IDF2011
INTEL DEVELOPER FORUM

Current and Future Memory Technologies for your Intel® Architecture Based Platforms

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Harry Yoon, Principal Engineer, Samsung

SPCS001

Sponsors of Tomorrow.™ intel

Agenda

- Intel Memory Usage Roadmap
- Memory industrial status and projection
- DDR3 Health & Industry Enabling Status
- DDR3 Value for DT/WKST/MB/SVR
- Memory education from leading supplier in industry – Samsung

The PDF for this Session presentation is available from our Technical Session Catalog at the end of the day at: intel.com/go/idfsessions

URL is on top of Session Agenda Pages in Pocket Guide

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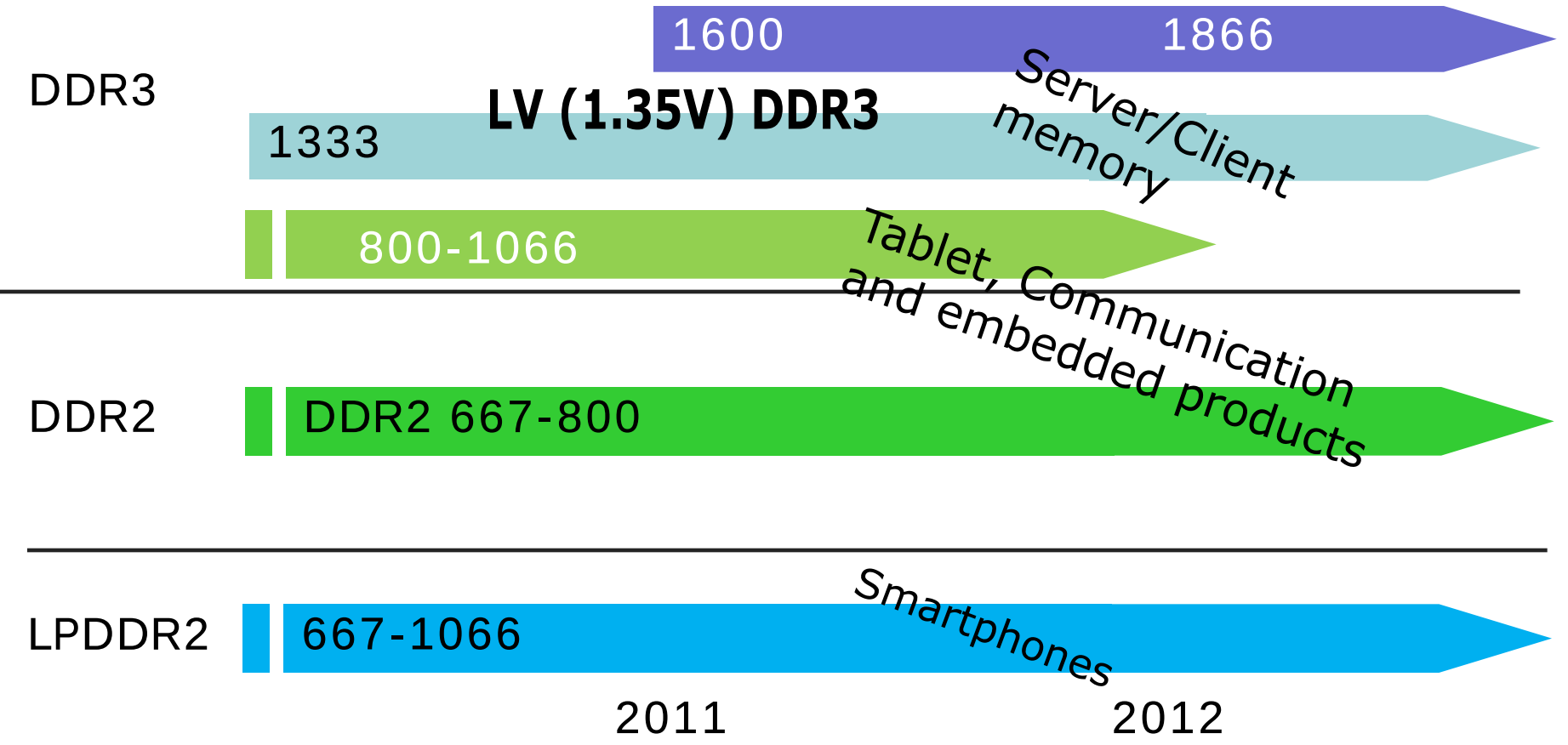
- **Intel Memory Usage Roadmap**
- **Memory industrial status and projection**
- **DDR3 Health & Industry Enabling Status**
- **DDR3 Value for DT/WKST/MB/SVR**
- **Memory education from leading supplier in industry - Samsung**

Memory Technology Roadmap



Intel offers right memory for the right products

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DDR3 Across Many Major Segments

		Product Name	Memory
Desktop	HEDT	Intel® Core™ i7 Extreme Processor	DDR3 up to 1600 + XMP
	MS	Intel Core i7 and Core i5 Processor	DDR3 up to 1333 + XMP
Mobile	XE	Intel Core i7 Processor	DDR3 up to 1600 + XMP
	T & L	Intel Core i5 Processor	DDR3 up to 1333
Server	MC/EX	Intel® Itanium® Processor 9100/Intel® Xeon® Processor 7500	DDR3 800/1066 1.5V & 1.35V
	EP	Intel Xeon Processor 5600	DDR3 up to 1333 1.5V & 1.35V
	WK/UP	Intel Xeon Processor 3400	DDR3 up to 1333
Netbook		Intel® Atom™ Processor N450	DDR2/3 up to 800
Tablet		Intel Atom Z760	DDR2 800

