Notebook and Tablet Display Supply Chain Map and Competition Analysis

2016.11.2 for IHS Technology Korea Display Conference

Jason Hsu, Principal Analyst

IHS Technology

2017 Notebook panel supply remain tight

Notebook panel maker shipments and sales targets: 2015-2017 (in millions)

Supplier	2015 (Actual)	2016 BP Oct 2016 (F)	2017 BP Oct 2016 (F)	2015 Y/Y (Actual)	2016 Y/Y Oct 2016 (F)	2017 Y/Y Oct 2016 (F)
Taiwan A	34.9	34	36	-11%	-3%	6%
China A	15.4	30	38	11%	95%	27%
China B	0	0.9	1			11%
Taiwan B	41	36.3	38.4	-16%	-11%	6%
Taiwan C	0.2	0.6	0.5		205%	-18%
China C	8.7	6.8	6	1%	-22%	-12%
Korea A	46.7	37.9	29	-10%	-19%	-23%
Japan A	0	0.3	0.3	-87%	1011%	0%
Korea B	30.4	12.7	2.3	-8%	-58%	-82%
Japan B	1.1	1.3	2.4	-58%	18%	85%
Total Supply	178.5	160.8	153.9	-7%	-10%	-4%
Total Demand	179.5	164.4	163.7	-10%	-8%	0%
Glut	-0.60%	-2.20%	-6.00%			

inventory

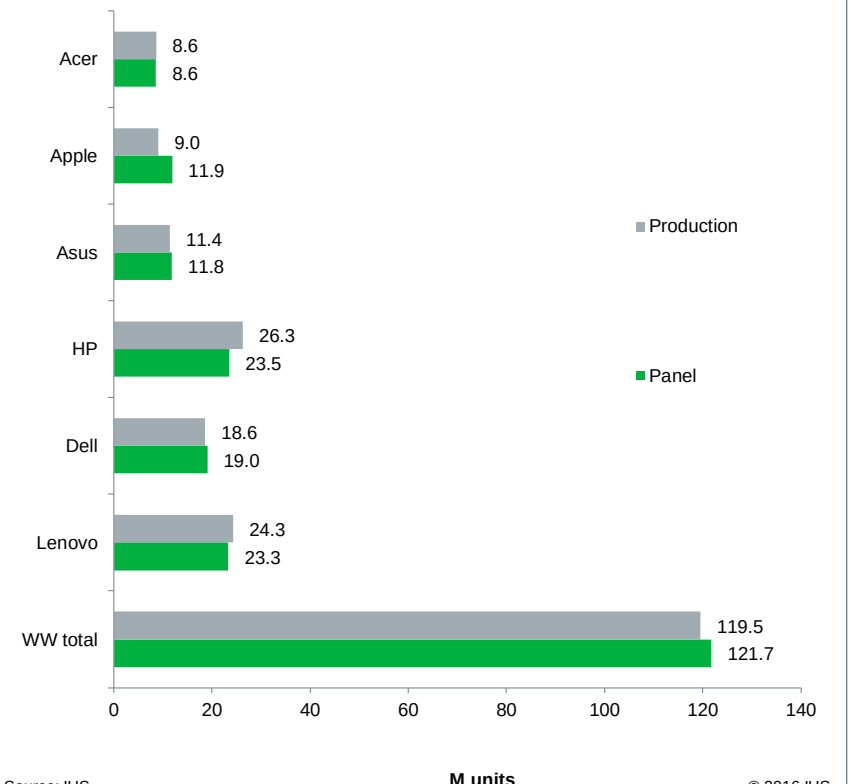
Notes: Business plan figures are not official company data. They are derived from our supply chain checks. These numbers are subject to change from time-to-time, given the complexity and dynamics in the market.

Source: IHS

- In 2H'16, panel demand is higher than production needs, in order to build panel inventory.
- End market is decreasing by 10M every year. Will it continue in 2017?

Building inventory is necessary to leading brands

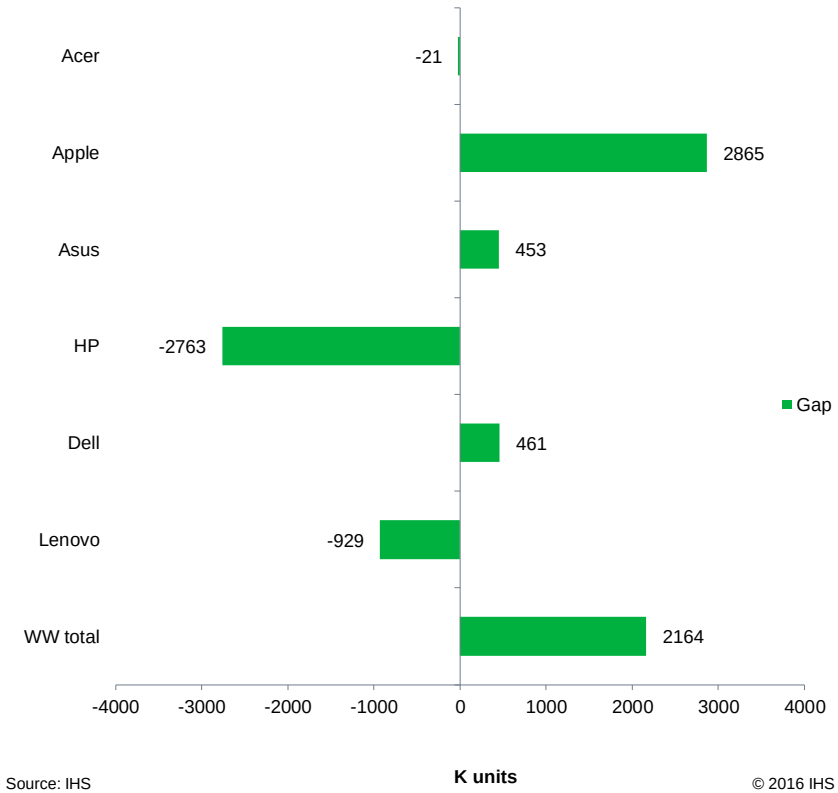
Notebook brand set production vs. panel purhcasing 1Q-3Q



