Intelligent lighting systems ... of the future

Dr James Mckenzie
PhotonStar LED group plc
Contents

• IoT
  • Internet of things
  • Market projections

• Lighting
  • What is it going to do to the professional lighting market
  • Current lighting – already very intelligent…. 
  • What's missing ?
  • What are the opportunities

• Intelligent lighting systems…of the future
Explosion in Connected Devices

20-30 BILLION\(^1\) BY 2020
= 3-5 nodes per person

500 BILLION\(^2\) BY 2025
= 1 node per 10m\(^2\) urban area

1 Cisco Industry Forecast
2 Cisco ex-CEO at Fortune’s Global Forum
Where is the value potential of the Internet of Things?

- Interoperability required to capture 40% of total value
- <1% of data currently used, mostly for alarms or real-time control; more can be used for optimization and prediction
- 2X more value from IoT applications than consumer
- Developing: 40% Developed: 60%
- Autonomous vehicles and condition-based maintenance
- $100B–750B
- Home
  - Chore automation and security
  - $200B–350B
- Public health and transportation
  - $600B–1.7T
- Outside Logistics
  - $550B–850B
- Human Health and fitness
  - $170B–1.6T
- Work places
  - Operations optimization
  - $100B–280B
- Retail environments
  - Automated checkout
  - $410B–1.7T
- Field service
  - Equipment optimization
  - $12T–3.7T

9 settings gave us a cross-sector view of a total potential impact of $3.9 trillion–11.1 trillion per year in 2025

Types of opportunities
- Transform business processes
  - Predictive maintenance, better asset utilization, higher productivity
- Enable new business models
  - For example, remote monitoring enables anything-as-a-service

Mckinsey 2015
What is it going to do to the professional lighting market?

- Smart homes
  - All are wireless
  - Use a hub to get internet connectivity
  - Use Zigbee / WiFi / z-wave etc

- All now have published APIs and can connect with other devices via the cloud

- These systems help us show to general population what is "the art of the possible"
Current lighting – already very intelligent....

• Past the light switch there are dozens of control systems and control protocols and thousands of products
  • DALI, DSI, 1-10
  • DMX
  • KNX
  • PoE,
  • Proprietary
• These are pretty flexible and can deliver all the requirements for lighting control the market will ever need (but not all in the same system!)
  • Energy saving, monitoring
  • Occupancy, Presence control
  • Diming, Daylight linking
  • Colour control, CCT control
  • Connectivity to Building Management Systems
• So we have it all covered - don’t we?
Warning: Technology that disrupts mature industries

- Many examples from recent history
- CMOS imaging sensors v’s emulsion film
- Download / streaming media v’s HMV or Blockbuster
- LED v’s traditional illumination sources
  - No surprises – The revolution is over - LED has won
  - The transition has now kicked off a new phase…..

*While the LED revolution may be over, the story of intelligent lighting is just beginning.*
What's changing it all – let's look at a typical Smart Phone

- Apollo Guidance systems – 1960 sub 1 MIPS
- Intel 286 – 1982 - 2.66 MIPS
- ARM M0 – 45 MIPS -> $0.4 as a functional microcontroller!
- ARM M3 – 125 MIPS
- ARM A9 – 7500 MIPS
- 2.4 GHz soft radio ICs sub $1 per node including network processor!
Sensors

Chip Scale Technology
The world runs on IP packets

- IT infrastructure is ubiquitous
- The modern world runs on IP packets
- Global standards prevail

http://www.internetlivestats.com/internet-users/
What problems have we been trying to solve with current intelligent lighting?

• Great lighting control specifically for the application
• Simplicity of operation
• Simplicity of installation
• Operating costs
  • Energy Savings
    • 80% are there with current LED products
    • Control factors maximizes the savings
• Maintenance costs
  • No lamp changes etc
• Integration with Building Management Systems in some cases
There is a discrepancy between natural and artificial light with regard to intensity, color, and dynamics of light.

Natural light is dynamic from sunrise to sunset.
Artificial lighting is fixed from wake-up to go-to-sleep.