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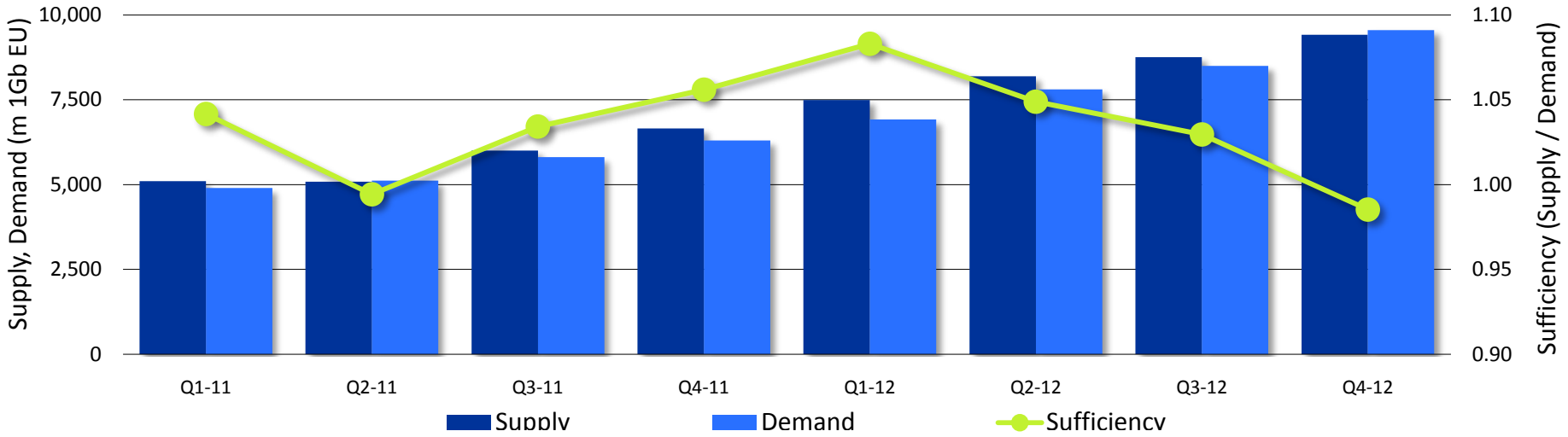
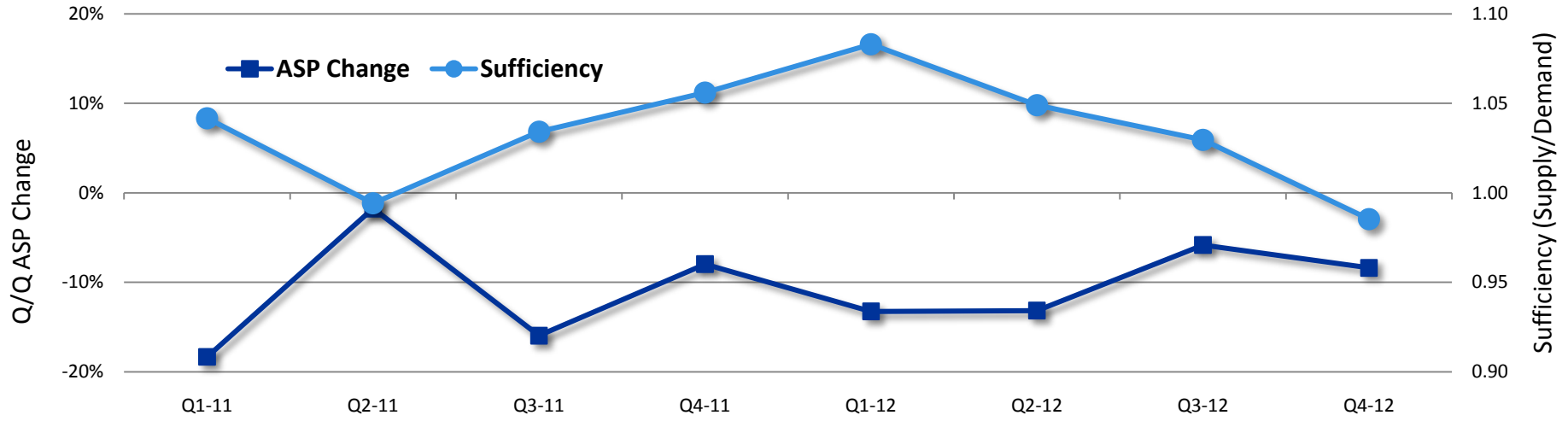
Supply / Demand



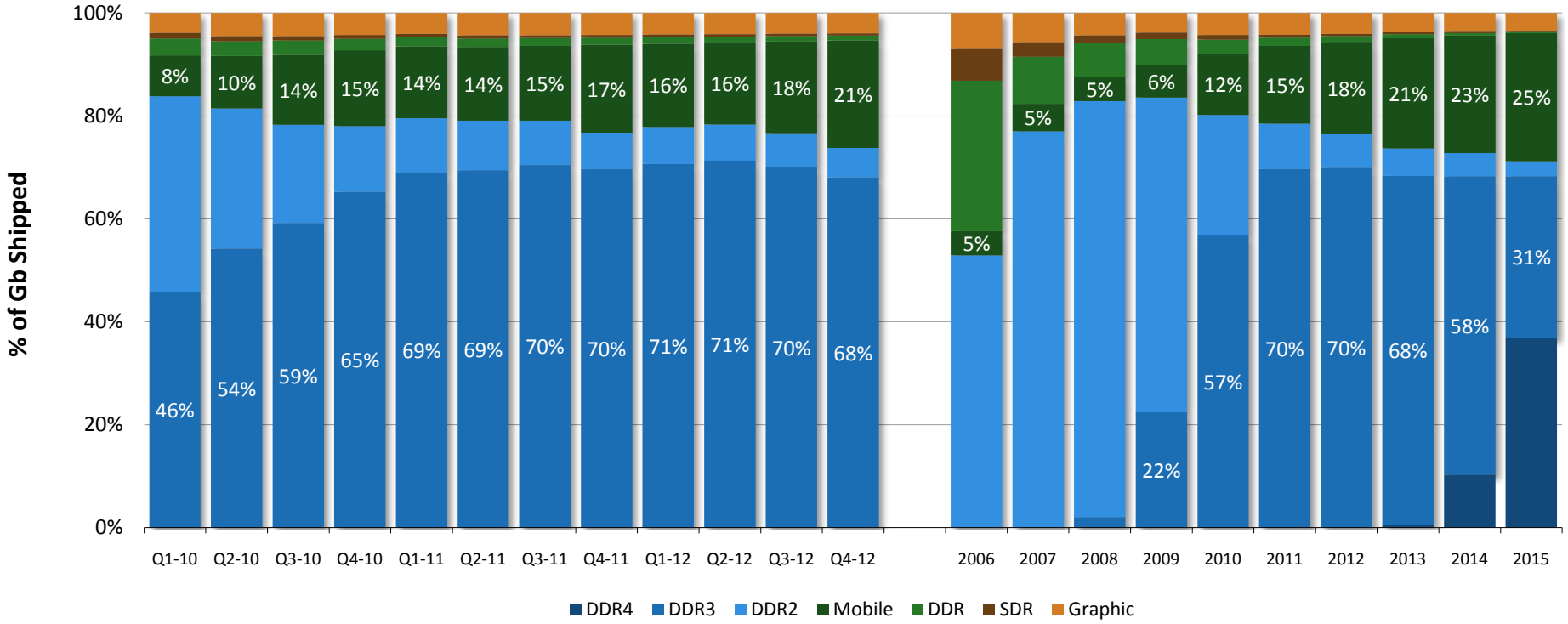


Source - IHS

7

DRAM Technology Forecast
Bit Basis

- Mobile DRAM is gaining bit share
  - 12% in 2010 growing to 25% in 2015
- DDR3 shipments surpassed DDR2 in Q1 2010
  - DDR3 now accounts for ~70% of bit shipments
- DDR4 will launch in 2012, crossover with DDR3 in mid 2015



