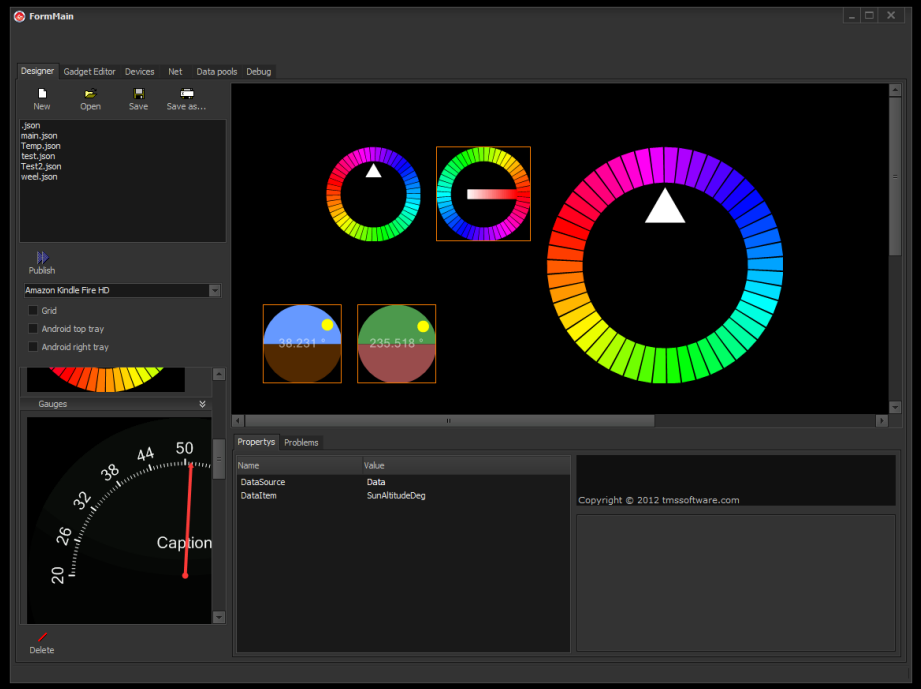
- Using JSON as a compact & human readable standard format
- Using a nesting mechanism to wrap & unwrap plain JSON data
- The wrap & unwarp mechanism is depending on the underlying data protocol and can be nested.

Simplified Commissioning



- Every node and/or subsystem is represented by an avatar
- An avatar is Lua code that describes and manipulates its owner in any kind of representation e.g. graphical
- By this means commissioning can be done with a simple tool, which doesn‘t know the specifics of the nodes.

Visualisation with Live Coding



- Visualisation for hardware independent GUI
- Live coding for any type of device
- All objects are Lua coded
- Supporting common Lua based game engines
  e.g. Corona / Gideros / Marmelade.

Occupation of Alien Systems

- SN, CN as PN as applications running on various systems
- Building gateways to Alien systems on SN, CN, PN
- Tunneling through Alien nodes
- Hacking & reverse engineering of Alien nodes?

Nogs Software & Hardware Matrix

Hardware / Software	Windows based	Lunix based	Android based	iOS based	Fieldbus Systems	Clever Nodes	Primitive Nodes
Debugger	Yes						
Nogs Communicator	Yes						
Nogs Configurator	Planned		Planned	Planned			
Nogs Designer	Yes, Live Coding		Planned	Planned			
Nogs SN	SN.EXE	SN.O	SN.APK	Planned			
Nogs CN	CN.EXE	CN.O	CN.APK	Planned	CN.EXE / Runtime	CN Runtime	
Nogs PN	PN*.EXE	PN*.O	PN*.APK	PN*.IPA	PN*.EXE		PN Runtime
Nogs MATLAB Simulink Block	Nogs CN Block	Planned					