We need light and darkness.
There is a period of the day when we are active and a period when we are sleeping.
Light is the most important timer for our internal clock.

Light has an effect on:
- Vision: 06:00, 12:00, 18:00
- Body: Alarmness, cognitive performance, and sleep/wake cycle
- Emotion: Mood, energy, and relaxation

Look beyond energy efficiency.
Human Centric Lighting increases the vision, well-being, and performance of people.

Examples of benefits:
- +4.5% Productivity
- -1% Errors
- -1% Absence

So have we got it all covered?

• New build – mostly for now, yes
  • LEDification – yes
  • Installation cost of controls - 2 cables instead of 1 (power and control, ignoring PoE)
  • Commissioning and set up – existing controls are expensive to set up and reconfigure
  • Human Centric lighting requires dynamic light sources (mostly) – DMX is a strong candidate, DALI coming on

• Retrofit - not really
  • LEDification – yes
  • Installation cost of controls – prohibitive cost, retrofitting control cables is highly disruptive
  • Human Centric lighting is therefore hard to deliver in this instance
So what will Intelligent lighting systems of the future look like?

- Let's look at some approaches and there are many…

2001: A Space Odyssey - 1968

I'm sorry Dave, I'm afraid I can't do that.
Wired Connectivity
*Power over Ethernet (PoE)*

- Cat 5/6 cabling
- Cisco promoting this heavily in Enterprise
- Lot of cable to control each light fixture
- Plug and play
Wired Connectivity

Power Line Communication

- Low data rate
- Can be blocked by switch gear and isolators
- Can't bridge phases

EnModus Wattwave diagram
Distributed Wireless Control for energy saving retrofit

- Organic response
- Distributed wireless control
- Tackling Energy saving retrofit
- no capex – energy saving pays for cost of the loan
- Simplified set up and occupancy sensor based control
Osram Lightify system

Hybrid approach with zigbee
- Home and Professional versions
- Combines benefits of DALI devices and Wireless (Zigbee) to reduce install costs
- Simplified commissioning
- App control
- Conventional control interfaces
Location, navigation and footfall

• Philips Beacon using VLC  
  (visual light communication)
  • Connectivity via PoE
  • Needs to ‘see’ smartphone camera
  • Smartphone ‘needs’ app (software)

• Bluetooth ibeacons

• Beaconing can work independently of lights or can be connected at higher software layers to provide in store navigation/footfall tracking
Smart City - enSense™Sensors

- Wireless Control and
  - Gas sensors
    - NO₂, CO, HS₂, O₃.....
  - Traffic counter
    - Volume, speed and demographic
    - No video stored or streamed
- Contactless temperature
- Microclimate
  - Temp, pressure and humidity
- Noise detection
  - Background or specific e.g. car crash
- Particulate sensor
  - Carbon black, dust, pollen
2014 halcyon™ - system

halcyonPRO is a wireless network of lamps, luminaires, light fittings, light tape, sensors & switches. Products listed below:

Key features & benefits

- **Circadian:** Your body clock or circadian rhythm is driven by light. Halcyon can emulate daylight for health, wellbeing & productivity.

- **Energy Saving:** Halcyon saves more than standard LEDs by automatically dimming/turning off unneeded lights and reporting your energy use.

- **Whole Building:** Centralised intelligence in the server monitors and controls the whole building.

- **Multi-User:** Intuitive for all users (including guests) who can all interact with Halcyon at the same time. Limit high level features to selected users only.

- **Scenes:** Paint your world with light – when you want it & how you want it.

