Connectivity for Automotive Light & Vision

Architecture for Software Defined Light&Sensor Networks in Vehicles

DVN Workshop – San Francisco - August 2023

APIX® ISELED® ILaS®

inova Semiconductors

Why „Software Defined Lighting"

Massive increase in light sources through out the car
- require color homogeneity, synchronization and small installation space

Dynamic effects on multicolor LED chains and matrices
- require highspeed data rate

Connected LEDs and sensors
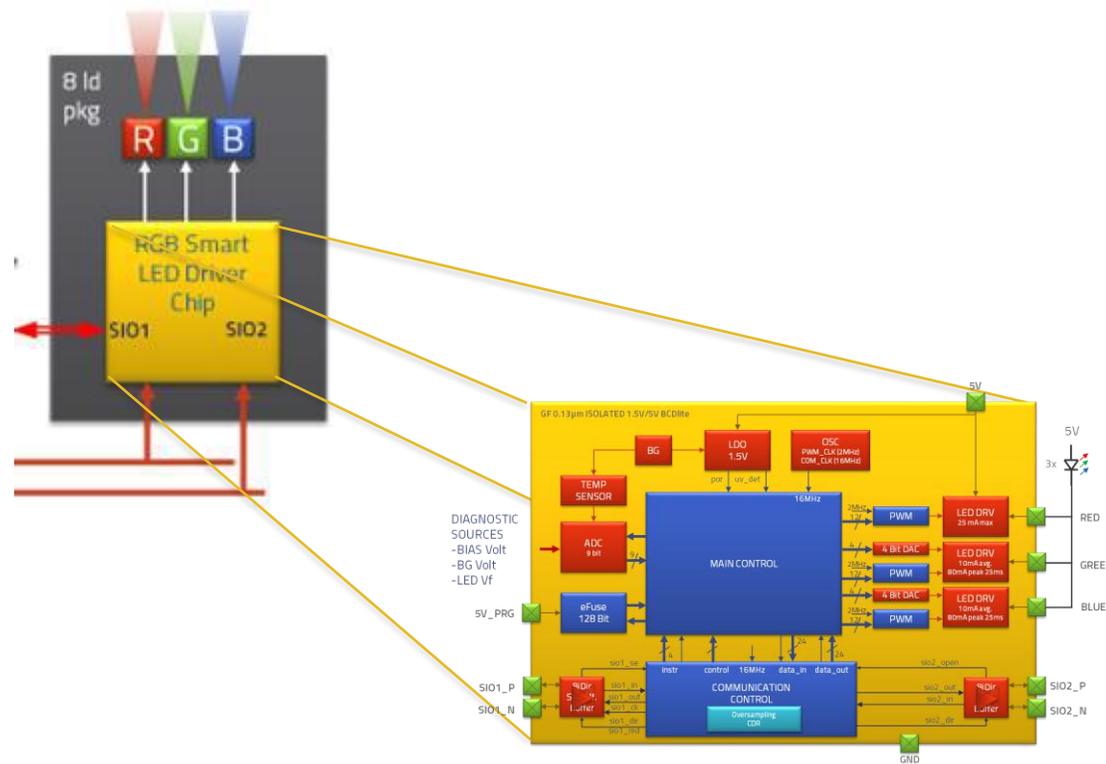- require low latency and fault tolerance

E/E architecture evolution and applications
- require efficient solutions for connectivity and synchronization

Easy to design and Cost efficient

> ....and "Software"
> needs some "Hardware" to run on and control

# RGB LEDs & RGB LED Driver – a tighly coupled pair of functions

- 3 individually different behaving LEDs (red, green, blue)
- Only tightly controlled drive current, PWM and temperature give the 3 channels the ability for precise color mixing and therefore quality light output
- The closer this pair knows their characteristics, the better it can compensate for deviations.
- Integrating both functions, allows to adopt even better to the LED characteristics, since the LED manufacturer is now capable to calibrate the RGB LED at his production line.
- A calibrated RGB LED doesn't need external interaction to generate a quality light output under changing conditions and allows to control it by a digital value - e.g. 24-bit or more – provided, that the calibration algorithm is on the driver and not the external controller.