Source: IHS

© 2016 IHS

Notebook brand set production vs. panel purhcasing Gap 1Q-3Q

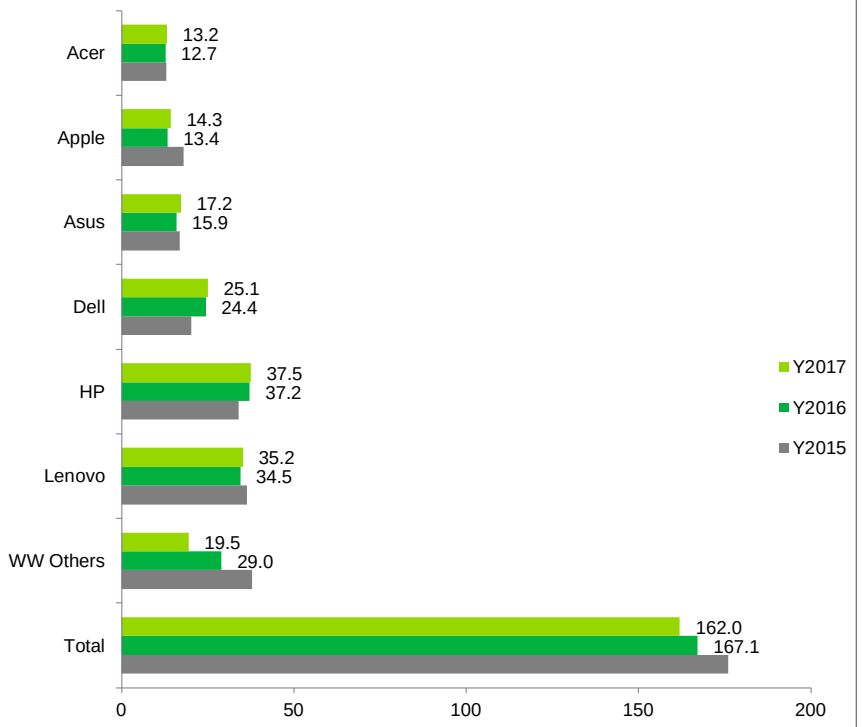


Source: IHS

© 2016 IHS

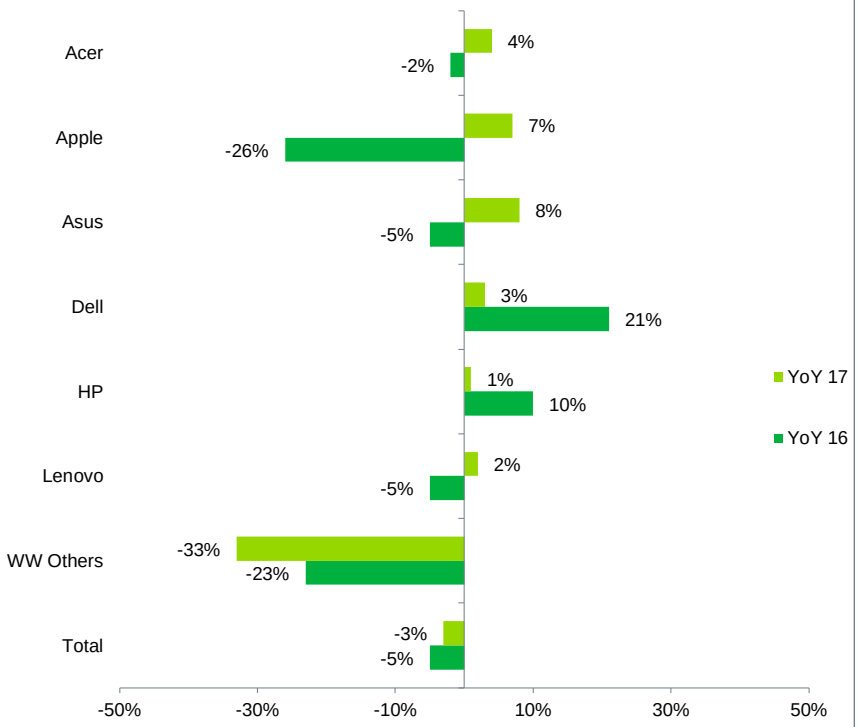
Higher brand domination to notebook in the future