Rapid Product Development

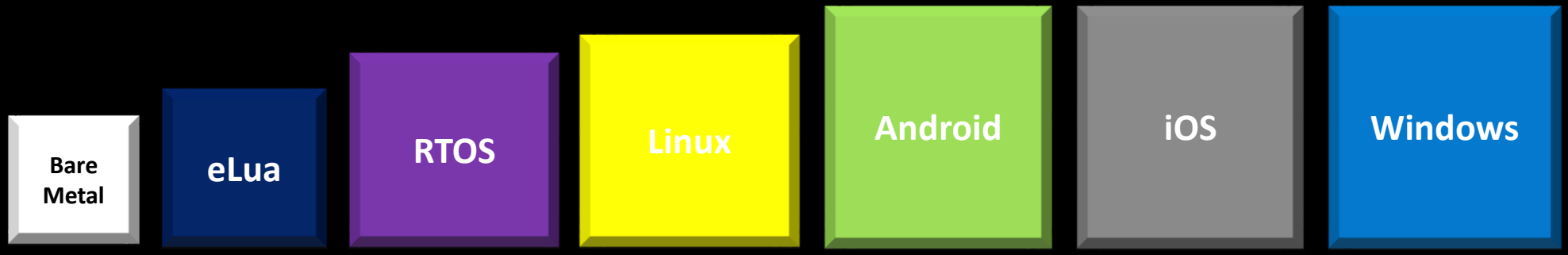
- Building reference hardware for quick start
- CPU boards for integration in series products
- Open hardware & software
- Turnkey.