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Intel® Memory Validation

- **DRAM Component Validation**
  - AC/DC testing using Automated Tester at extreme test condition according to specifications
  - RLC testing using Vector Network Analyzer extracting package parasitic data
- **Thermal, Temp Sensor, and Heat Spreader Validation**
- **DIMM System Validation**
  - Functional stress testing at extreme test corners according to specifications
  - System power management testing – power/reset cycle test, S3, C-state test
  - Platform margin testing
- **Thousands of platforms tested for reliable operation by launch**

Comprehensive Validation to Specifications, use Intel® products with reliable memory

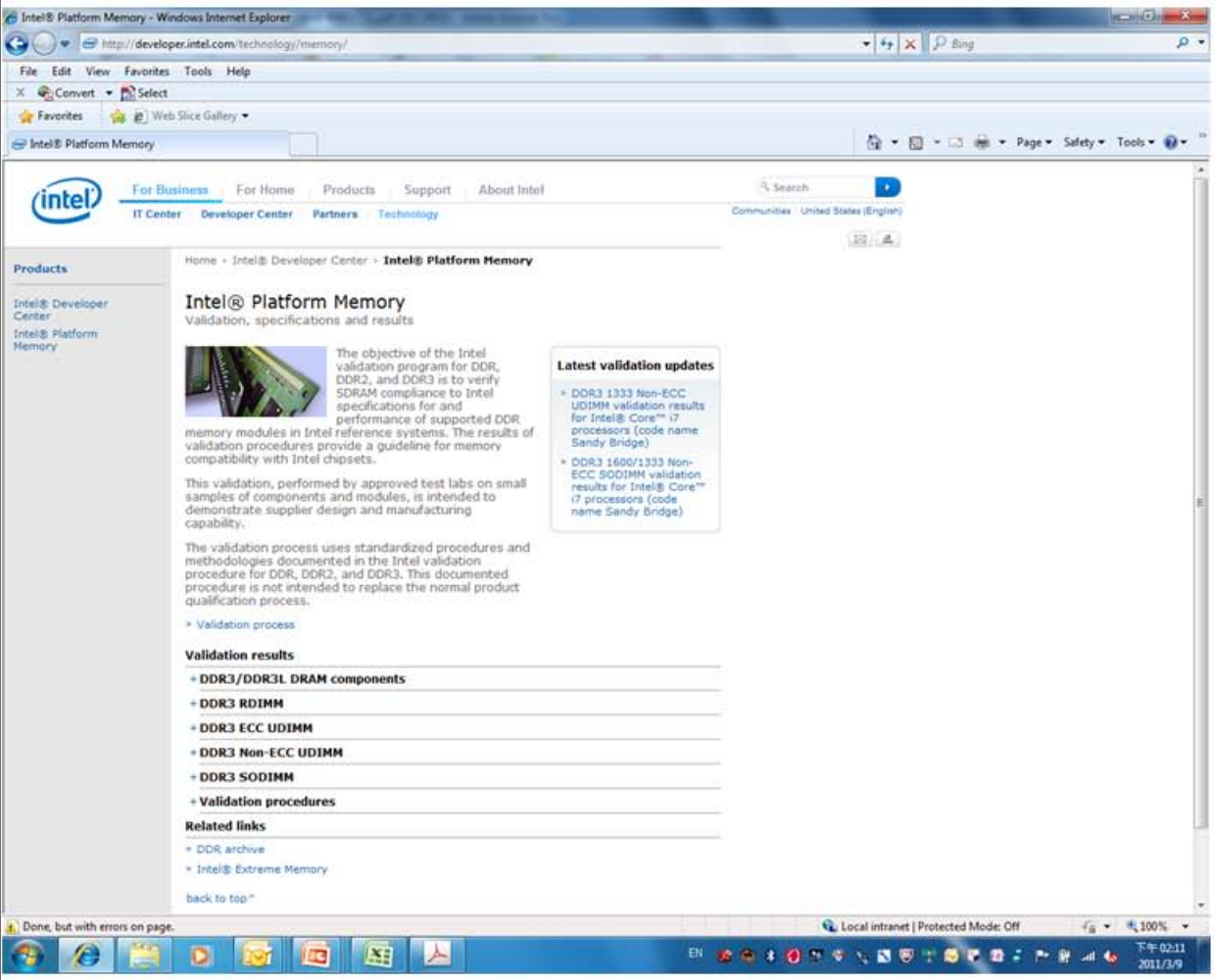
Memory Ecosystem for DDR3

-> Leading suppliers shipping in volume…

- **DRAM – Samsung*, Hynix*, Micron*, Elpida*, and Nanya***
- **DIMM – Kingston*, A-data*, Apacer*, Crucial*, etc**
- **Register/Buffer – Inphi*, IDT*, Montage*, and Ti***
- **Temp Sensor – NXP*, ST Micro*, Microchip*, Atmel*, IDT*, and On-Semi***

