

2015 DOE SSL R&D Workshop

Global LED Manufacturing

Insights from Epistar offer a global perspective on LED manufacturing, the evolution of LED technology, and the use of mid-power and high power LED in lighting

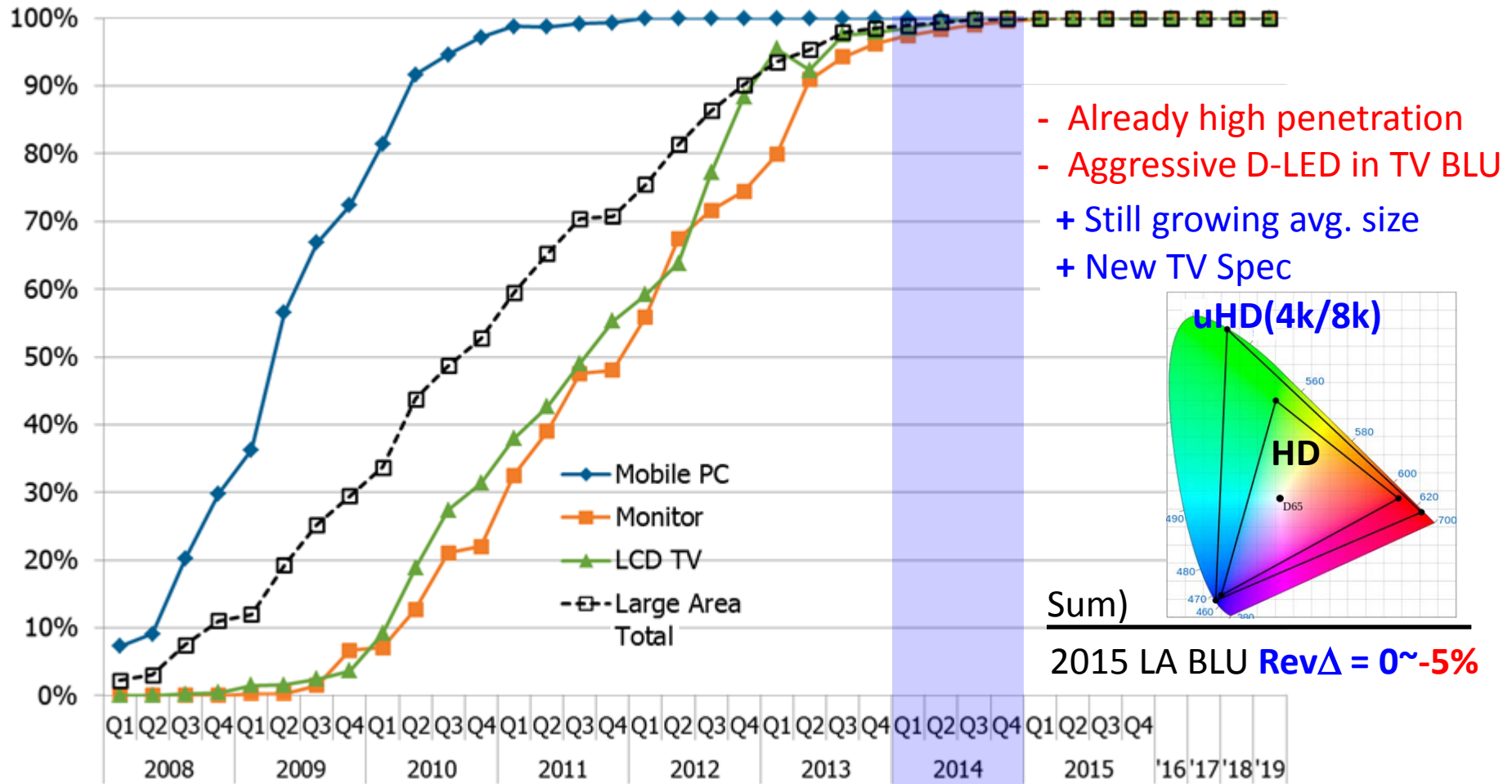
BJ LEE,

Jan 27, 2015

Outline

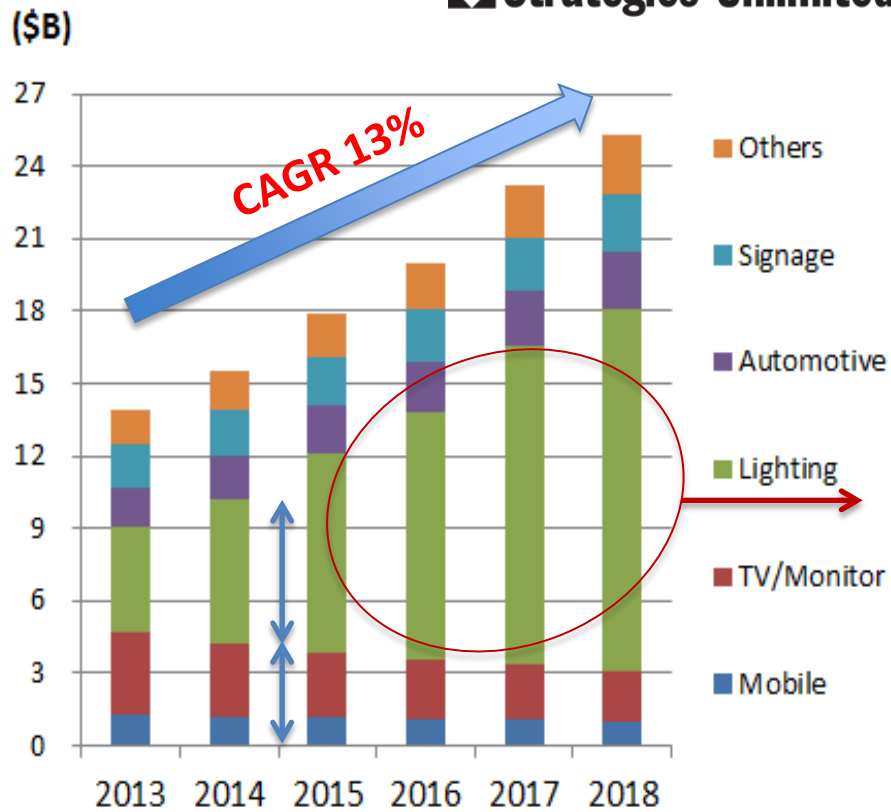
- Global LED Device Market
- Challenges of LED Device for TV BLU & SSL
- New Light Engine Design
- Summary

LED in Large Area BLU - less room for growth...