Notebook brand set production forecast



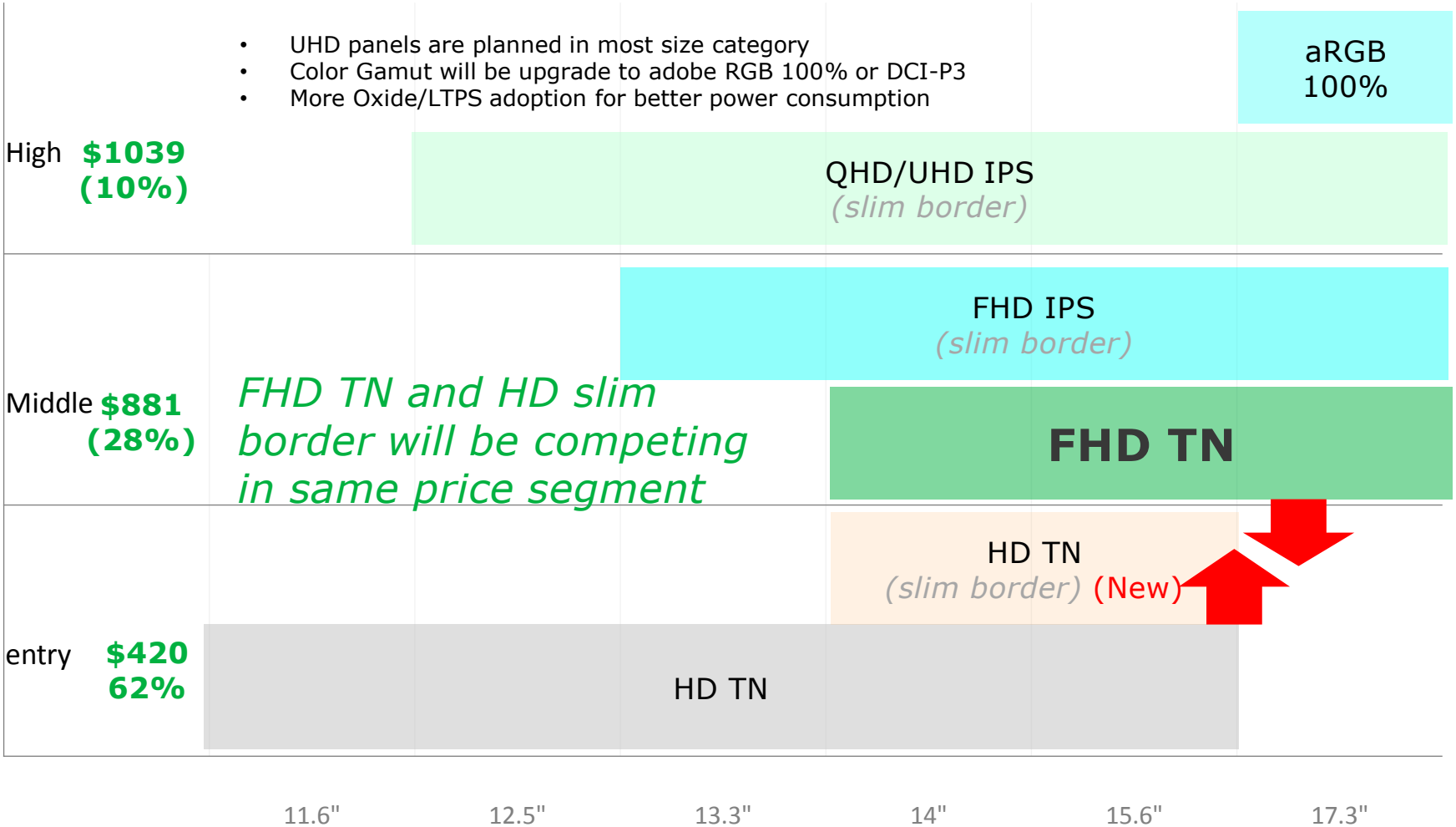
Source: IHS

Notebook brand set production forecast YoY



Source: IHS

Display differentiator for middle-low class is critical



Source: IHS

Brands could adopt parallel designs for VESA and slim border

10%

FHD TN VESA

+$5-8

50%

HD TN VESA

+$1-3

FHD IPS Slim border

30%

HD TN Slim border

10%

- Brands have agreed that slim boarder the future design, however, most of spec the slim borders panel are FHD IPS. Though, these FHD IPS NBs are profitable, they are still want to penetrate it lower price segment to share the tooling fee. As a result, Bands are asking to develop slim border HD TN panels.
- Brands like Lenovo, HP, Acer and Asus. Panels makers including Innolux and BOE have showed their intention of developing these panels.

A new battle of IPS competition

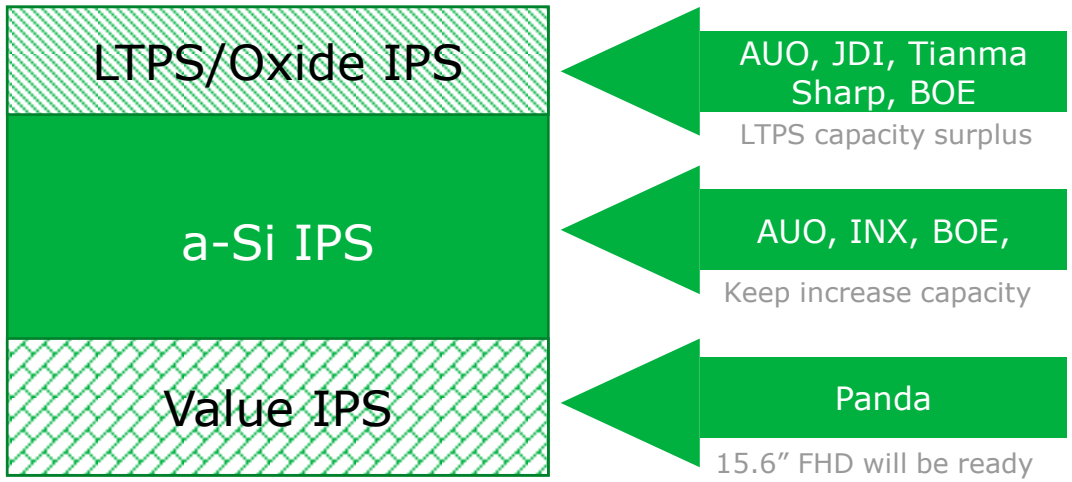
Panel maker IPS supply forecast			
Panel makers	2016(f)	2017(f)	2017(f)
Taiwan A	7.1	9.3	8.9
China A	3.4	9.1	5.5
Taiwan B	3.7	8.5	4.5
China B	0.9	1	1
Taiwan C	0.3	0.3	0.3
China C	0	3	0.5
Korea A	16.2	25	25
Japan A	0.3	0	0
Korea B	7.7	2.3	2.3
Japan B	1.2	2.4	2.4
Total	**40**	**60.9**	**50.4**