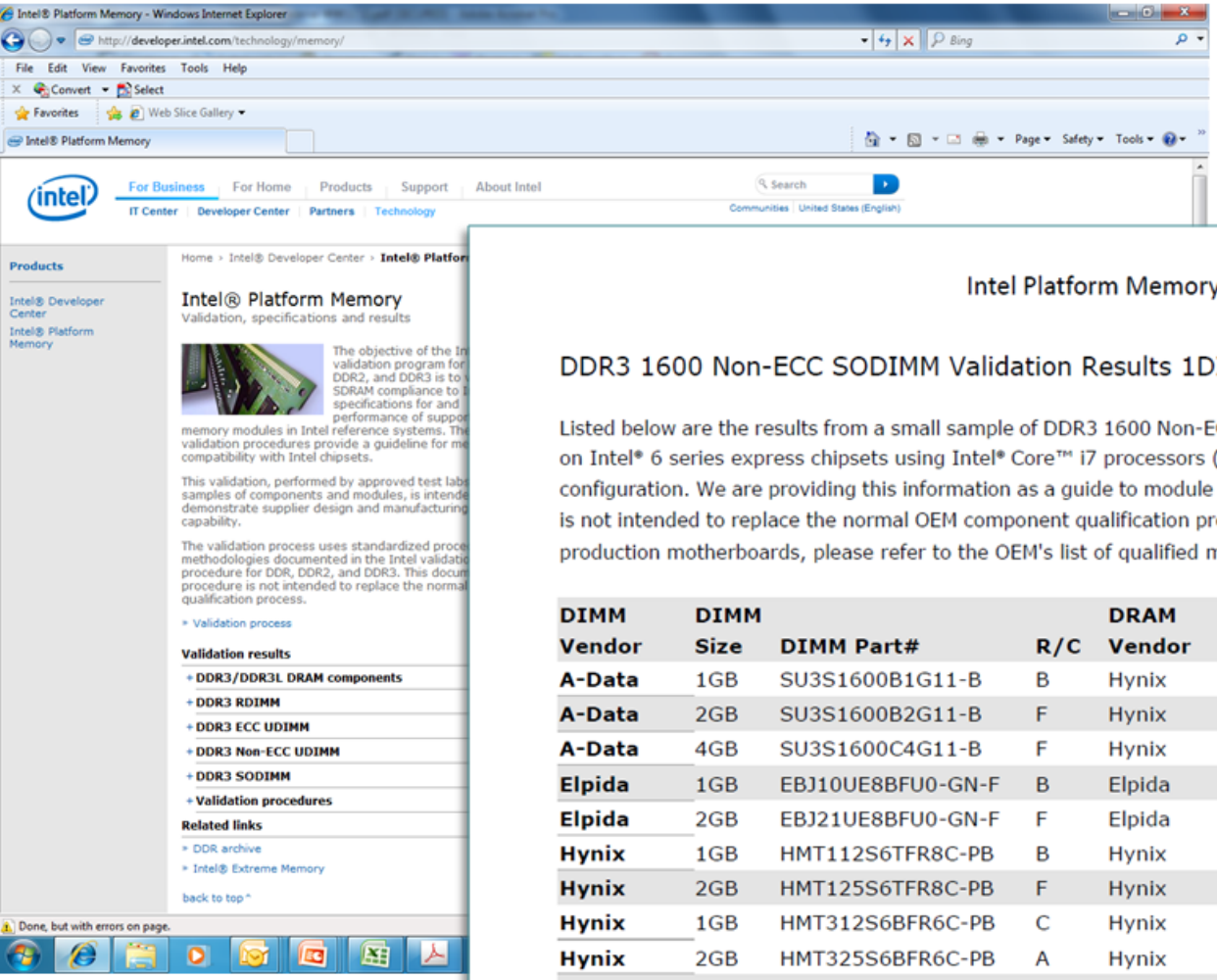
DDR3 Ecosystem Very Healthy

Validated DDR3 Memory for Intel® Core™ i7 Processor



Use Intel Validated Memory For Efficient Platform Development

Validated DDR3 Memory for Intel® Core™ i7 Processor



Intel Platform Memory Operations

DDR3 1600 Non-ECC SODIMM Validation Results 1DIMM/ch

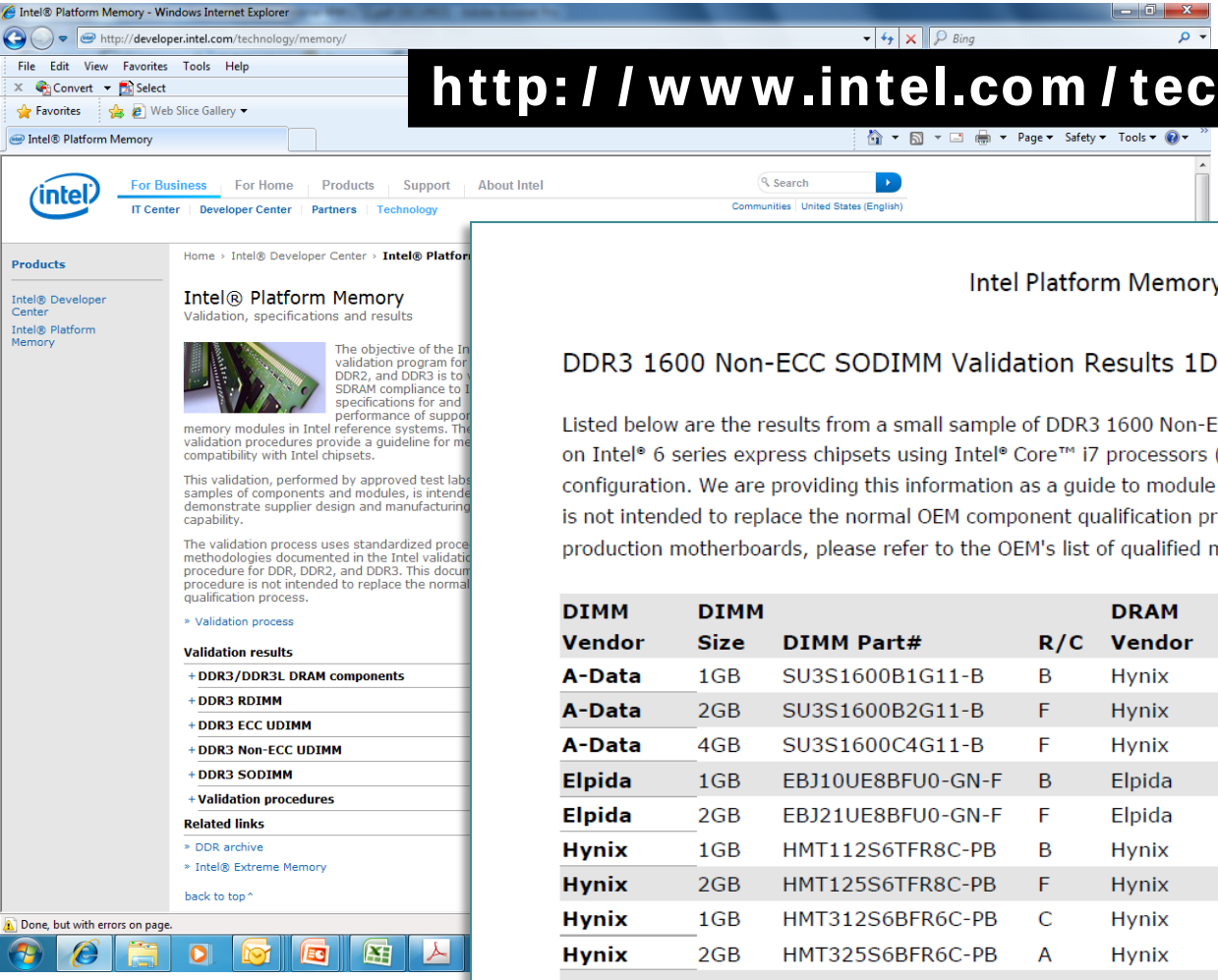
Listed below are the results from a small sample of DDR3 1600 Non-ECC SoDIMM modules tested on reference platforms based on Intel® 6 series express chipsets using Intel® Core™ i7 processors (codename Sandy Bridge), in a 1DIMM/channel configuration. We are providing this information as a guide to module performance with Intel® reference platforms. This testing is not intended to replace the normal OEM component qualification process. For results on specific Intel® motherboards or OEM production motherboards, please refer to the OEM's list of qualified memory suppliers.