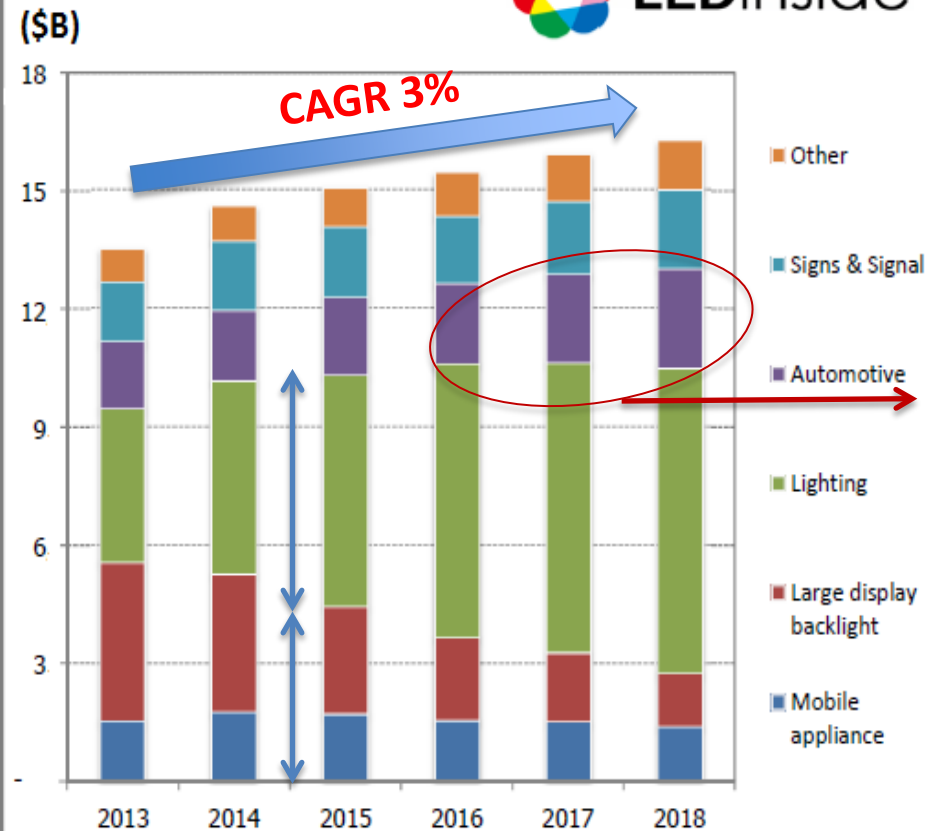


Global LED Package Devices Market Trend

Strategies Unlimited



LEDinside



Main growth engine: **Lighting and Automotive**

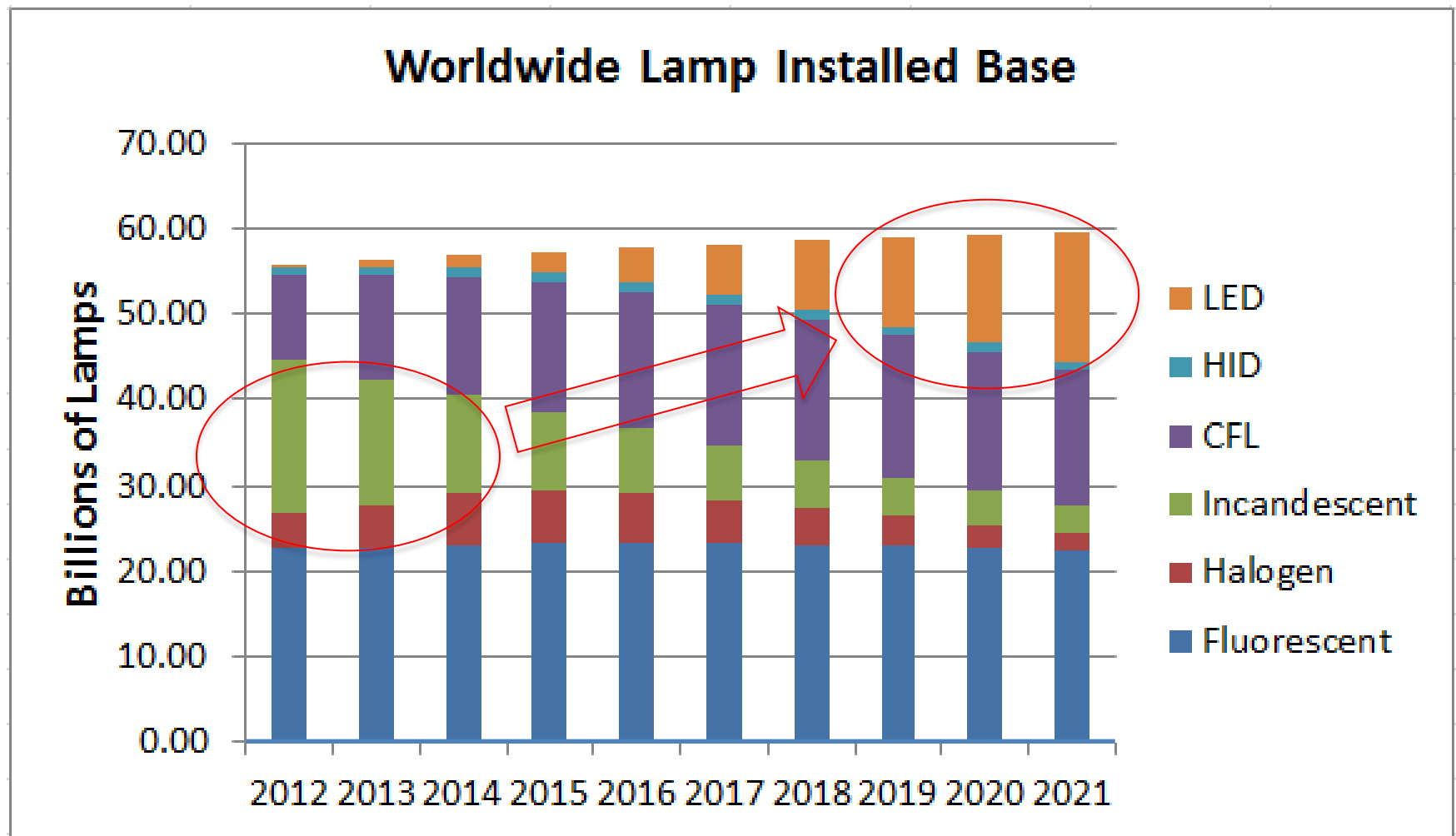
Global BLU/SSL LED Demand in 2014/2015

BLU	TV & Monitor			Mobile	
	Direct-lit TV	Edge-lit TV	Monitor	Smart Phone	Tablet
'14 M-Unit	119	98	162	1,163	301
TIE [M]	10.3 M_TIE for 2014				
'15 M-Unit	137	92	159	1,213	367
TIE [M]	11.0 M_TIE for 2015				

* TIE: two inch equivalent

Lighting	Lamp					Luminaire			
	A-Bulb	T-Lamp	MR	Reflector	B/C/S/E	Street Light	High Bay	Parking	Down-light & Ceiling
'14 M-Unit	1,000	200	120	122	36	3	6	14	35
TIE [M]	13.8 M_TIE for 2014								
'15 M-Unit	2,000	400	160	159	57	4	6	14	35
TIE [M]	25.9 M_TIE for 2015								