Imagine a professional musician with his instrument, or a professional dancing couple
They don't need the teacher to tell them how to play their instrument or to form the perfect symbiosis
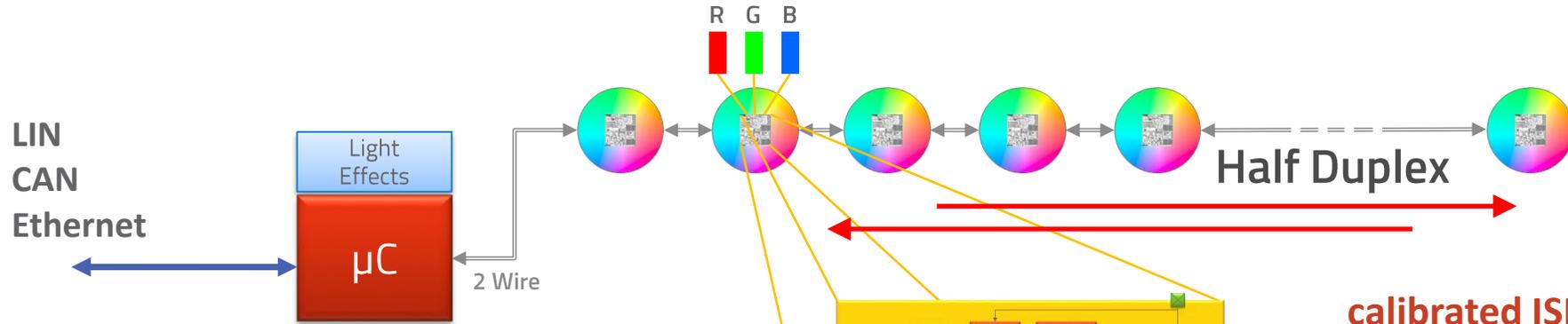
... Integrated Smart Embedded LED
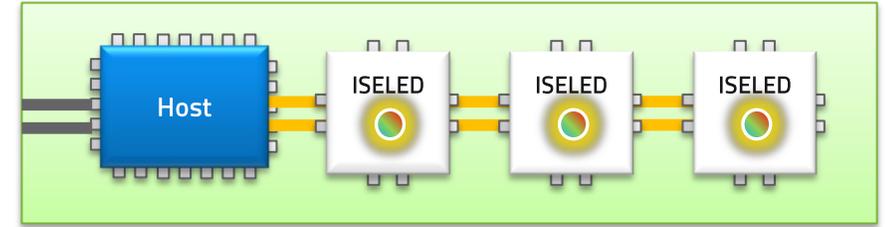
- Integrated solution of RGB LEDs with the LED driver chip into a single component, which then allows:
  - Color calibration of the RGB LED at the LED manufacturer instead of the system manufacturer
  - Internal temperature compensation within the module
  - Storage of the individual calibration & compensation values within the RGB LED module
- Integrates the bidirectional ISELED® communication protocol to allow:
  - 4K address space for individual or multicast addressing of any LED in a daisy-chaining configuration
  - Controlling the homogenous color of any RGB LED by a simple, digital 24-bit value instead of controlling 3-channel current & PWM.
  - Diagnostic read-back of individual internal parameters
- ISELED® communication bus is optimized for RGB LEDs mounted on light strips on a PCB to meet automotive EMC requirements. Short cable distances may be supported by using external filters
- Power efficient 5V supply only