Source: IHS @ IHS 2106

Brand maker IPS demand forecast		
Brand	2016(f)	2017(f)
Apple	9.3	10
Dell	8	11
Lenovo	10.2	13.6
HP	6.3	8.8
Acer	1	1
Asus	1.6	1.8
Others	3.6	4.2
Total	**40**	**50.4**

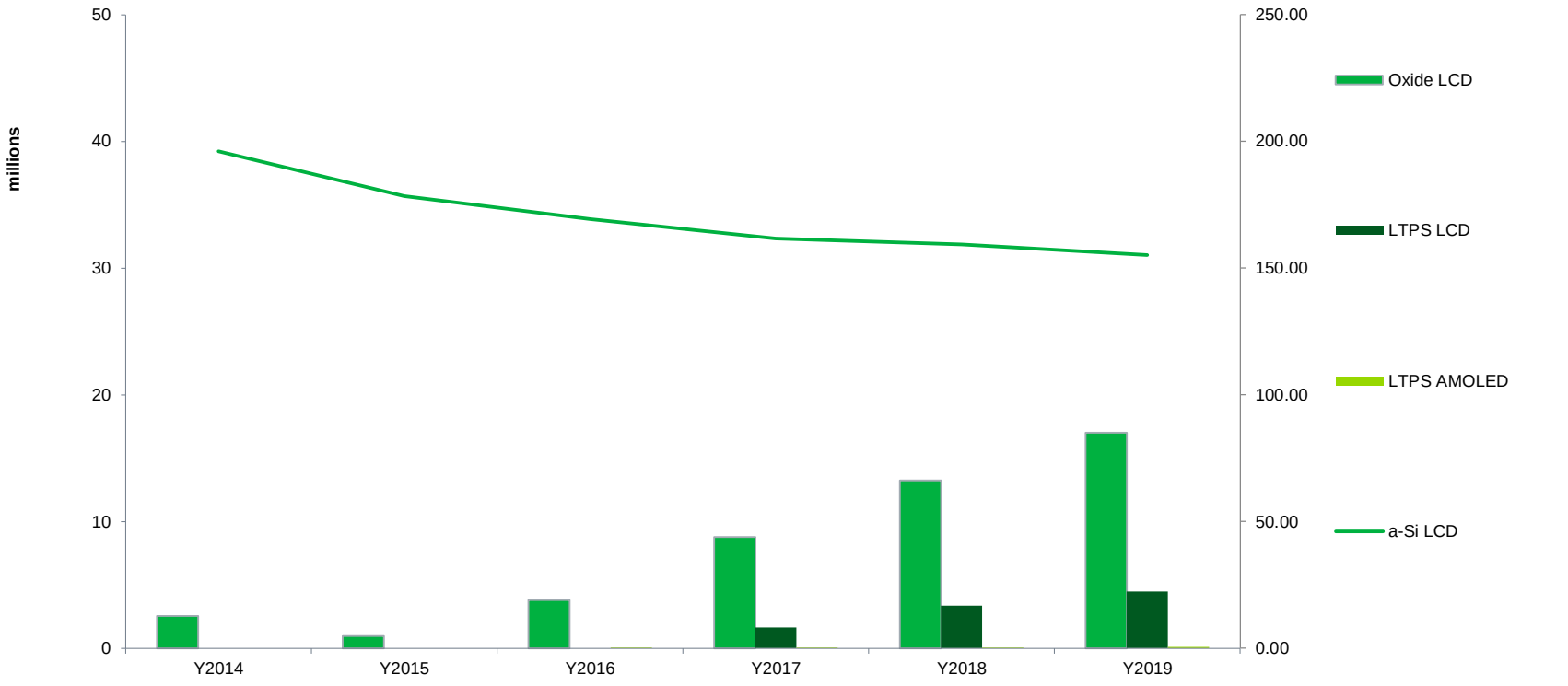
Source: IHS @ IHS 2106

- Total IPS panel demand will climb from 40M (26%) in 2016 to 50.4M (33%) in 2017.
- There are 5.4M orders will be released and 10M new demand to fulfill.