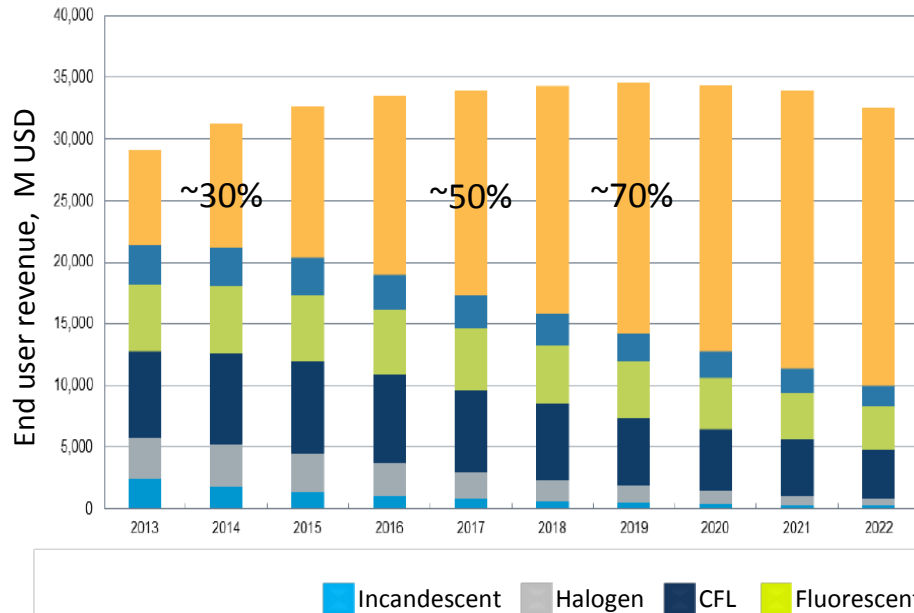
Worldwide Lamp Installation



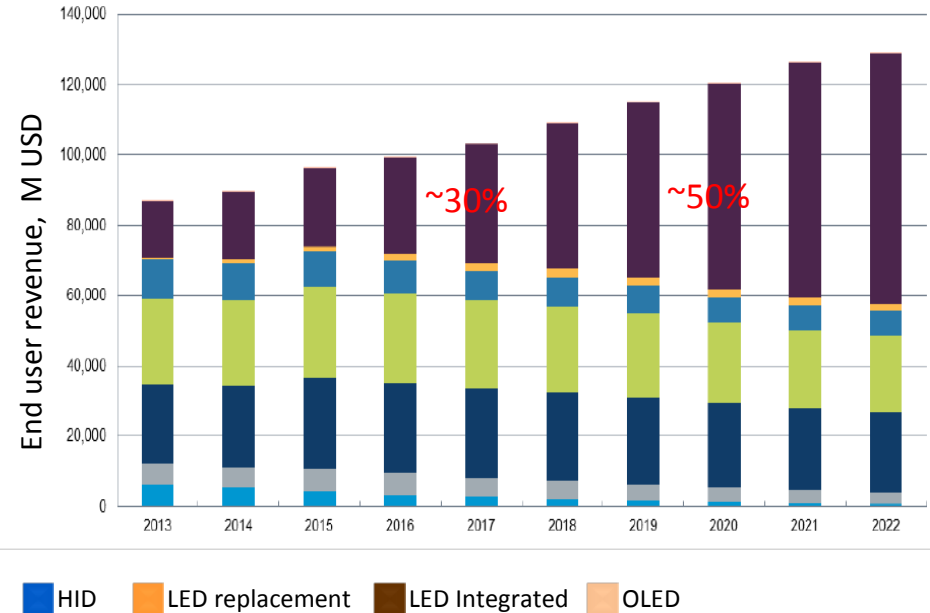
Source: IHS, Nov. 2013

Worldwide Lighting Market Trend

Light source market

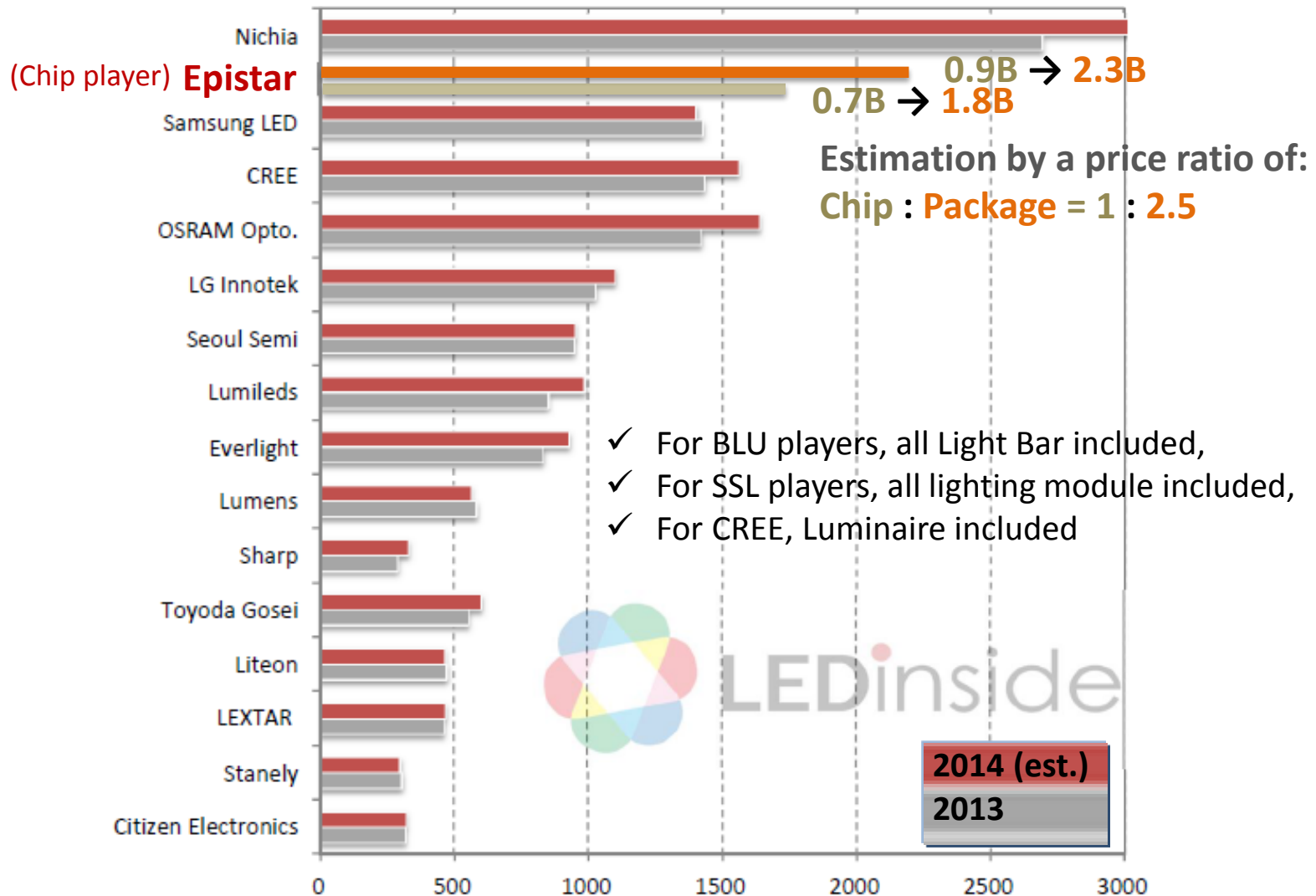


Luminaire market



Source: IHS, Nov. 2013

Global LED Device Major Players



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Revolution of LED Package Design for TV BLU



XVGA

HDMI

UHD 4K2K

UHD 8K4K

Edge-Lit



0.2~0.5W
5630 PPA



0.5~1.0W
7030 PCT



1.0~1.5 W
????

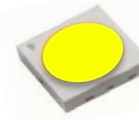
Direct-view



0.5~0.8W
2835 PCT



0.8~1.2W
3030 EMC



1.2~2.0W 3535 EMC
w/ Flip-Chip

From Backlighting to Lighting



5630 PPA light-engine



3020 PCT/3030 EMC light-engine

What's next?