Imagine directing an Orchestra of professional musicians or an ensemble of dancers
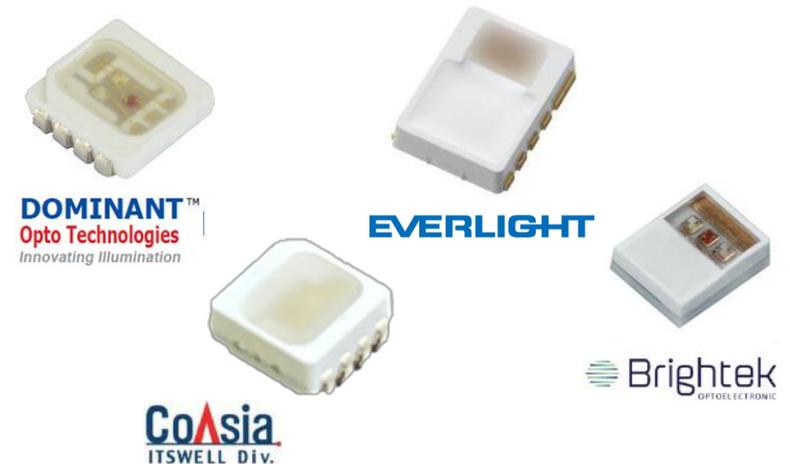
… Integrated Smart Embedded LED

R G B

Half Duplex

**LIN
CAN
Ethernet**

Light Effects

µC

2 Wire

**calibrated ISELED LEDs don't require
In-system- or End-of-Line calibration**

High Integration

- ISELED Driver & Controller IC
- LEDs
- Optics
- Integrated oscillator, bandgap etc,
- Nearly no external components necessary
- **Colour calibration included**
- Lowest System Costs

Daisy-Chaining of up to 4079 LEDs

DOMINANT™
Opto Technologies
Innovating Illumination

EVERLIGHT

CoAsia
ITSWELL Div.

Brightek
OPTOELECTRONIC
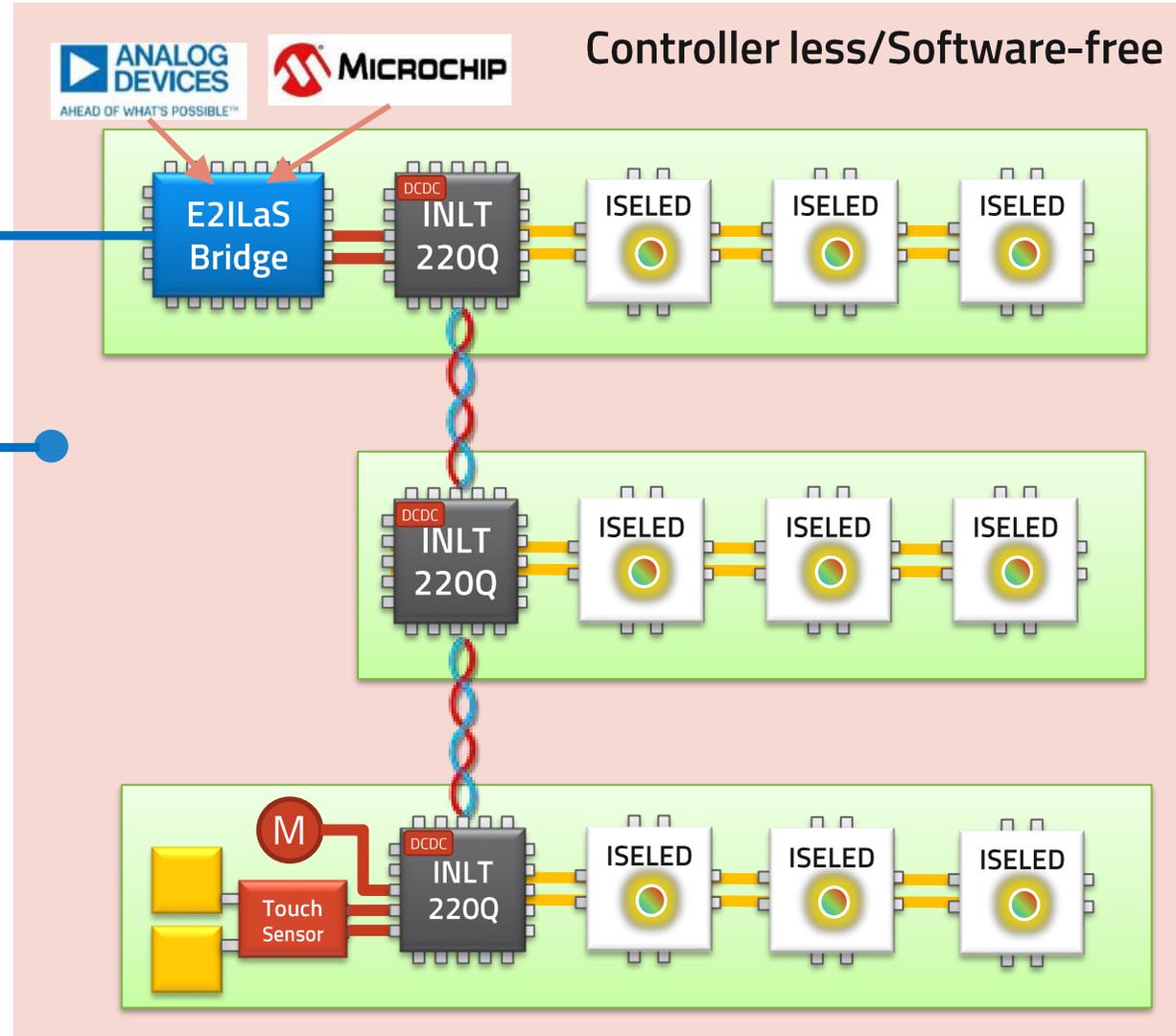
... ISELED Light and Sensor Network