DIMM Vendor	DIMM Size	DIMM Part#	R/C	DRAM Vendor	DRAM Part#	DRAM Config	DRAM Date Code
A-Data	1GB	SU3S1600B1G11-B	B	Hynix	H5TQ1G83DFR-PBC	1Gbx8	1030
A-Data	2GB	SU3S1600B2G11-B	F	Hynix	H5TQ1G83DFR-PBC	1Gbx8	1030
A-Data	4GB	SU3S1600C4G11-B	F	Hynix	H5TQ2G83BFR-PBC	2Gbx8	1046
Elpida	1GB	EBJ10UE8BFU0-GN-F	B	Elpida	EDJ1108BFBG-GN-F	1Gbx8	1039
Elpida	2GB	EBJ21UE8BFU0-GN-F	F	Elpida	EDJ1108BFBG-GN-F	1Gbx8	1039
Hynix	1GB	HMT112S6TFR8C-PB	B	Hynix	H5TQ1G83TFR-PBC	1Gbx8	1028
Hynix	2GB	HMT125S6TFR8C-PB	F	Hynix	H5TQ1G83TFR-PBC	1Gbx8	1028
Hynix	1GB	HMT312S6BFR6C-PB	C	Hynix	H5TQ2G63BFR-PBC	2Gbx16	1048
Hynix	2GB	HMT325S6BFR6C-PB	A	Hynix	H5TQ2G63BFR-PBC	2Gbx16	1048
Hynix	2GB	HMT325S6BFR8C-PB	B	Hynix	H5TQ2G83BFR-PBC	2Gbx8	1048
Hynix	4GB	HMT351S6BFR8C-PB	F	Hynix	H5TQ2G83BFR-PBC	2Gbx8	1048

Use Intel Validated Memory For Efficient Platform Development

Validated DDR3 Memory for Intel® Core™ i7 Processor

http://www.intel.com/technology/memory/



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A-Data	4GB	SU3S1600C4G11-B	F	Hynix	H5TQ2G83BFR-PBC	2Gbx8	1046
Elpida	1GB	EBJ10UE8BFU0-GN-F	B	Elpida	EDJ1108BFBG-GN-F		
Elpida	2GB	EBJ21UE8BFU0-GN-F	F	Elpida	EDJ1108BF		
Hynix	1GB	HMT112S6TFR8C-PB	B	Hynix	H5TQ1		
Hynix	2GB	HMT125S6TFR8C-PB	F	Hynix	H5T		
Hynix	1GB	HMT312S6BFR6C-PB	C	Hynix	H5		
Hynix	2GB	HMT325S6BFR6C-PB	A	Hynix	H5T		
Hynix	2GB	HMT325S6BFR8C-PB	B	Hynix	H5TQ		
Hynix	4GB	HMT351S6BFR8C-PB	F	Hynix	H5TQ2G8		

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DDR3 SoDIMM Validation Result For Sandy Bridge

New DDR3 modules added regularly. Please check URL for the most up to date list

Use Intel Validated Memory For Efficient Platform Development

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Differentiated Desktops
Focused Strategy is Driving Growth

Enthusiast	Lifestyle	Business	Home Hub	Entry DT
Performance opportunities	Form factor is Key	Stable & Reliable	Stable & Reliable	Volume opportunities

Traditional Tower

Undifferentiated, high volume, low ASP

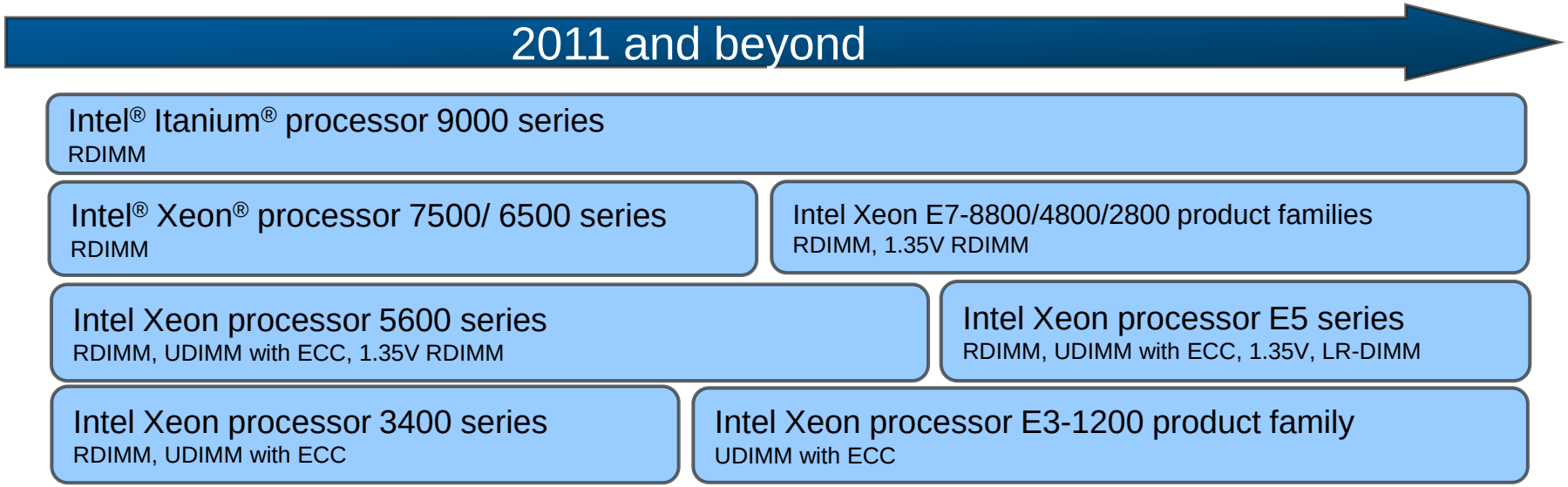
UltraBook™ Redefining the PC Experience

	Experience	Memory
Ultra Thin	**Aesthetics w/Sleek Industrial Design**	**Soldered Down Memory**
Ultra Mobile	**Minimum 12 hr Battery Life**	**Low Power Self Refresh Memory**
Ultra Mainstream	**Mainstream SPP <$999**	**Balance Memory Cost & Capacity**

UltraBook™ Redefining PC Memory

DDR3 Support in Intel® Server Products

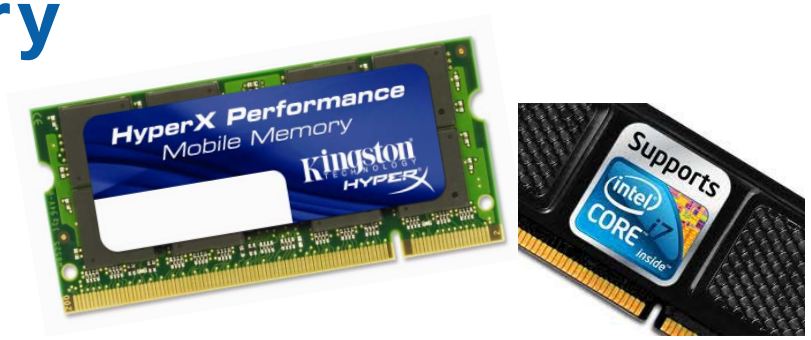
- DDR3 continues to be the technology of choice for Intel's server platforms launching in 2011



- Intel's Expandable and Mission Critical server products support large memory configurations with the Intel Xeon processor 7510 Scalable Memory Buffer