2010

2011

2012

2013

2014

2015

Edge-type BLU dominating

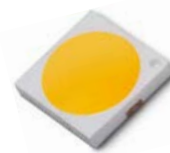
Direct-type BLU dominating



0.5W
5630 PPA



0.8W
7030 PCT



1.0W
3030 EMC



1.5W 3535 EMC
w/ Flip-Chip

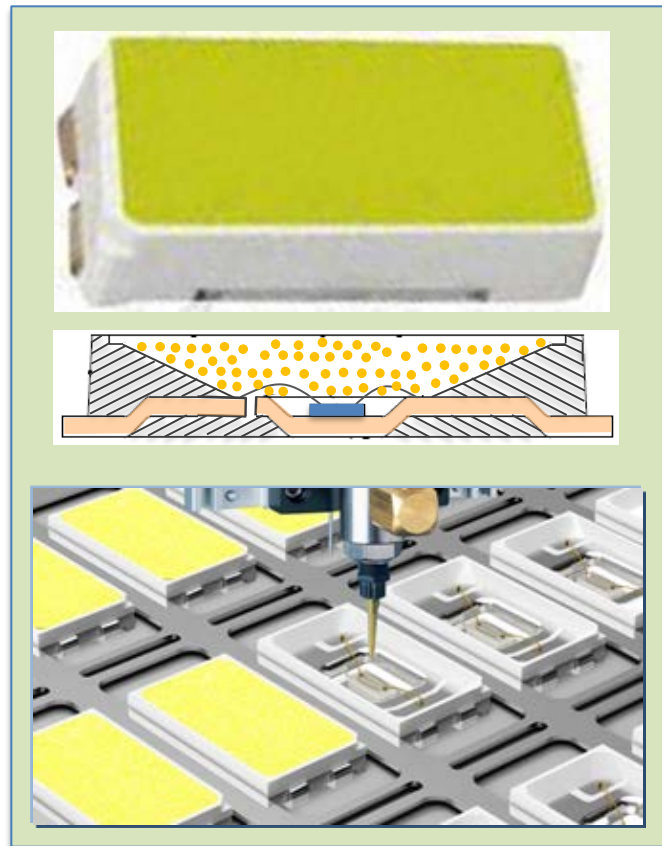


~3W SMC
w/ Flip-Chip

Innovations Driven from the Requirements of BLU

- ✓ The BLU market use **Mid-power** LEDs
 - Good performance, Volume production, Low cost,
- ✓ The SSL market use more and more **Mid-power** LEDs
- ✓ The BLU market is trying low cost **Mid-size high power** (~2W) with **Flip chip** inside,

Packages Trend and Evolution



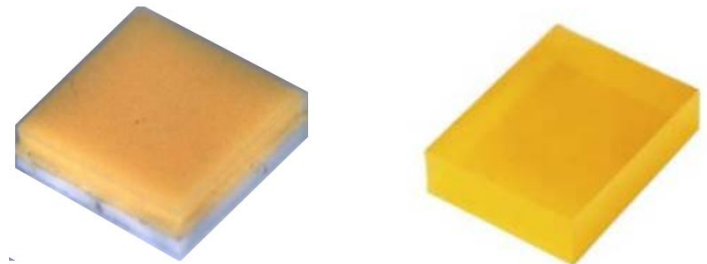
Leaded PLCC with PPA/PCT

Higher T-operation



Leadless QFN with EMC/SMC

miniaturization

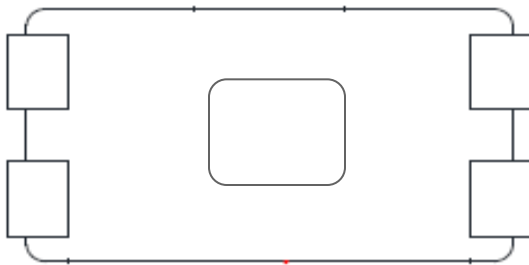


Chip scale package (CSP) White chip (WC)

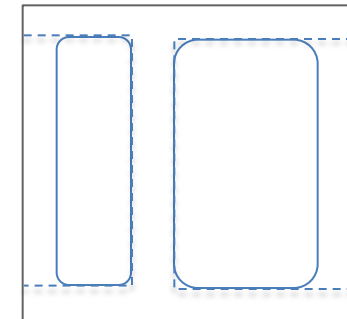
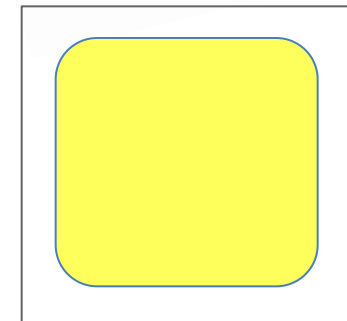
Leadless QFN Become Popular ...



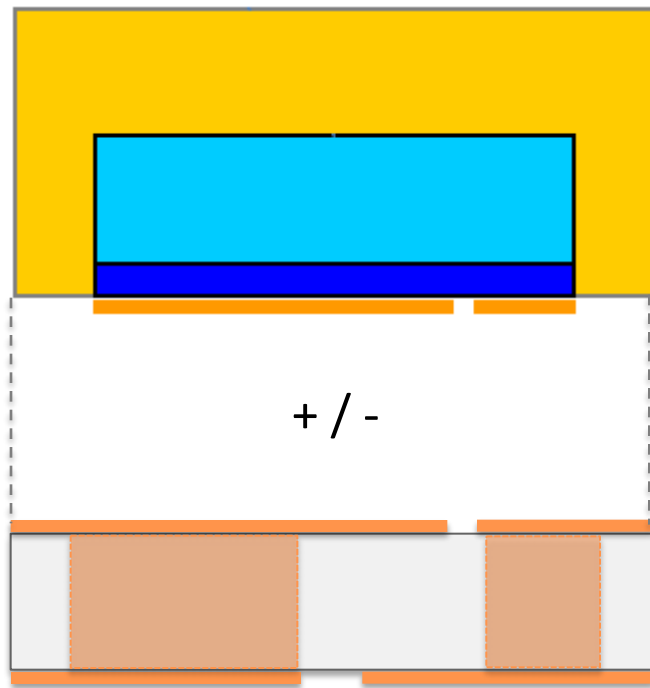
Higher temperature material



Better heat dissipation



CSP & White Chip are Advancing & Evolving

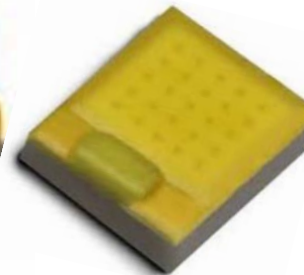


Ceramic / Flat frame / Metal

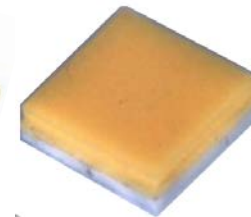
1.6x1.6 mm



2.0x1.6 mm



1.4x1.4 mm

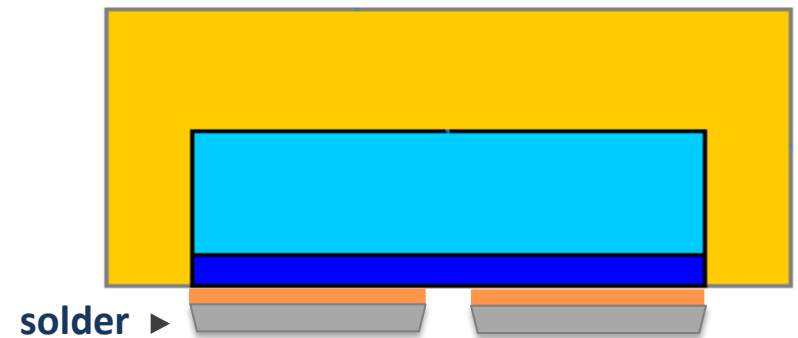
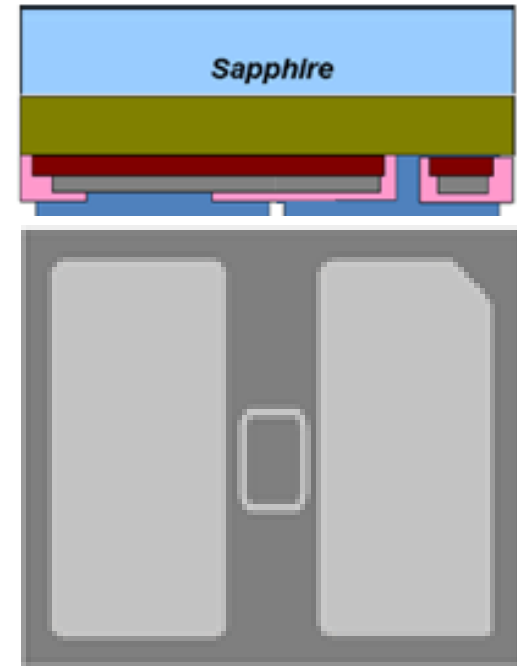
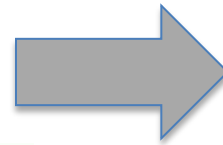
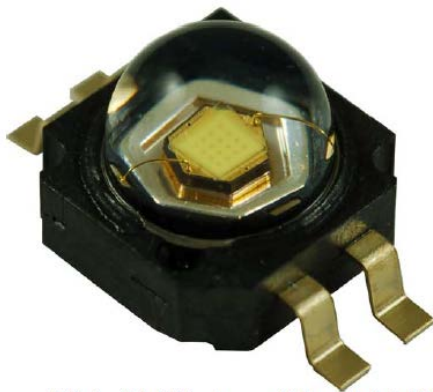
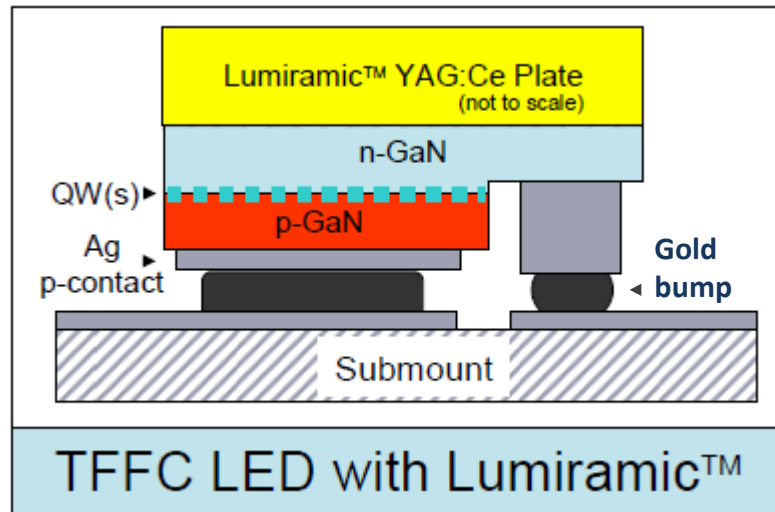