- Cable connectivity solution for ISELED RGB LEDs and Sensors
  - 40V robust design that meets automotive ESD and EMC requirements
  - Single 12V power supply with integrated 5V DCDC controller for power efficient lighting implementation
  - Low power mode and wake-up signaling
  - Optimized for connectivity of LED-, sensor-, actuator-subsystems **via unshielded twisted-pair cable**
  - GPIOs for control of external devices.
- Enhanced bidirectional ILaS® communication protocol:
  - Supports a physically segmented daisy-chain of ISELED® LEDs
  - Fault tolerance through network segmentation and transceiver bypath (Fail-over pass through)
  - User space in OTP (one-time programmable) memory to store network topology information
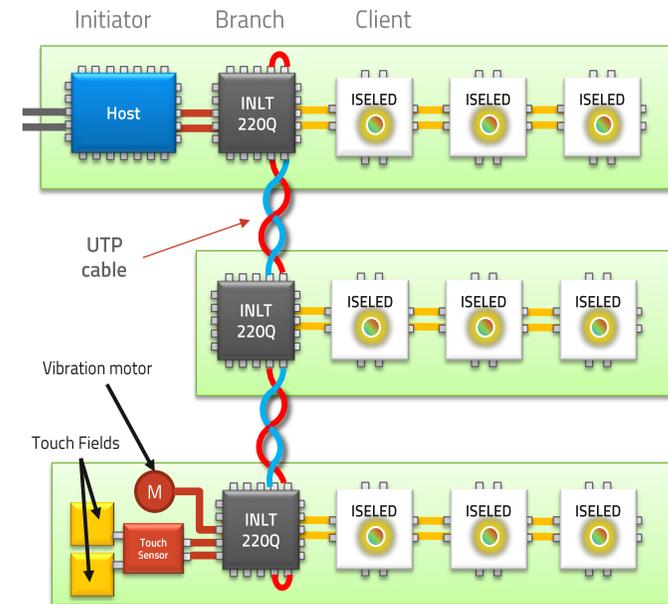
Imagine to orchestrate multiple groups of professional musicians or groups of dancers

SDV Architecture - Ethernet to ILaS

Controller less/Software-free

Central Controller
Interior Light Control
„Light Engine"