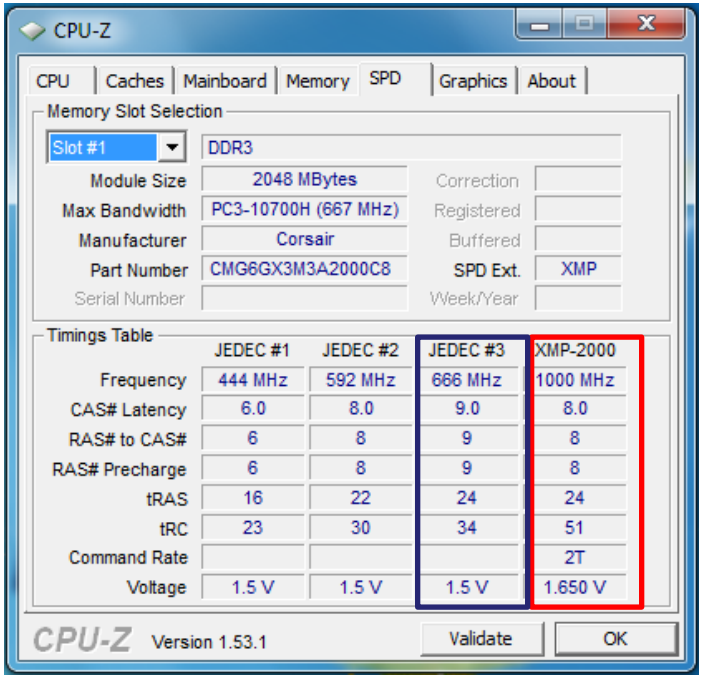
Intel® server products offer flexibility of memory type to address the range of end user priorities

Intel® Extreme Memory (Intel® XMP) Profile



- Intel® XMP - expansion of the standard DDR3 memory specification. Enables speeds, latencies outside of JEDEC Specification
  - Contains profiles of pre-tested memory timings in SPD for easy OC
  - DIMM supporting 2010 Intel® Core™ i7, i5 and 2nd Generation Intel Core i7, i5, i3
  - Enables robust, overclocking solution designed to take advantage of the unlocked capability of Intel® CPUs
- Intel® XMP compliant DIMMs available
  - Corsair*, OCZ*, Kingston*, Patriot*, Crucial*, Geil* & others

http://www.intel.com/consumer/game/extreme-memory.htm

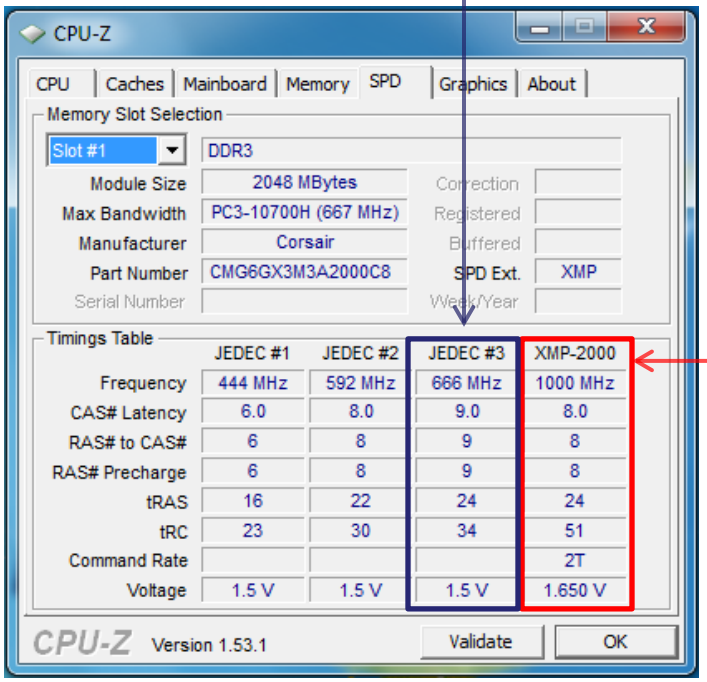


Intel® Extreme Memory Profile (Intel® XMP)

How It Works

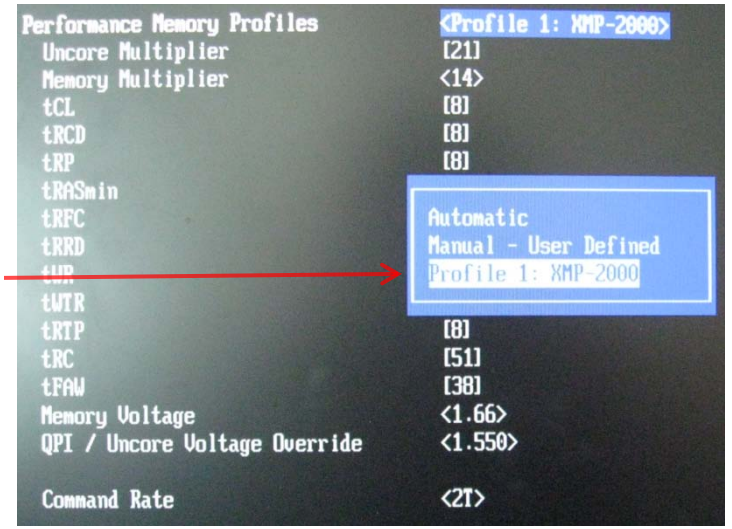
1. Intel® XMP Enabled BIOS reads module SPD at power-on. JEDEC and XMP Profiles are stored on UDIMM or SODIMM SPD

2. System boots with highest supported JEDEC defined parameters



3. Predefined and tested Intel XMP profiles can be selected by the end user through BIOS setup

4. Reset system to apply



Intel® XMP exceeds JEDEC timings and system voltages: It is overclocking

Summary

- DDR3 provides improved power consumption and performance over previous generations
- Intel continues to promote mobile, desktop, workstation, server adoption of DDR3
- All major suppliers have DDR3 as their volume focused product
- UltraBook™ Redefining PC Memory
- Intel® Extreme Memory Profile defines new levels of memory performance

DDR3 Is Mainstream Now

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Samsung DRAM Solution

2011. 09. 14

Memory Product Planning & Application Engineering
Samsung Electronics Co., Ltd.