1.3x1.3mm



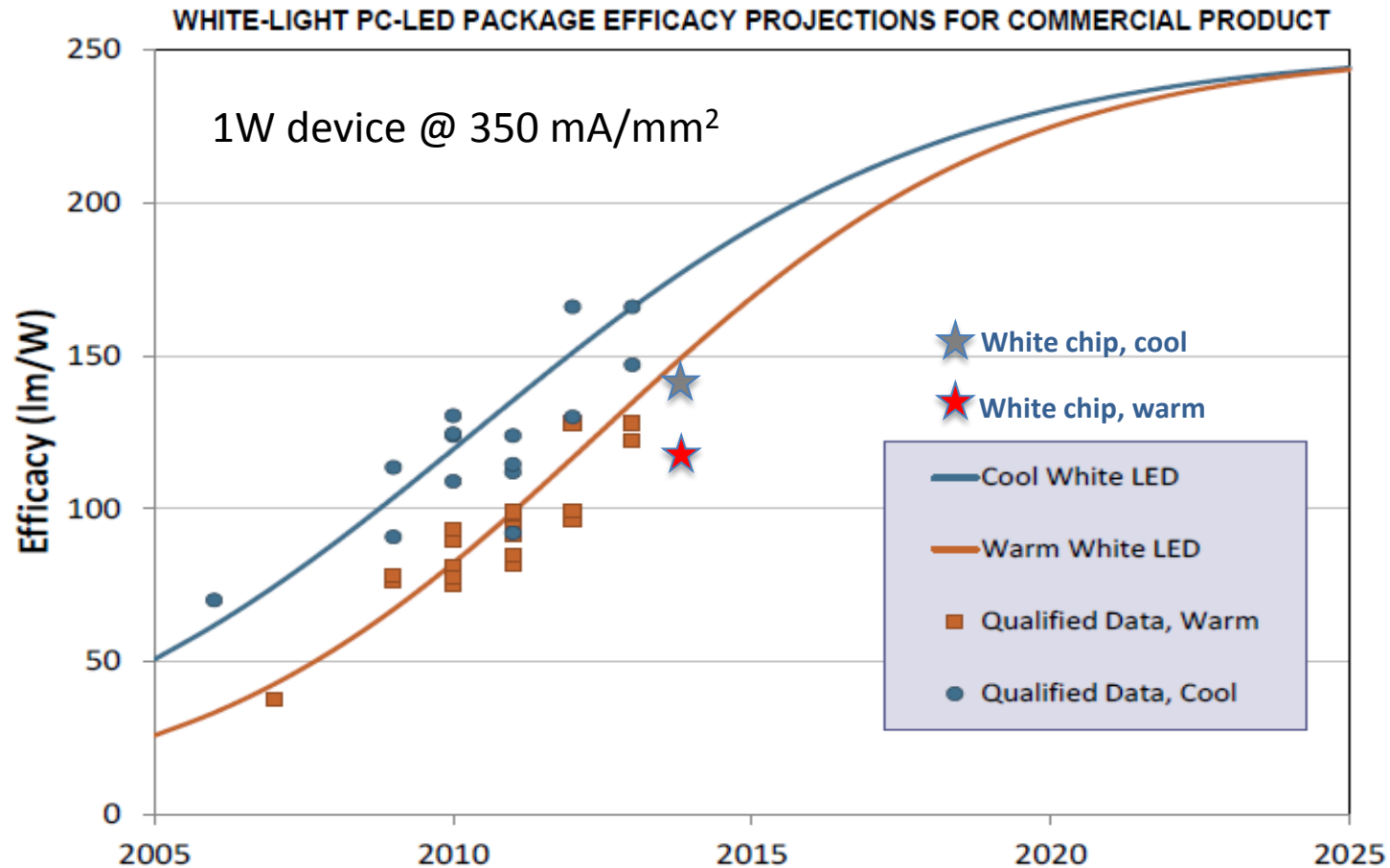
- ✓ Small foot print
- ✓ Wide angle
- ✓ Flip chip
- ✓ Good heat dissipation

Low Cost Flip Chip Package – the Ultimate Solution?