10Base-T1S
ETH
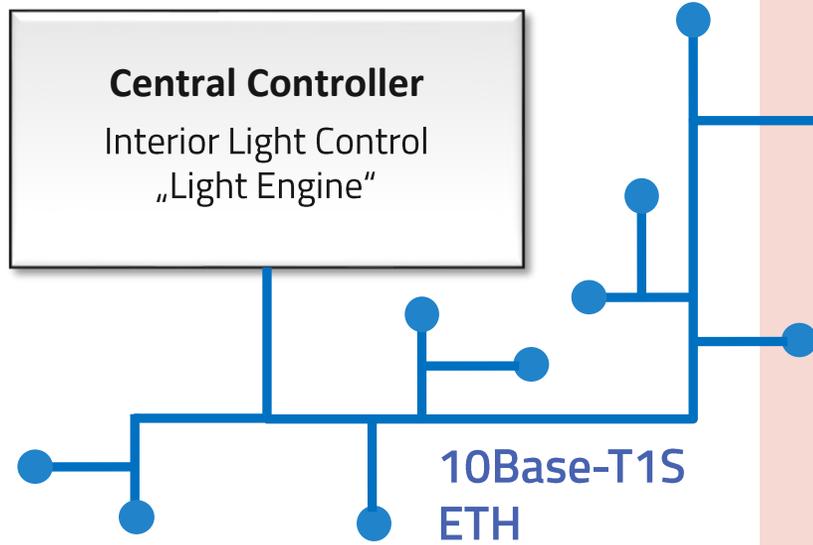
Plug'n play – no calibration
Centrally Controlled
Simple Light Synchronization
- control per „raw data" (no re-calculation required)
- Ethernet PTP (precision time protocol)

Allows updates „on the fly"

ILaS Network – Connectivity

Short UTP cable

Filter

Filter

Host or Eth.Hub

DCDC INLT 220Q

#1

12V

Battery

UTP cable for long cables / no filters needed

12V

DCDC INLT 220Q

5V

ISELED #3

ISELED #4

ISELED #5

5V GND

5V GND

5V GND

ISELED #6

ISELED #7

ISELED #8

#2

Battery

GND

Last in chain

ILaS RGB DCDC #9

ILaS RGB DCDC #10

12V

INLT 220Q DCDC

#11

5V

#12

#13

#14

ISELED

ISELED

ISELED

Repeater Devices

APIX® ISELED® ILaS®

inova Semiconductors

ISELED – Open Alliance

The open Alliance provides complete system solutions for smart LED, initially targeting automotive interior lighting.

More information can be found at https://iseled.com/.

Silicon

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LED

DOMINANT Opto Technologies Innovating Illumination · EVERLIGHT · CoAsia · Lextar A Member of Ennostar · Brightek · Hongbright · HARVATEK · LITEON

MCU

MICROCHIP · NXP · RENESAS · autochips · ZHIXIN · BLUE WHALE 水木蓝鲸 · YUNTU 云途

Tier 1

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Misc.

DISPLAY LAB PFORZHEIM UNIVERSITY · TE connectivity · TACTOTEK · LIGHTWORKS PASSION FOR LIGHT · LUCIE LABS · ASE · intron 英恒 · technica engineering · UG SYSTEMS