SAMSUNG
TURN ON TOMORROW

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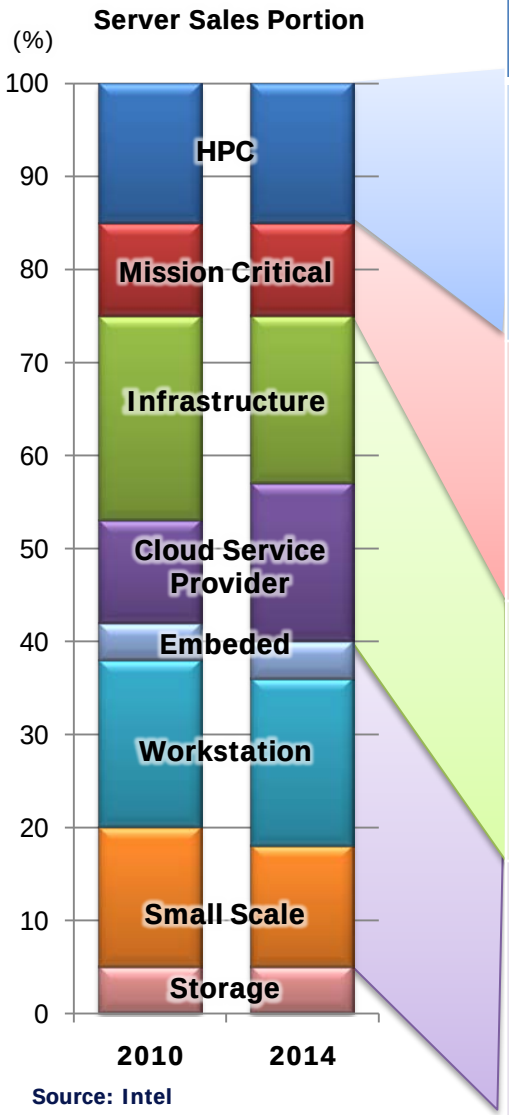
TURN ON TOMORROW

Server Segmentation & Memory Requirement



Usage Model	Trend	Requirement		Memory Requirement
High Performance Computing	MPP (RISC) / Cluster (x86)	TCO CPU Memory RAS		• High Density • High Speed • Low Latency • LRDIMM • Custom DIMM
Mission Critical	RISC Sales trend (SPARC, POWER)	TCO CPU Memory RAS		• High Speed • High Capacity • 4Gb DRAM • Standard DIMM
Conventional (Cost Sensitive Server)	Standardize & Low cost	TCO CPU Memory RAS		• Green Memory - 1.25V/1.35V - Advance Process • Standard DIMM • High supportability
Cloud Computing & Low End	IAAS, PAAS, Many User, Microserver, SAAS Low Computing Power High Connectivity	TCO CPU Memory RAS		• Small F/F DIMM - MiniDIMM - ECC SODIMM • 4Gb DRAM • Standardization • Green Memory

High Density Solution

- **With advanced technology, Samsung offers optimal solution for Server**
  - 35nm technology now, 20nm class product available soon

Density	Type	Comp.	Org.	Availability
2GB	RDIMM, ECC UDIMM	2Gb	1Rx8	Now
4GB	RDIMM, ECC UDIMM	2Gb	1Rx4, 2Rx8	Now
		4Gb	1Rx8	Now
8GB	RDIMM, ECC UDIMM	2Gb	2Rx4, 4Rx8	Now
		4Gb	1Rx4, 2Rx8	Now
16GB	RDIMM, LRDIMM	2Gb	4Rx4	Now
		4Gb	2Rx4, 4Rx8	Now
32GB	RDIMM, LRDIMM	4Gb	4Rx4	Now
64GB/128GB	Under consideration			

Samsung is investigating over 32GB solutions for Ultra High Density Application

Low Power Green DDR3 Solution

- **Advanced process technology is driving significant power reduction**

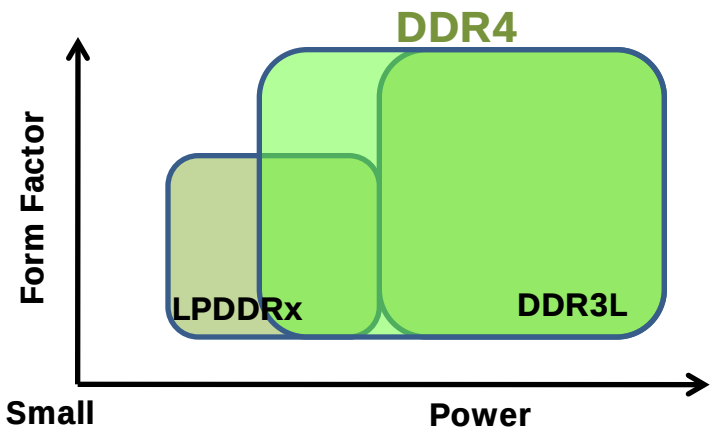
Memory Power Consumption Cut by ~30% at Each Process Node

- Considered with an 8 hours active and 16 hours idle status in server

Source: Samsung Lab.

More Green & Smooth Transition – DDR4

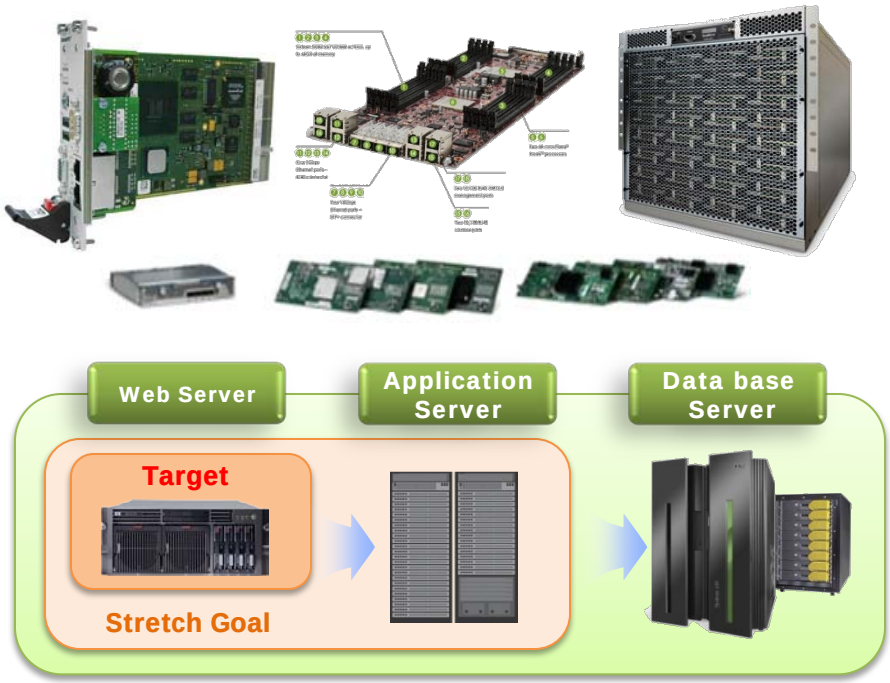
- **Efficient power / performance**
- **No significant die size impact with higher speed & less power over DDR3**
  - DDR4 POD deceases IO Power & supports higher speed
- **Support 1.2V VDD / VDDQ same as LPDDRx**