Emerging displays for notebook are on the rise

Notebook Panel Technology Forecast



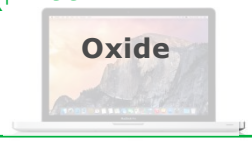
Source: IHS

Oxide LCD and OLED touch bar are innovations for MacBook Pro

MacBook Pro
Core i
13.3" (226PPI) / 15.4" (220 PPI)
2Q'12 / 3Q'12
LGD/SDC

MacBook Pro Touch bar $1799+
Core i
13.3" (226 PPI) / 15.4" (220 PPI)
4Q'16 / 1Q'17
LGD/SDC/Sharp

MacBook $1299+
Core M
12" (226PPI)
1Q'15
LGD/SDC



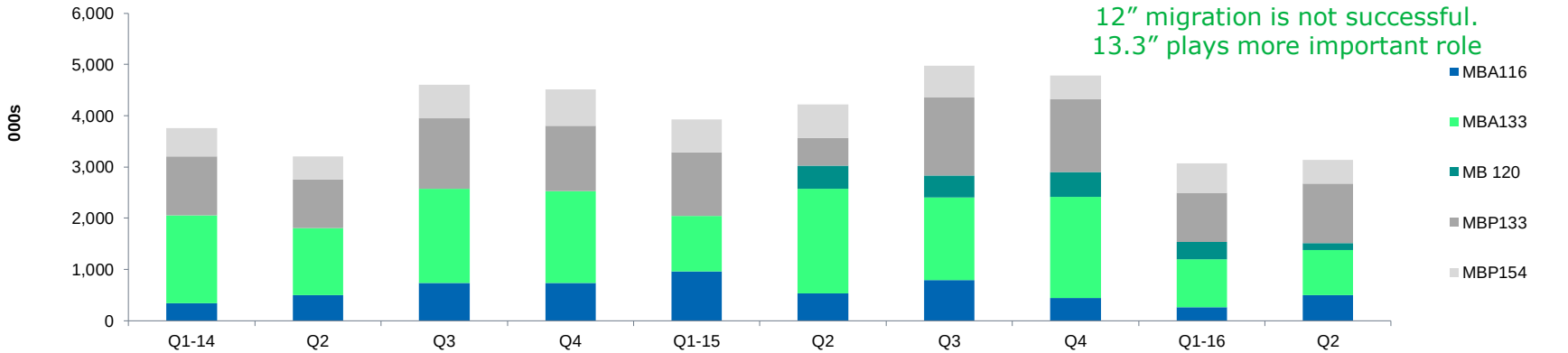
MacBook Pro $1499+
Core i
13.3" (226 PPI)
4Q'16 / 1Q'17
LGD/SDC/Sharp

MacBook Air $999+
Core i
11.6" (135 PPI) / 13.3" (128 PPI)
Q1'08 / Q4'10
LGD/SDC/(AUO)

11.6" EOL

★ Q3'16
BOE to supply 13.3"

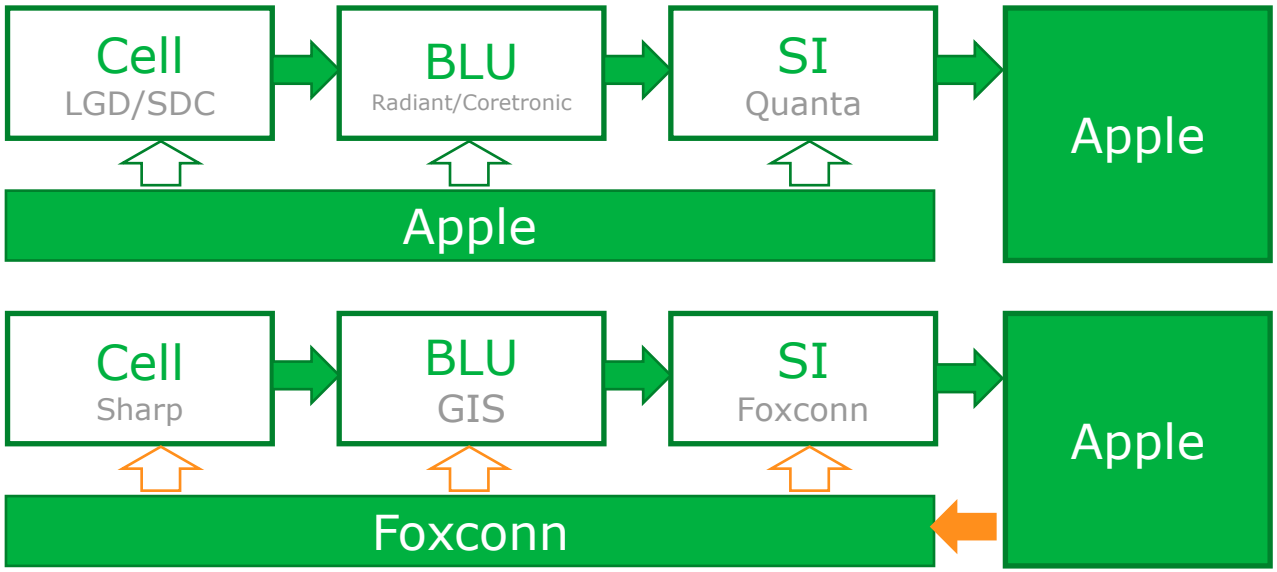
Apple Notebook Shipment



Source: IHS

© 2016 IHS

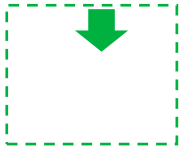
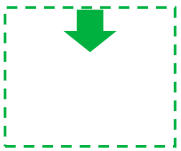
Foxconn proposes new business model to Apple



Total solution is proposed by Apple
Target 50%

	Display	System Integrator	Customer
Impact	• A Japan panel maker could receive significant order increase.	• Quanta is will be serious threatened by Foxconn	• Cost Reduction, and management efficiency. Foxconn will take the major responsibility of production yield.
Risk	• Japan makers have yet been the role of primary supplier. The mass production capacity and schedule could be a challenge	• Foxconn has less experience on producing MacBook Pro	• Will supplier keep same support as usually. (play-off)