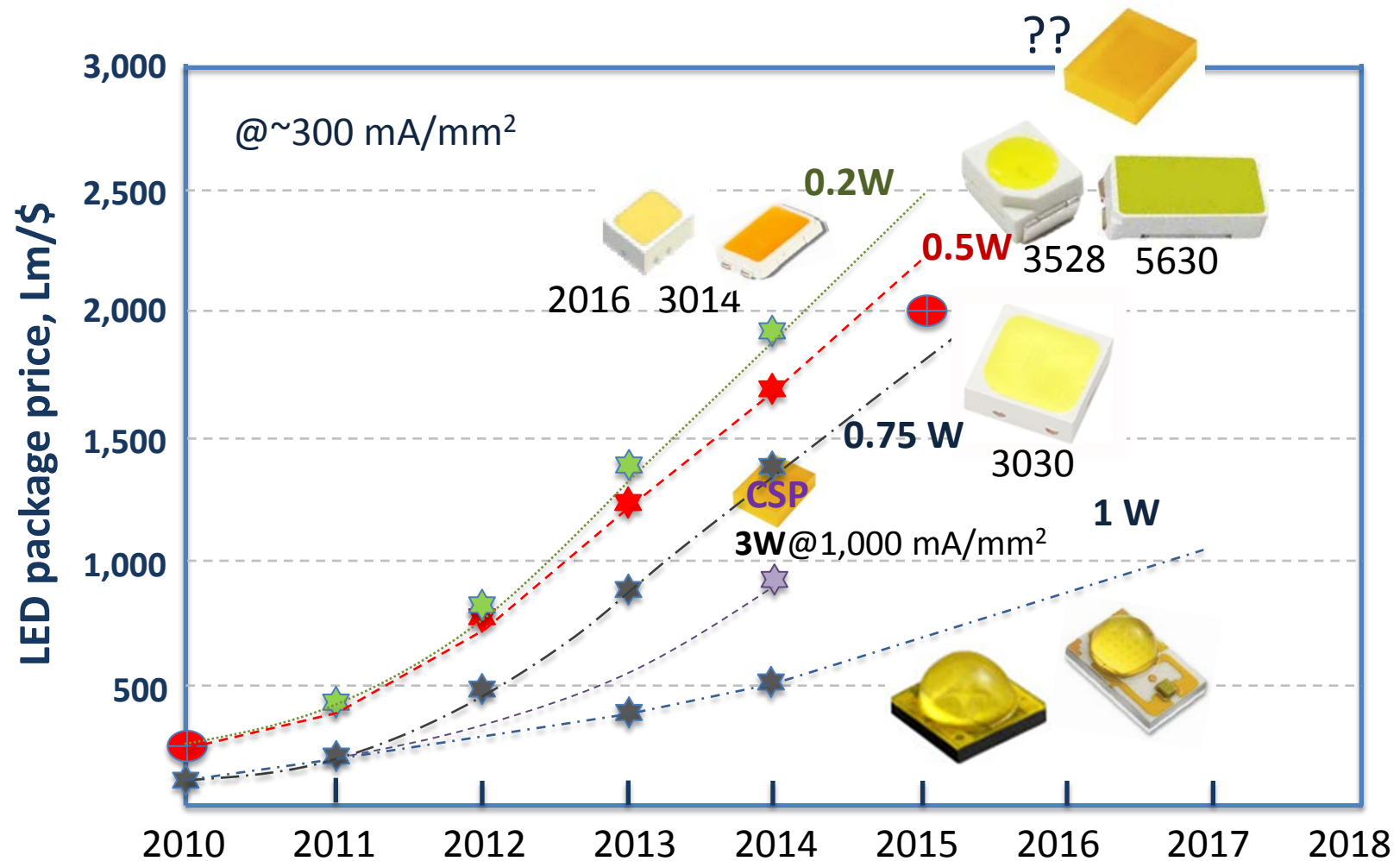


Source: Lumileds, Epistar

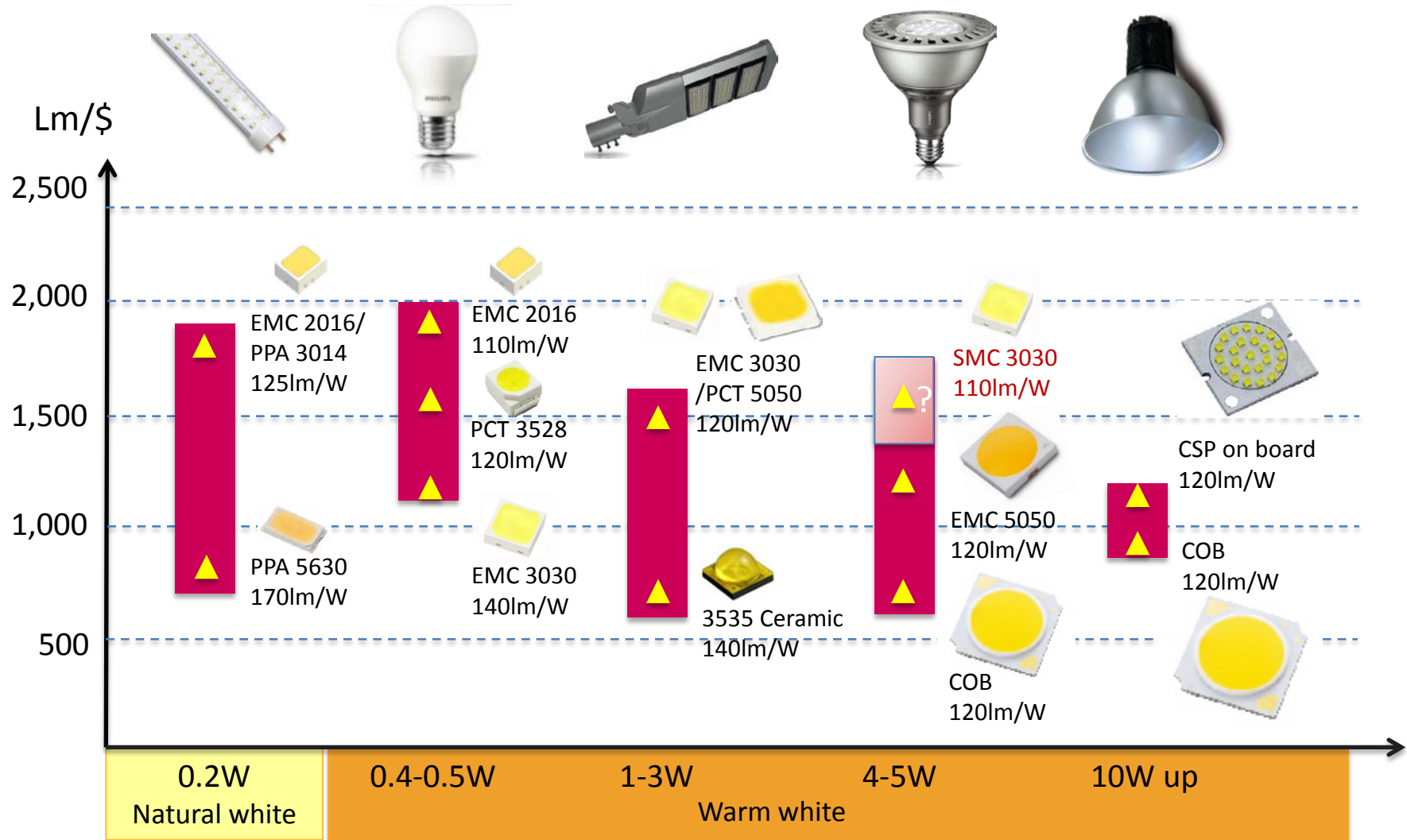
Continuous Improvement in Efficacy, lm/W



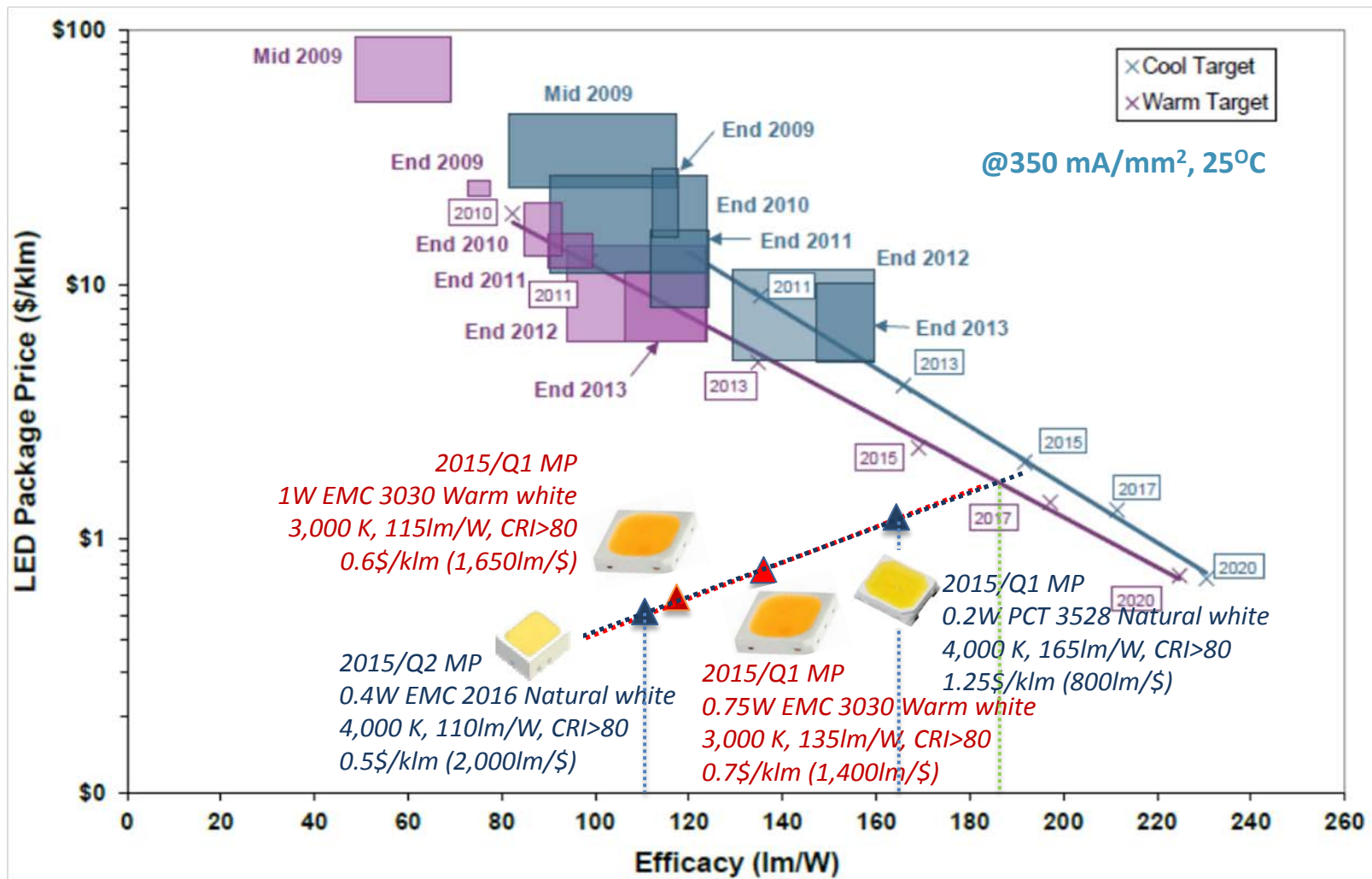
Endless Challenge of Cost Reduction, lm/\$