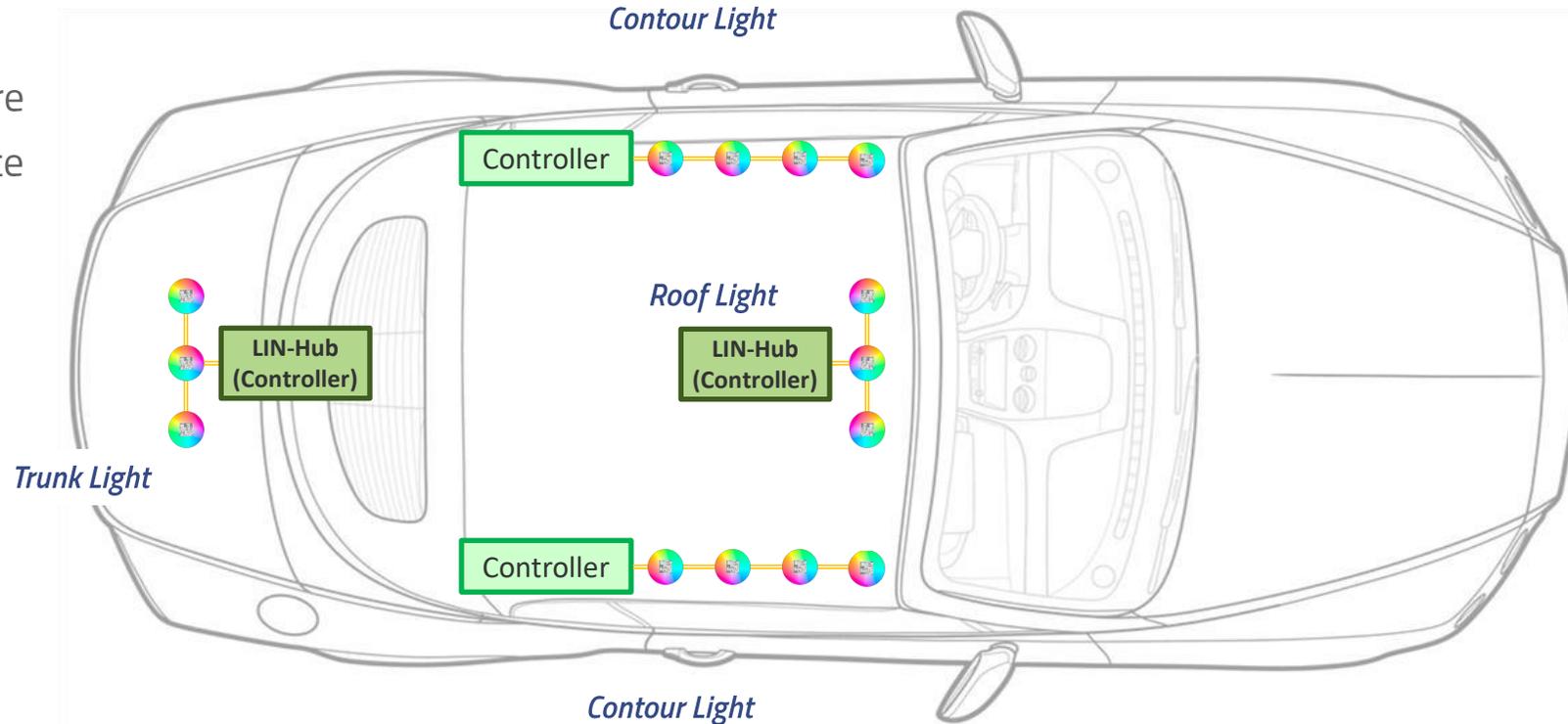APIX · ISELED · ILaS · inova Semiconductors

Lights inside the car - today

Technical Solution:

- Multiple (Micro)Controllers with Software
- LIN Hubs (with Microontroller) for remote LED installments

Limitations:

- Limited dynamic light effects
- Difficult to achieve brightness and color homogenity between subsystems
- Calibration of RGB LEDs in SW by tier 1
- Very limited diagnostics
- Low speed
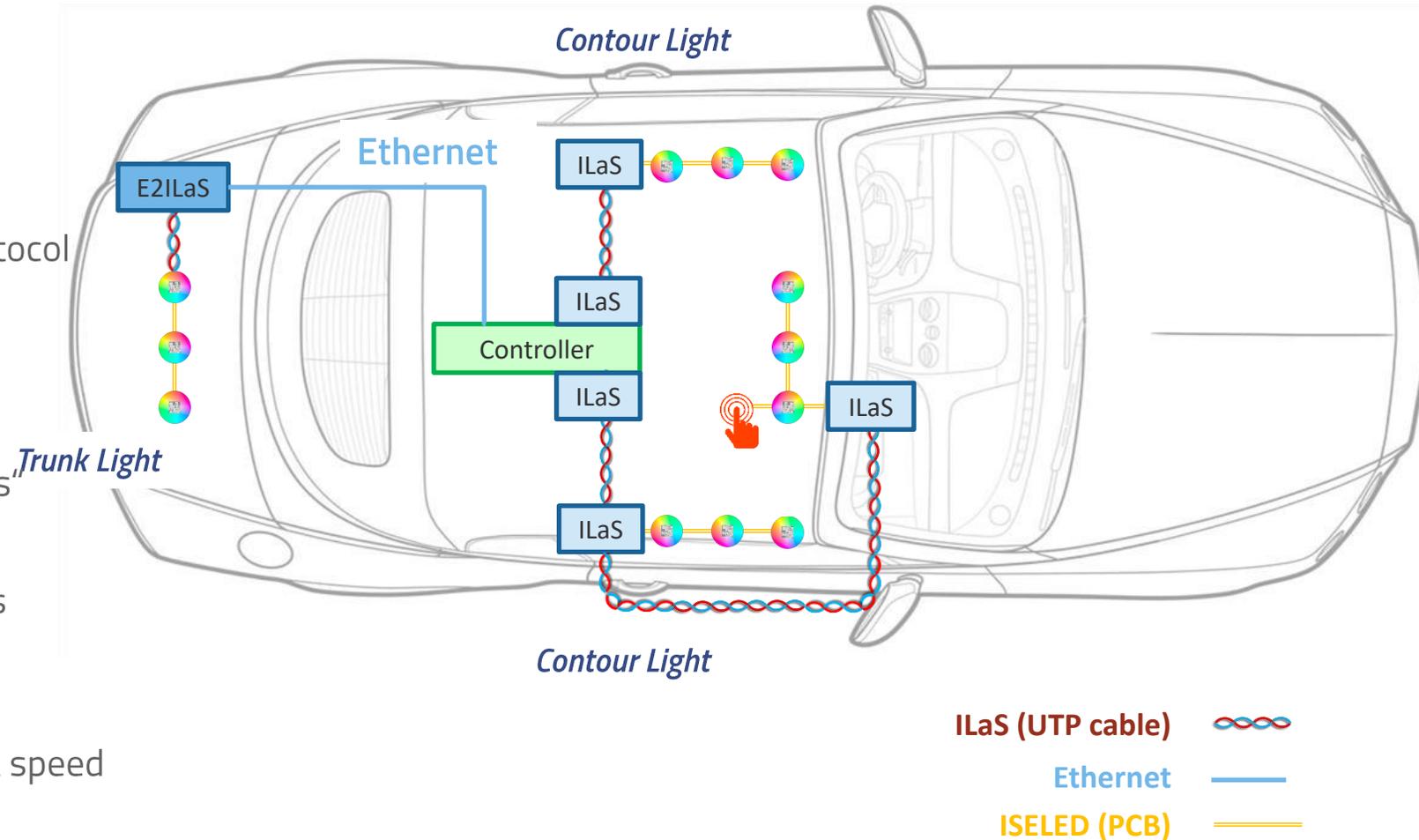- Limited color or brightness adjustments by the user

Contour Light

Controller

Roof Light

LIN-Hub (Controller)

LIN-Hub (Controller)

Trunk Light

Controller

Contour Light

Software Defined Lighting – ILaS / ISELED architecture

Technical Solution:

- ONLY one central Controller possible
- Leverages available Ethernet Network
- Alternatively (or only) ILas Bus (edge)
- One media independent bi-directional protocol
- Each LED and sensor with unique address

Benefits:

- Smart LED and Sensors on one „virtual bus"
- Controllerless (no SW) subsystems
- Total freedom of placing LEDs and sensors thorughout the car
- No LED calibration necessary
- Dynamic and functional lighting at highest speed
- Diagnostic support
- Reduction of weight, harness, cost

Contour Light

Ethernet

E2ILaS

ILaS

ILaS

Controller

ILaS

ILaS

ILaS

Trunk Light

Contour Light

ILaS (UTP cable)

Ethernet

ISELED (PCB)

APIX® ISELED® ILaS®

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Software Defined Lighting – „Like a Display"

Software Approach: SYMPLICITY !