- **Better Light:** You & your world appear natural in any of Halcyon’s white colours. High quality, patented ChromaWhite.
History and drivers for PhotonStar and halcyon

- Phase 1 – Lighting control 2014/15
  - Energy Saving - commercial focus
  - Productivity of People via circadian lighting
  - Linux server + 2.4GHz 802.15.4 6lowpan
  - Operational cost reduction – remote emergency compliance tests – 1 yr payback!
  - Cloud connectivity via IBM Bluemix customer support platform – HalcyonCSP

- Phase 2 – Wireless retrofit Building Management Systems (BMS) with cloud Q1 2016
  - Expansion past lighting, broader BMS applications, heating, cooling, power management, critical asset management
  - Focus on reduced operational costs in existing buildings
  - HalcyonPRO2 integration of z-wave and enocean devices to solve cost problems
  - Information driven value added services, predictive maintenance, remote compliance monitoring
  - ‘building management as a service’ – halcyon cloudBMS™
  - Integration with Asset management software such as Maximo/Tririga via Trimax plug in to halcyon cloudBMS

- Phase 3 – Cognitive analytics coming soon in 2017
ChromaWhite2.0 light source

- CW2.0 Controller and Light engines – by PhotonStar Technology Ltd
  - Advanced Microprocessor control
    - XMC 1200 32-bit ARM Cortex-M0
  - CW2.0 Control architecture features
    - Advanced multi-dimensional colour matrix plus thermal compensation spectrally optimized for Circadian lighting
    - PowerLoc – Smoothly ensures driver, light engine never draw more than maximum permissible loads
    - Soft start, Hot Swap protection
    - Flicker Free 12 bit internal dimming resolution
    - Dynamic fade rates and smoothing
    - 24V/48V DC operation
    - DMX or Halcyon controls
    - 600lm to 4000lm light engines (inc Zhaga book 3)

- ChromaWhite 2.0 CircadianMAX ColourMax – 1800K to 7000K + RGB colours, pastels etc
  - Advanced microprocessor controlled 5 LED channels (WW, CW, R, G, 480nm Blue)
    - 5 DMX addresses – 1 to control CCT and 1 to control Intensity + Red, Green, Blue intensity

- Halcyon wireless offers
  - Unique IP v6 address, MAC address
  - Energy Monitoring
  - Temperature monitoring (driver, LE)
  - Heath metrics for driver, radio and light engine over time
  - ‘Burn time’ and history
Luxloop – more than just a light fixture

- Colour Mix cavity for Circadian lighting
- IoT enabled
  - Central clear plastic area is designed to pack in electronics / wireless sensors (0.5kg max)
  - Wireless friendly design
  - Mains and 48V DC and USB (4x1A)
- Options include
  - Ibeacons – location services in buildings – powered to reduce maintenance
  - Wifi /bluetooth - Speakers / microphones – voice commands, announcements
  - Emergency lighting
  - Wifi routers
  - Lifi equipment
  - IP camera - people counting etc
  - Sensors
2017 halcyon system
2017 Halcyon capabilities
cloudBMS building management as a service...new in 2017
• Hard part is implementing change when for so long, what wasn’t broken didn’t need fixing
• The new paradigm is all about smart lighting with environmental sensing both internal and external applications
• To survive the lighting industry needs to embrace software development
• Employ people that understand this...
• And look like this..
Security of smart connected devices is fundamentally linked to the ability of users to trust their environment. If people don’t believe their connected devices and their information are reasonably secure from misuse or harm, the resulting erosion of trust causes a reluctance to use the such devices and their businesses will not benefit from the efficiencies and analytical insights these system deliver.

- Developing products is hard
- Adding security as an afterthought is harder
- Solution
  - design in security as part of your product from day 1
- Huge amount of information available
  - UK has IOT Security Foundation
    - [https://iotsecurityfoundation.org/](https://iotsecurityfoundation.org/)
  - Many other options
To make use of information and create value from an IoT system a cloud compute solution is required

Many vendors, Many platforms

Everything is as a Service

This moves the commercial discussions from CAPEX to OPEX and that is the key to successful business models in IoT....

...providing businesses with the ability to learn more about their operating environment, and identify and act with the potential to create new value.
So what will Intelligent lighting systems of the future look like

• 1st and foremost – they will need to deliver the application requirements for lighting (office, hospitality, roadway etc etc)
• Will be wireless and cheaper to install
• Will have plenty of computing power and lots of software
• Will be part of the IoT
• Will be lower cost than todays control solutions
• Will leverage cloud
• Will generate huge amounts of data that we can leverage for new applications, value and services