New size is required to differentiate iPad Pro with Air

Display	7.9" QXGA	7.9" QXGA	9.7" QXGA	9.7" QXGA	10.5" QXGA+	12.9" QXGA++
Processor	A7	A8X	A8X	A9X	A10X	A9X
$799						iPad Pro 12 Q4'15 4G/32G
$599				iPad Pro 9 Q2'16 2G/32G EOL	**iPad Pro 10** **Q2'17** **4G/32G** New	
$499						
$399		iPad mini 4 Q4'15 2G/16G	iPad Air 2 Q4'14 2G/16G			
$269	iPad mini 2 Q4'14 1G/16G EOL					

Source: IHS

@2016 IHS

Can $299 happen to iPad Air 2? What's the impact?

iPad Product launch time table

	2010		2011		2012		2013		2014		2015		2016		2017	
	Mar	Oct	Apr	Nov	Mar	Nov	Mar	Nov	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct
iPad	A4/256M/XGA															
iPad 2			A5/512M/XGA	$499 →					$299							
new iPad					A5x/1G/QXGA											
iPad 4						A6x/1G/QXGA										
iPad Air								A7/1G/QXGA								
iPad Air 2										A8x/1G/QXGA	$499 →				$299(?)	
iPad Pro 12.9												A9x/2G/QXGA++				
iPad Pro 9.7														A9x/2G/QXGA+		
iPad Pro 10.5																A10/2G/QXGA+

Source: IHS

@ 2016 IHS

7.9" / 9.7" Tablet Spec and RSP Comparison

	7.9"	9.7
$399	iPad Mini 4 $399 (7.9" QXGA) Galaxy Tab S2 $349 (7.9" QXGA)	iPad Air 2 $399 (9.7" QXGA) Galaxy Tab S2 $399 (9.7" QXGA) ZenPad S3 10 $349 (9.7" QXGA)
$299	iPad mini 2 $269 (7.9" QXGA) Zen Pad S2 $259 (7.9" QXGA)	Galaxy Tab A 9.7 $299 (9.7" XGA)
$199	Galaxy Tab A 8 $169 (8" XGA)	

Source: IHS

@ 2016 IHS

iPad and Competitors Cost Simulation

	iPad Air 2		Competitor	
Price / Cost	USD	%	USD	%
Margin	29	10%	29	12%
Brand Premium	50	16%	-	0%
Cost	220	74%	220	88%
RSP	299	100%	249	100%

Source: IHS

@ 2016 IHS

Japan panel maker becomes more aggressive on Apple business

Apple Notebook and Tablet Panel Purchasing Forecast

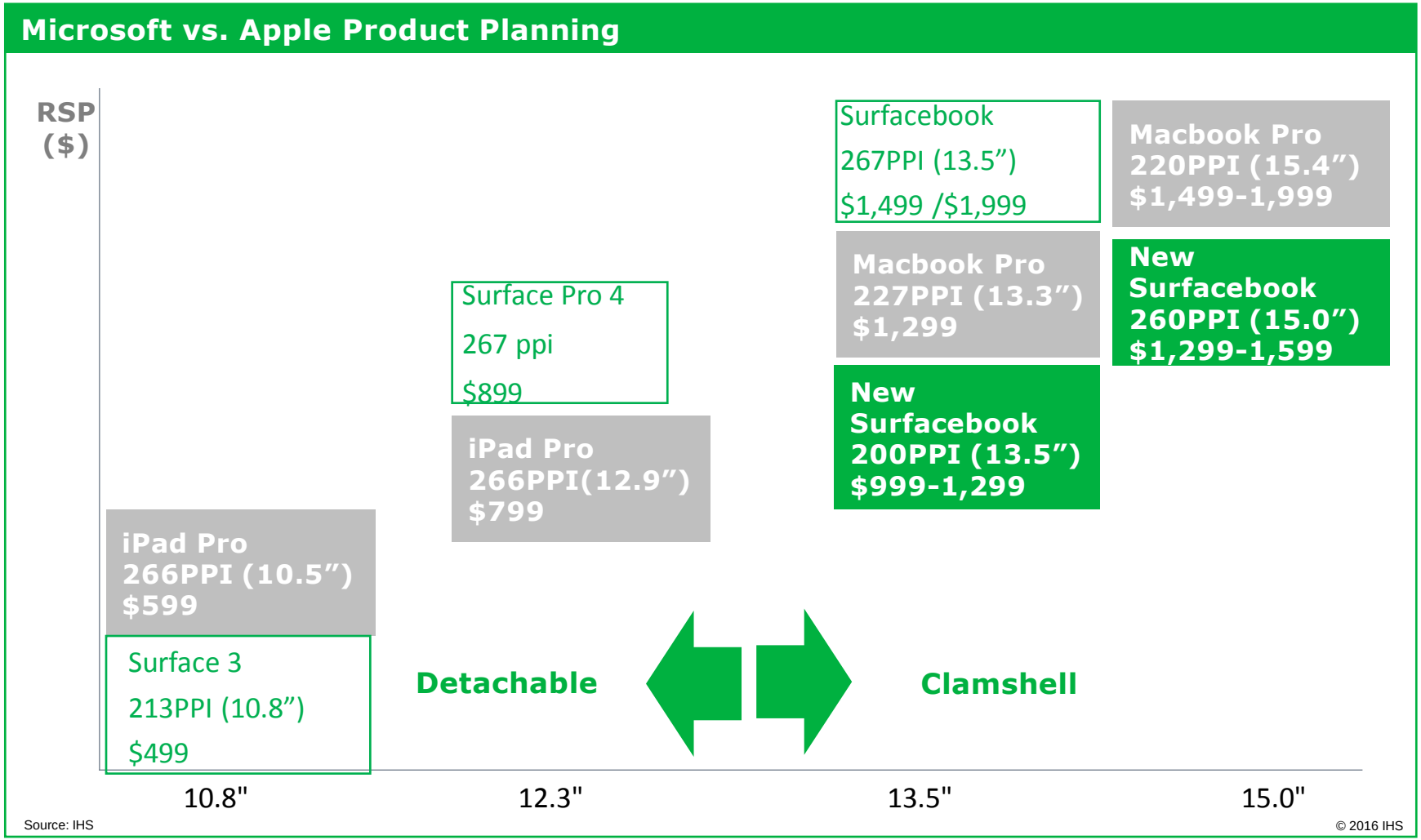
	Notebook			Tablet		
Company	2015	2016(f)	2017(f)	2015	2016(f)	2017(f)
Taiwan A	0.4	EOL		EOL		
China A		0.3	0.8			
Korea A	10	5.5	2.3	9.8	9	1
Korea B	9.2	10.5	9	26	24.5	21.5
Japan A			2.4	5.4	6.6	20.5
Total	19.6	16.3	14.5	41.2	40.1	43