Rapid Multiplatform Development

- IPv6, IPv4
- TCP
- UDP
- CoAP
- HTTP Client & Server
- FTP
- SMTP

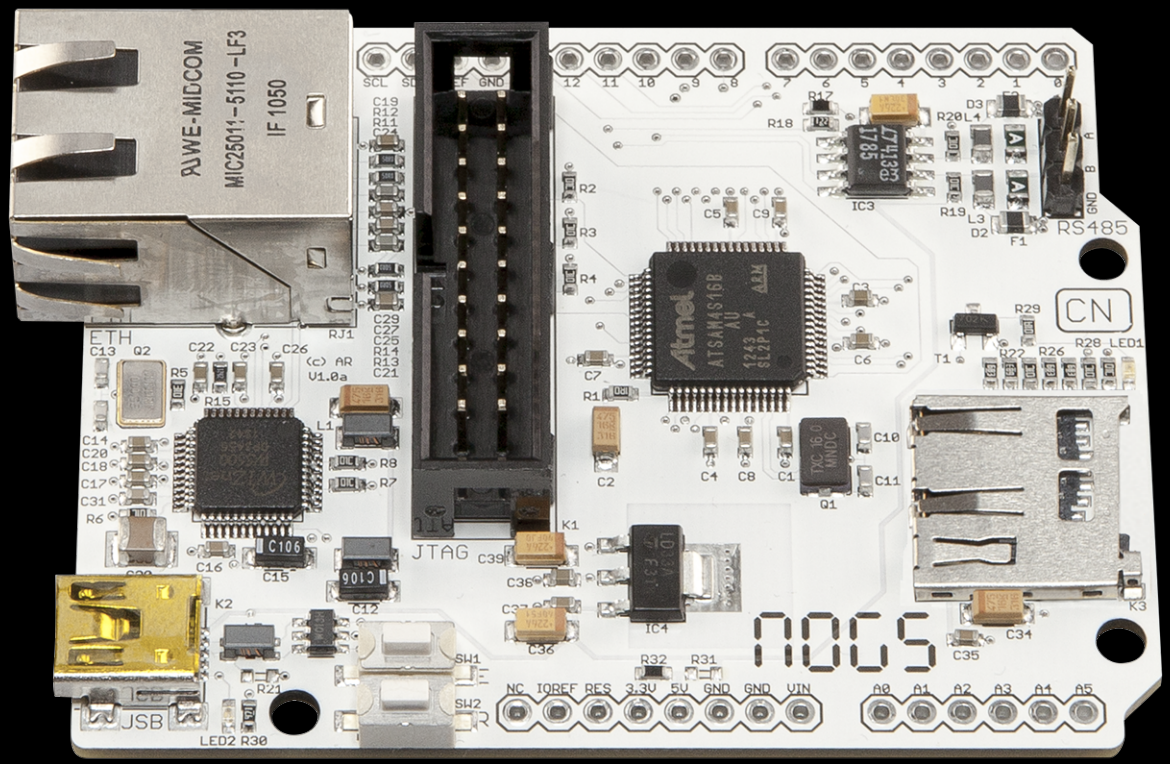
Clever Node

- ZeroBrane Studio
  - Debugger
  - Crossplatform Live Coding
- LuaRocks

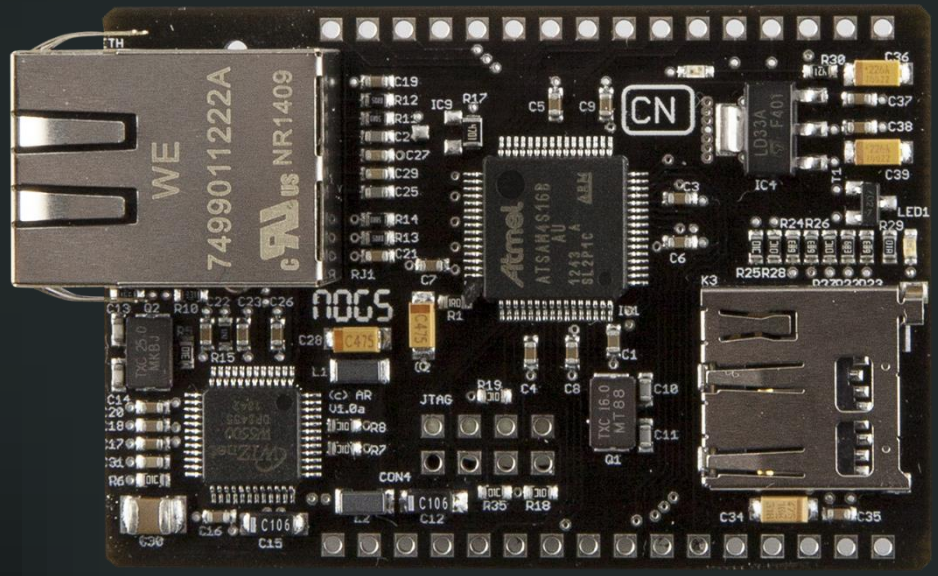


PiNogs - on PiNogs Backplane

Nogs Nucleo CN1 - Arduino format

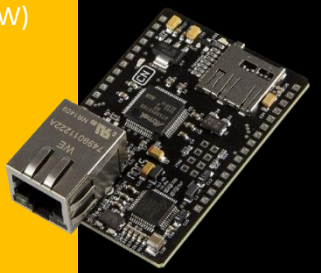


Nogs Stamp CN1 - for series products



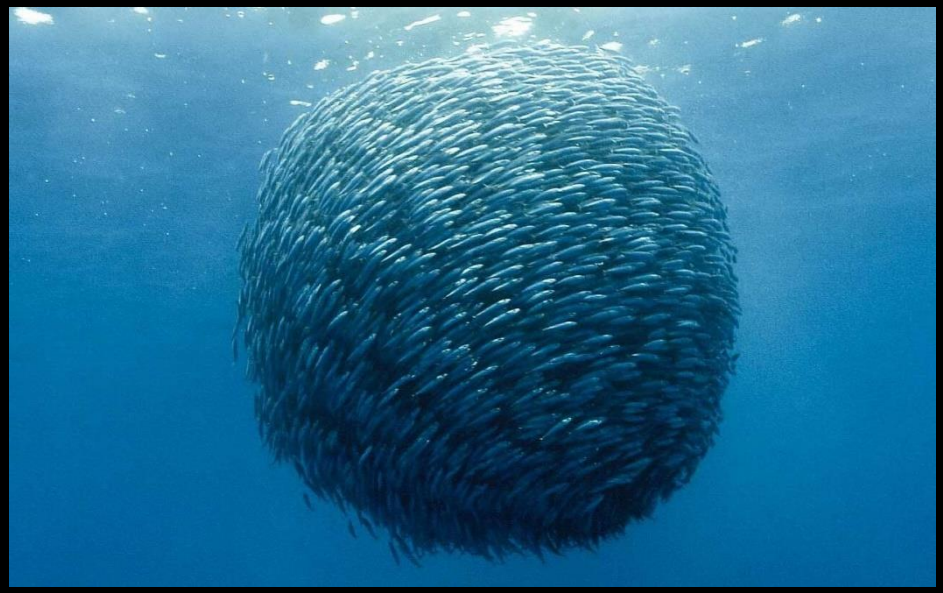
Comparison of single Board PN, CN & SN

Name	Arduino Uno	Nogs Nucleo	Nogs Stamp	piNogs	Raspberry Pi	BeagleBone Black
Model	R3	CN1	CN1	CN1	Model B	REV A6
Price	25 €				35 €	50 €
Size	68.6 x 53,3 mm	68.6 x 53.3 mm	56 x 38 mm	31,4 x 31,4 mm	85.6 x 53.98 mm	86 x 53 mm
Processor	ATMega 328	ARM Cortex-M4	ARM Cortex-M4	ARM Cortex-M4	ARM 11	ARM Cortex-A8
Clock Speed	16 MHz	120 MHz	120 MHz	180 MHz	700 MHz	1 GHz
RAM	2 KB	160 KB	160 KB	256 KB	512 MB	512 MB
Flash	32 KB	1024 KB	1024 KB	2048 KB		2 GB
Storage	1 KB ERPOM	Micro SD	Micro SD		SD Card	Micro SD
Encription		RNG, 72bit serial, OTP	RNG, 72bit serial, OTP	RNG, 72bit serial, OTP		
Input Voltage	7-12 V	5 V Micro USB Host	5 V	5 V	5 V Micro USB Host	Jack
Min Power	42 mA (0.3W)	150 mA (0.75 W)	150 mA (0.75 W)	120 mA (0.75 W)	700 mA (3.5W)	170 mA (0.85W)
Digital GPIO	14	14	14		8	65
Analog Input	6 10-bit	6 10-bit	6 10-bit		N/A	7 10-bit
PWM	6	3	3			8
TWI/I2C	2	1	1		1	2
SPI	1	1	1		1	1
UART	1	3	4		1	5
RTOS	Arduino	Clever Node	Clever Node	Clever Node	Linux etc.	Android, Linux etc.