Lm/\$ Requirement for Different Applications



Price-Efficacy Trade-Off for LED Package

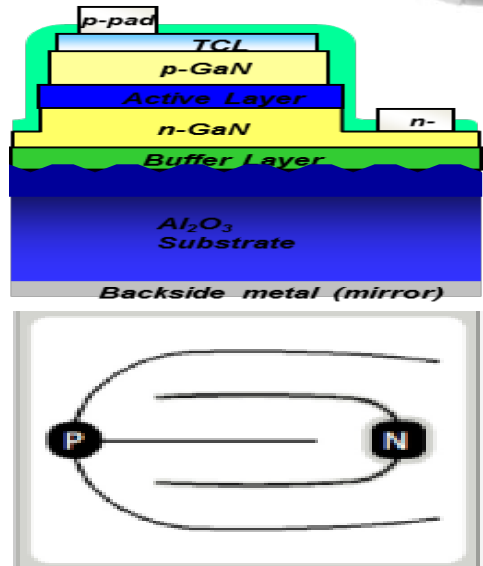


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- Challenges of LED Device for TV BLU & SSL
- **New Light Engine Design**
- Summary

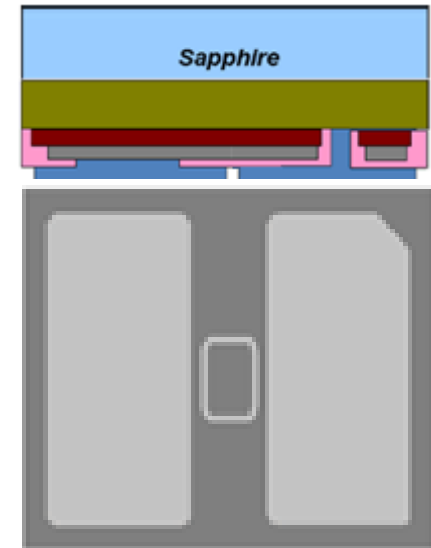
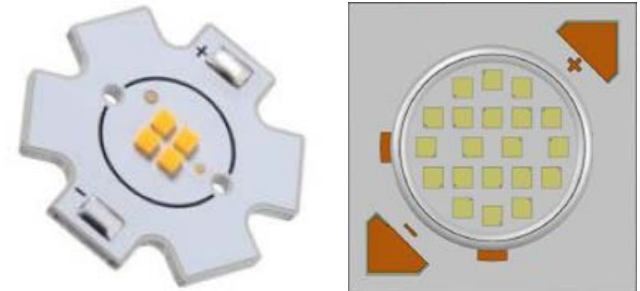
New Trend for Light Engine Design—CSP/WC on Board

COB



Lateral Chip

HD COB—CSP/WC on board



Flip Chip

New Trend for Light Engine Design—Flip Chip on Board

Filament with Flip Chip on glass, may not best-fit but more reliable



Flip chip on board, **No Wire**, a lot of new application may be explored

New Trend for Light Engine Design--Driver on Board



30ea x 3V ~ 90V

Easy to use

Lower cost?



25ea x 3V ~ 75V

Fewer number of chips/pkgs

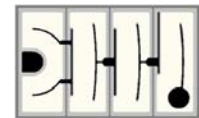
Limited space

... ..



HV Chip

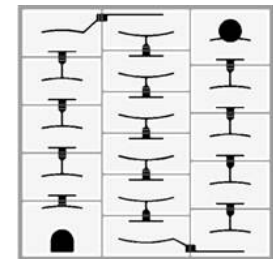
0.5 W



2S x (4*12)V ~ 96V



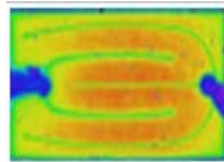
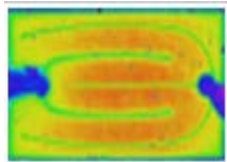
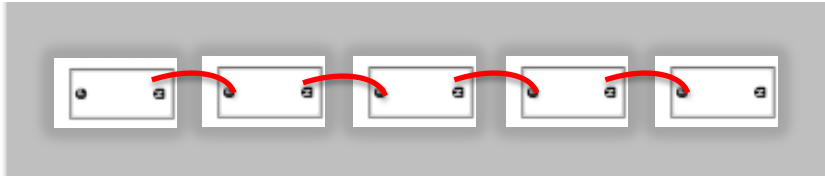
1.5 W



8 ea x 48V ~ 380V

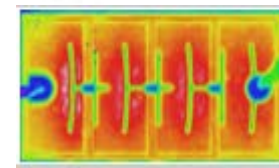
High Voltage LED chip (HV LED)

3V + 3V + 3V + 3V + 3V

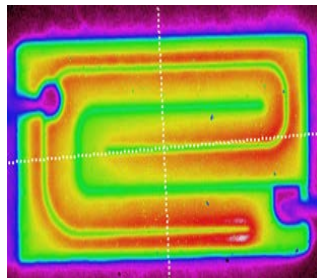
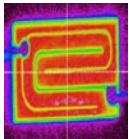


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15V

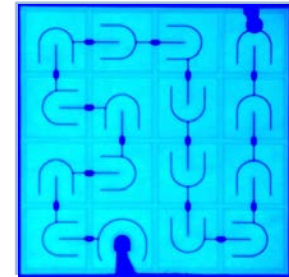
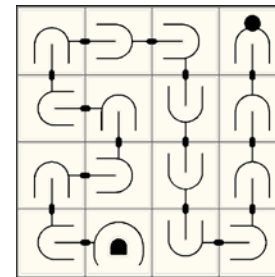