Source: IHS

@ IHS 2016

- A China maker began to supply 13.3” 1440x900 to Apple (MacBook Air)
- A Korea maker plans to reallocate Oxide capacity on Gen8, the experimental production may take time and led to production yield
- Japan panel maker is aggressively to approach the LCD orders for MacBook Pro (13.3” and 15.4”)

Microsoft next step? Full-line competition with Apple



Microsoft, the 3by2 display bellwether and its followers

Size Resolution	10.8" 1920X1280	12"/12.3" 2160X1440/2736X1824	13.5" 3000X2000/2250x1500	15.0" 3240X2160
Status	•EOL due to Intel processor discontinued	•Very success and become reference design.	•Cost is very high, PnP GPU created many bugs •Develop clamshell NB at lower resolution	•Develop Clamshell NB
Brands action	•Samsung is planning 10.6" 1920x1280.(BOE) •Panasonic is selling 10.8" to WBX	•12.3" 2880x1920 could be generally adopted •next step is to develop 13.0" 3000x2000	•No brand follow SurfaceBook design •Are brand interested in 3:2 panels for clamshell?	•Brand is still not firmed if the 3by2 will be accepted for clamshell •Are brand interested in 3:2 panels for clamshell?

Google, Apple and Microsoft set-up reference Designs

Notebook & Tablet Design by size & forma factor analysis				
	7.x" -9.x"	10.x"-11.x"	12.x"-13.x"	14" +
Y2016 K units	182,587	62,066	38,721	109,152
Y2020 K units	137,159	70,178	61,190	114,660
GAGR (5 Years)	-5.56%	2.49%	9.58%	0.99%
MSFT		Surface 3 (EOL)	Surface Pro 5 12.3" New Surface Book 13.5"	New Surface Book 15"
			13.3" convertible ultrabook 12.x-13" surface-like	14" /15.6" convertible NB for entry
Apple	Cost Reduction 7.9" / 9.7"	iPad Pro w/ KB 10.5"	iPad Pro w/ KB 12.9"	
		MacBook Air 11.6	MacBook / Air/ Pro 13.3	MacBook Pro 15.4
Google	Amazon 7" at $49 Amazon 8" at $69	Pixel C w KB 10.2	New Pixel w KB 12.3"	
	diffcult for white-box now	 Chromebook + Google Play		
Form factor & Usage	Slate China for video US/EU for reader	2-in-1 Chinese WBX coming data consumption	2-in-1 premium design data creation	2-in-1 Penetrate to mainstream everyday PC

Source: IHS

@IHS 2016

3:2 Aspect Notebook/Tablet Display Summary

3:2 aspect panel development plan						
	10.x"		12.x"		13.x	
3000x2000			12.x" JDI (LTPS) 12.3” Panda (Oxide)		15.0" LGD 3240x2160 14.1” Panda (Oxide) 13.0" AUO (LTPS) 13.0" JDI (LTPS) ~~13.0" LGD (Oxide)~~ 13.5" PLD 13.5" LGD	Microsoft (HP/~~Lenovo~~) (Lenovo) (Lenovo) Microsoft (Microsoft)
2880x1920			12.0" AUO 12.6" BOE 12.7" INX (TBD) 12.3" Sharp (Oxide)	Lenovo/HP Asus Dell/Google		
2736x1824			12.3" SDC (Oxide) 12.3" LGD (Oxide)	Microsoft (SP4) Microsoft (SP5)/~~(Dell)~~		
2400x1600			12.3” Sharp	Samsung		
2250x1500					13.5" PLD 13.5" Sharp (Oxide)	(Microsoft) (Microsoft)
2160x1440			12.6" BOE 12.0" BOE 12.0" Tianma 12.0" PLD 12.0" SDC 12.0" INX	Asus Huawei Huawei Acer Lenovo (Google)	13.0" INX	Huawei
1920x1280	PLD(10.8") SDC(10.8") BOE(10.8”)	Microsoft Microsoft Samsung	12.0" LGD 12.0" LGD 12.3" Sharp (Oxide)	HP Toshiba Google		
1440x960			12.0 INX"			

Source: IHS

@2016 IHS

Is 3:2 aspect Notebook/Tablet a blue ocean to brands?