- Each LED or sensor is like a „Pixel" of a display
- Virtually connected via ILaS Protocol
- LEDs can easily be controlled:
    - Colour Value
    - Brightness
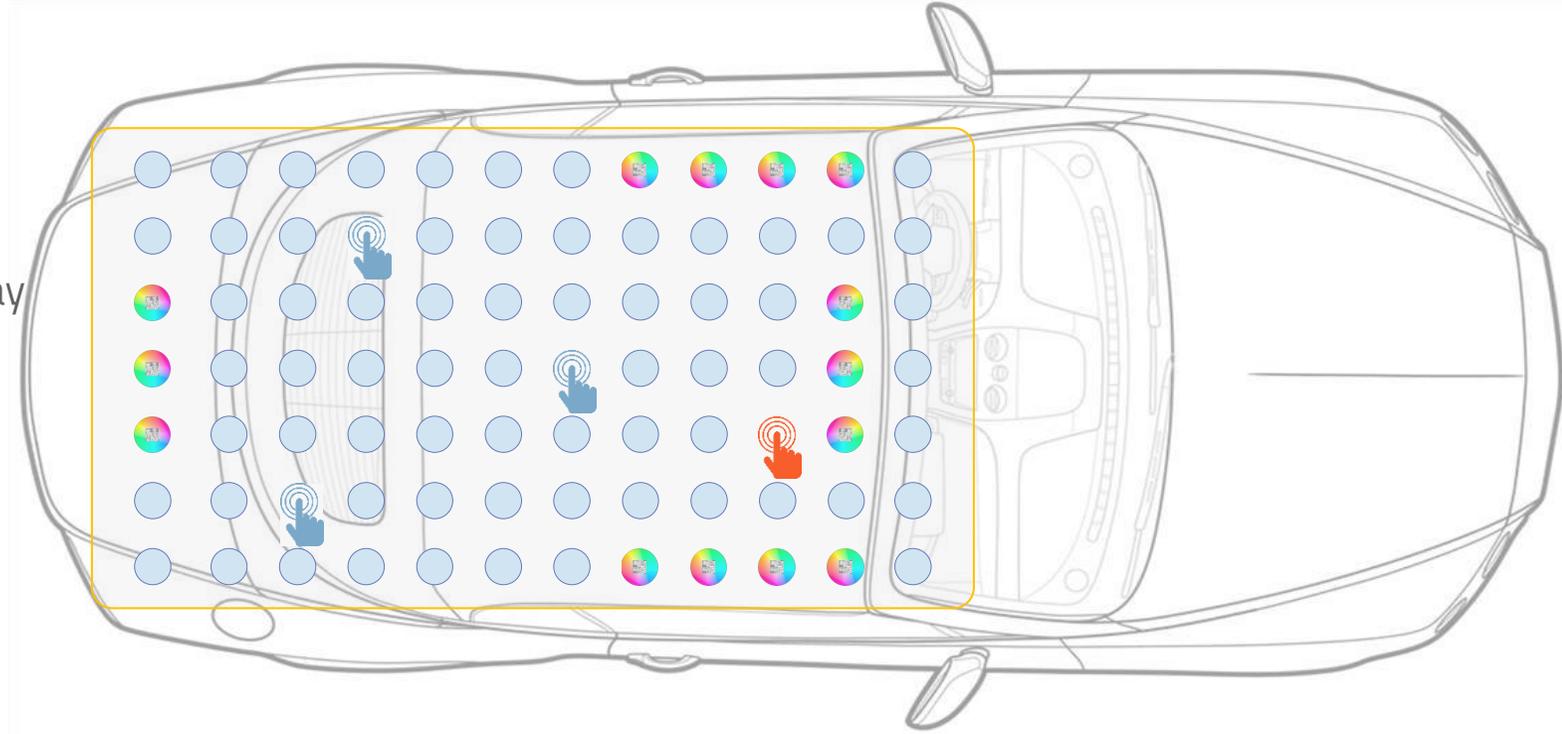
Imagine focus on choreography and orchestrating rather than at same time teaching the individual musicians to play their instrument well, or the dancing couple how to harmonize.

Take-aways:

- ISELED and ILaS architecture optimized for **"Software Defined Lighting"**
- **One Controller** for all interior and functional lighting
- Highly **scalable** and leveraging **available E/E infrastructure**
- **No calibration** of RGB LEDs
- **Synchronization** and **Homogenization** of Light Events
- **High Speed Dynamic** Light effects
- Optimized **total cost** solution
- **Minimized Software effort** for complex light scenarios
- **Multi Source** - Available from many suppliers

" Plug' n Play "