DEV IDE	Arduino Tool	Lua, ZeroBrane Studio Debugger & Live Coding, Arduino Tool	Lua, ZeroBrane Studio Debugger & Live Coding	Lua, ZeroBrane Studio Debugger & Live Coding	IDLE, Scratch, Squeak/Linux	Python, Scratch, Squeak, Cloud9/Linux
Ethernet		10/100	10/100	10/100	10/100	10/100
USB Master		Micro USB 2.0	Option via Pin		2 USB 2.0	USB 2.0
Video Output		EVE Option	EVE Option		HDMI, Composite	Micro HDMI
Audio Output		EVE Option	EVE Option		HDMI, Analog	N/A
Interfaces		RS-485			CSI, LCD	CAN, LCD
Expansions	Arduino Shields	Arduino Shields 3.3 V	Stamp Shields		Expansion Boards	BeagleBoard Cape
Nogs Integration	PN for Arduino	CN Bare Metal	CN Bare Metal	CN Bare Metal	CN.O, PN*.O	SN.APK, CN.APK, PN*.APK, CN.0, PN*.O



Nogs Stamp CN1

Outlook



Swarm Intelligence

- Economics
  Apps for embedded as a market
  Sensor data as a service
- Artificial Intelligence
  Fuzzy Logic
  Semantic Networks (JSON-LD)
  Neuronal Networks
  Collaborative Intelligence
- New Hardware
  CN SoC
  Lua VM on FPGA
  Native Lua CPU?

Nogs Wrap Up

- Dynamic coding of smart objects
  on the fly
- Transferring objects instead of data
  as a new communication paradigm
- Unified communication
  by nesting & wrapping
- Simplified commissioning & visualisation
  by using avatars & live coding
- Rapid product delevopment
  by open hardware & software.

Join the Club …

Thank you - Questions?

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Have a look at GitHub soon