3:2 Aspect Notebook/Tablet Price Positioning

	Atom/4G/64G	M3/4G/64G	M3/4G/128G	M5/4G/128G	M5/8G/512G	i5/8G/256G
$999			**Lenovo** X1 Tablet (12” 2160x1440)			**Asus** Transformer 3 Pro (12.6” 2880x1920)
$899			**Microsoft** Surface Pro 4 (12.3” 2736x1824)			
$799			**HP** Spectre X2 (12” 1920x1280)		**Asus** Transformer 3 (12.6” 2880x1829)	
$699		**Lenovo** Miix 700 (12” 2160x1440)	**Huawei** Matebook (12” 2160x1440)			**Acer** Switch Alpha 12 (12” 2160x1440)
$599	**Toshiba** Dynapad (12” 1920x1280)			**HP** Pavilion x2 (12” 1920x1280)		

Source: IHS

Differentiating the 3:2 displays

3:2 Notebook/Tablet Product Differentiation

Differentiation

- Super slim
- Narrow border
- Low power

>266 PPI Display
Core M Processor
(ultra light)
$899+

Performance

>266 PPI Display
Core I Processor

$899+

- High contrast
- Low reflection
- Low power

Price

- Open-cell Possible

≤216 PPI Display
Core M Processor

$499-699

Value

≤ 216 PPI Display
Core I Processor

$699-899

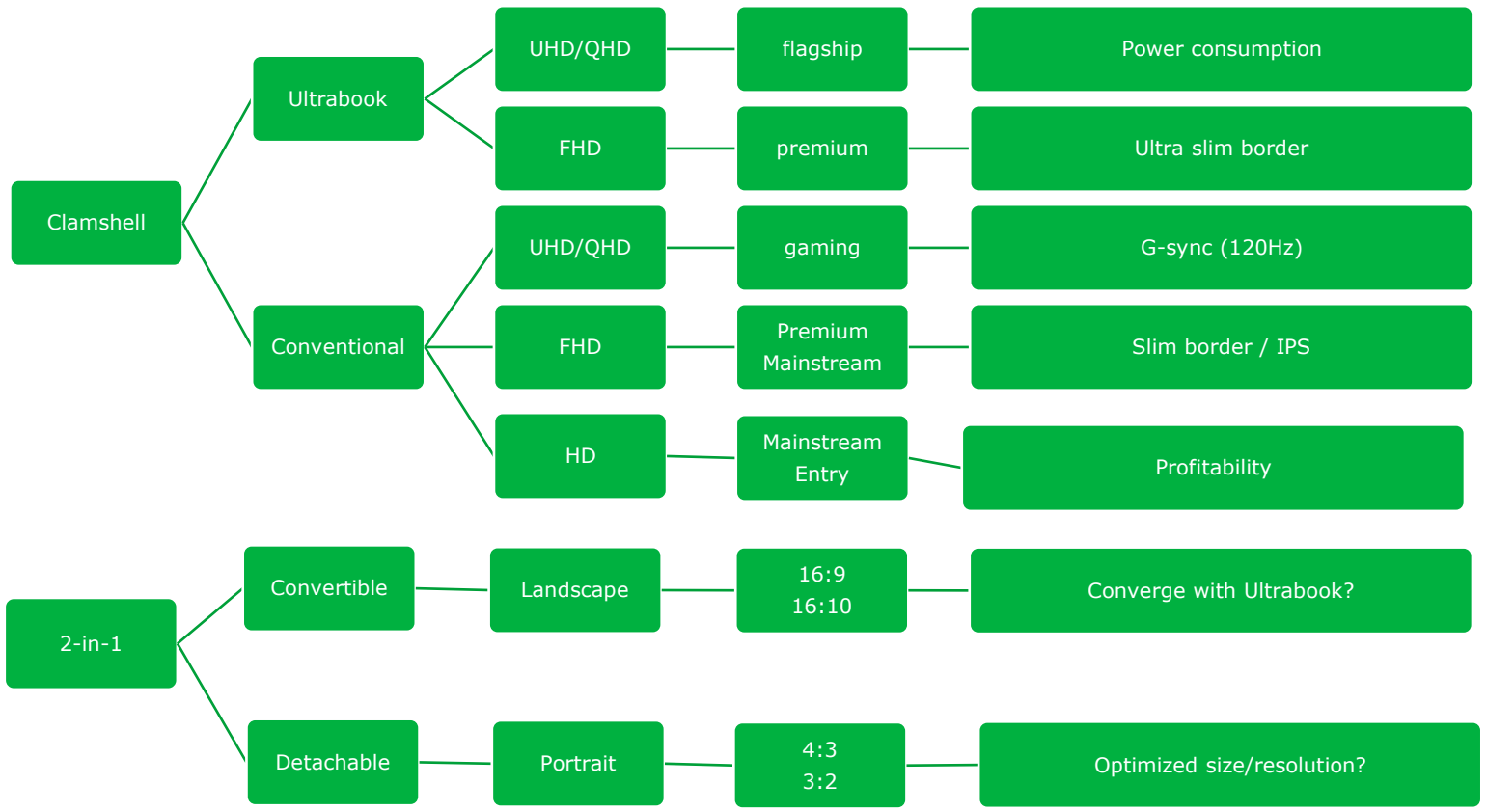
- LCM cost ≤10% RSP

Source: IHS

© 2016 IHS

Key issues of notebook display

Notebook Display Design Feature and Challenges



Source: IHS

Thank you for your attentions

jason.hsu@ihsmarkit.com