Easily build up HV module for city power



3V

3V

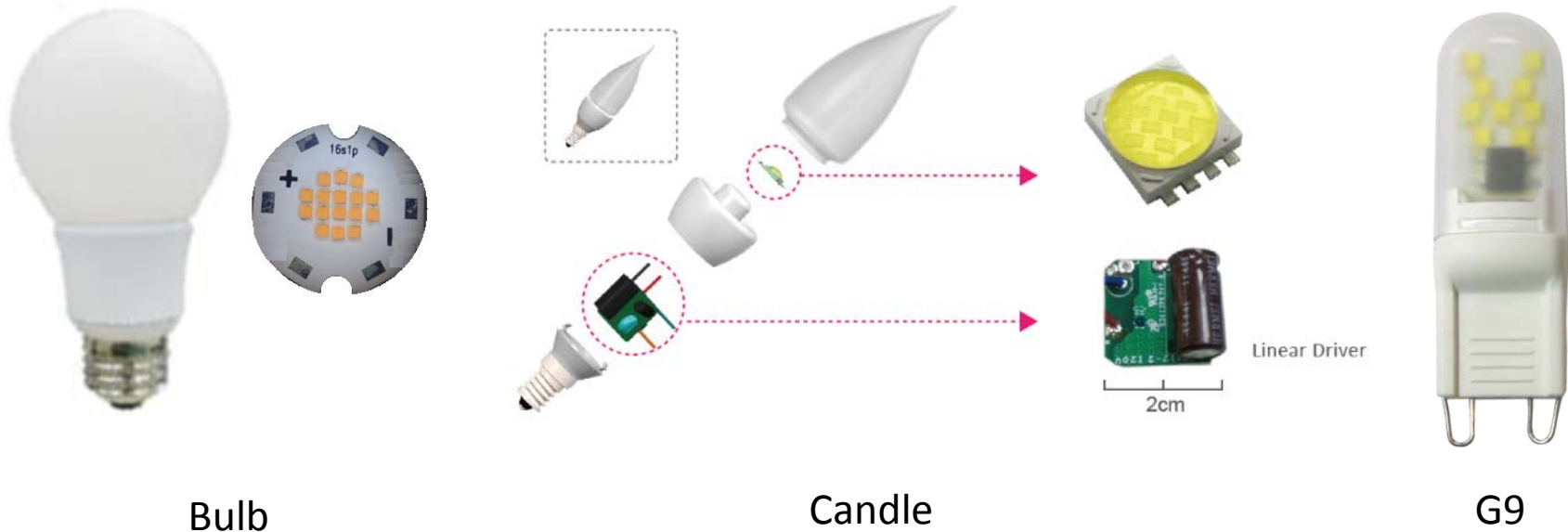


48V

Better current spreading

HV Light Engine for Residential Applications

HV LED chips are perfect for Omni-directional bulb, candle, G9 etc..., which have limited space for drivers.



HV Light Engine for Industry & Outdoor Applications

Most of failures in LED outdoor luminaires are come from drivers



3V LED

>>



LV module

+



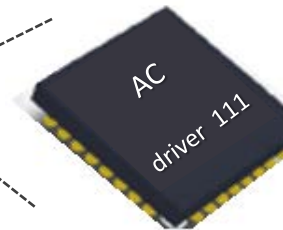
external driver



12~60V LED >>



HV module + driver IC



Using HV module, by multiple chips or HV chips, with driver IC



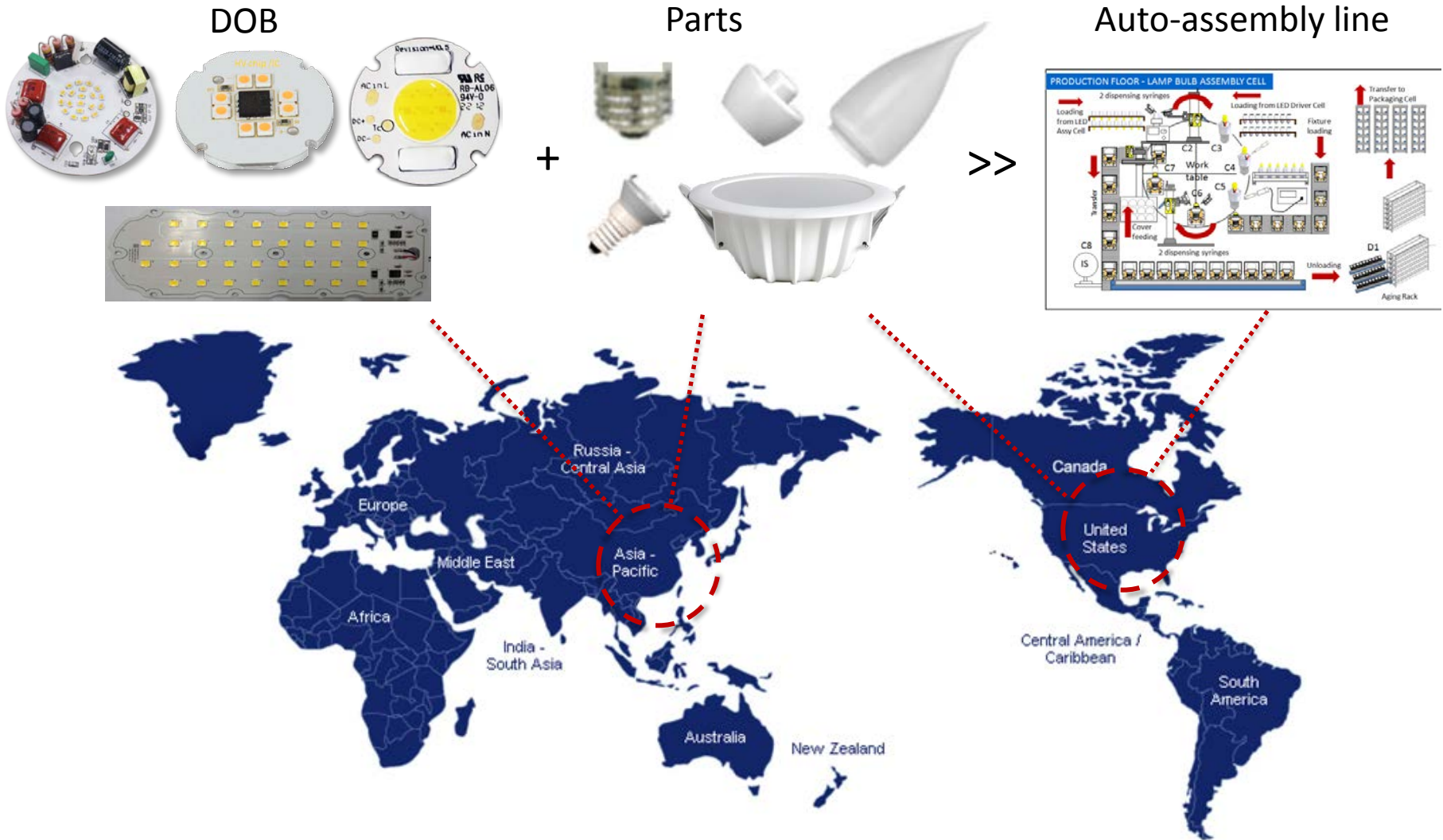
better reliability & Lower system Cost

Benefits Using Driver on Board (DoB)

- ✓ Small form factor
- ✓ Lower cost compare to external drivers
- ✓ Reduce the inventory of components for various driver
- ✓ Acceptable dimmer function
- ✓ Lower cost and easy manufacturing at luminaire level



Made in USA is Feasible...



Summary

- ✓ The growth of worldwide LED market is driven by general illumination and automotive lighting in the next few years
- ✓ Though LED BLU market has been saturated, the challenges of performance improvement and cost reduction drive innovations in chip and package design
- ✓ Mid-power LED chip and package has strong lm/\$ and good lm/W, which has become a main stream in various lighting applications
- ✓ CSP and DoB are the new impacts to the market and can speed up the SSL penetration
- ✓ HV LED could be an important solution for many lighting applications
- ✓ DoB is easier to be adapted by conventional lighting fixture companies, and
- ✓ Made in USA becomes feasible

Thank You!