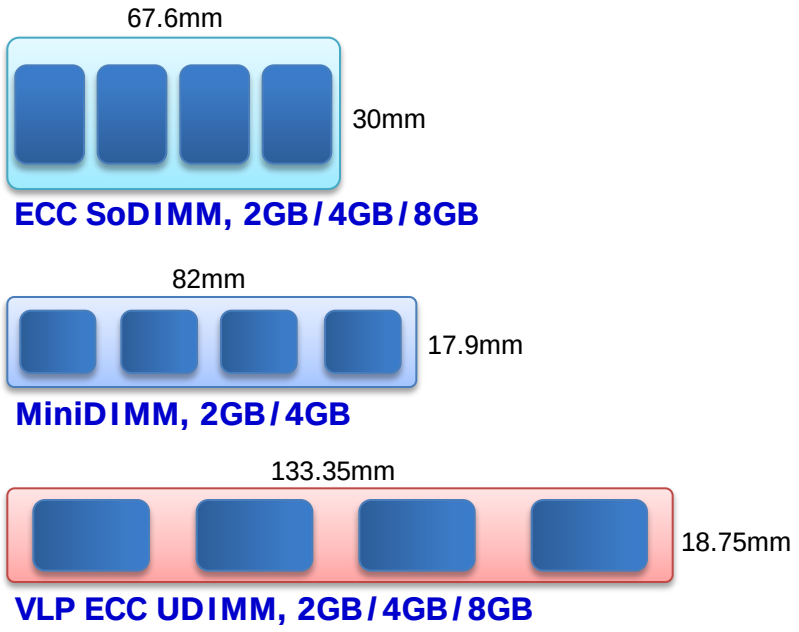
	Special Functionality
Low Power for Server/Mobile Application	CAL (CMD/ADDR Latency)
	MPSM (Max Power Saving Mode)
	1.2V
	POD
Better Reliability for Server/On Board solution	CRC
	Connectivity Check

Emerging Application – Micro-Server

- **Micro-server is a newly emerging server segment aiming the efficiency of performance/power**
- **Small form factor module for space minimization**
  - Requires power efficient solution (4Gb base 4GB)
  - Samsung is supporting 3 types solutions for small form factor requirement



[Micro-server Applications]



[Small F/F Solutions of Samsung]

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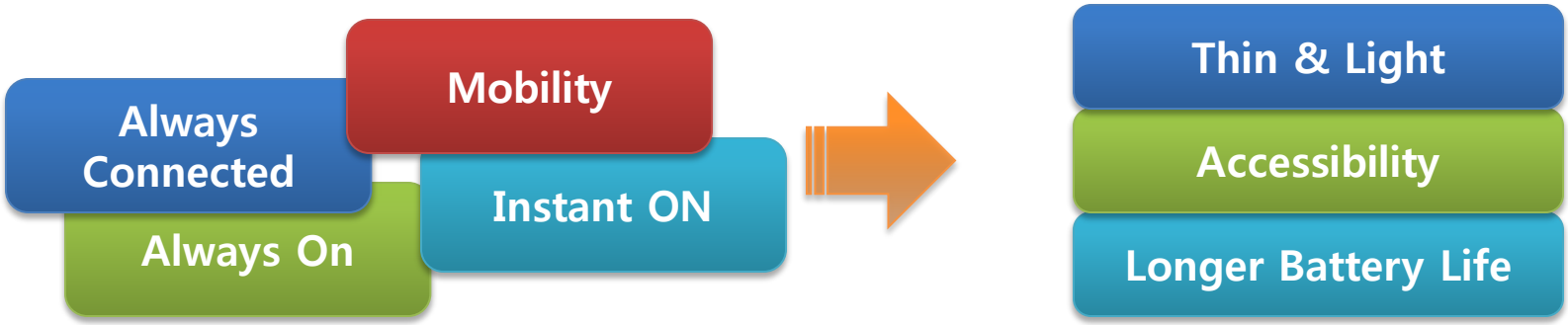
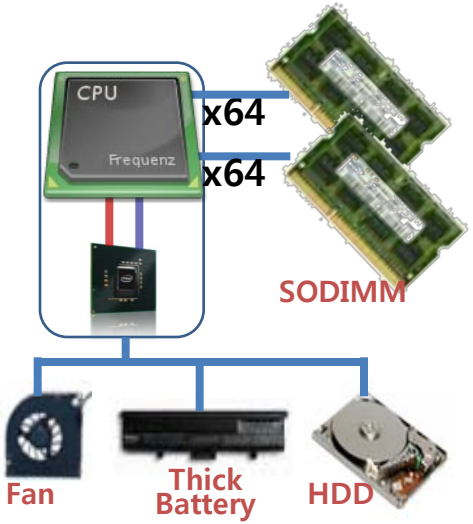
Gear Shift to Ultrathin Notebook

- **UX(User Experience) is driving new paradigm & Intel Ultrabook™ accelerates this movement**

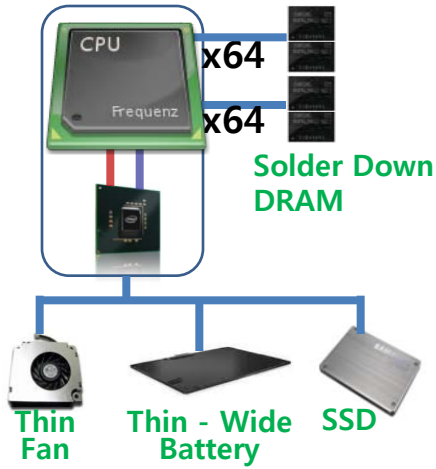


Conventional Notebook ('11)



Cheap & Commodity

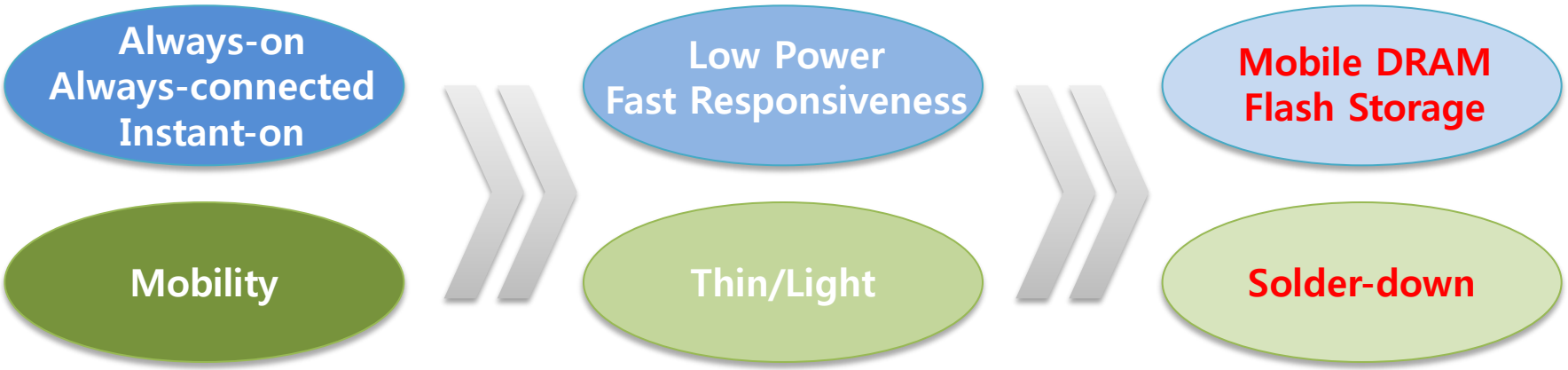
Ultra Thin Notebook ('13)

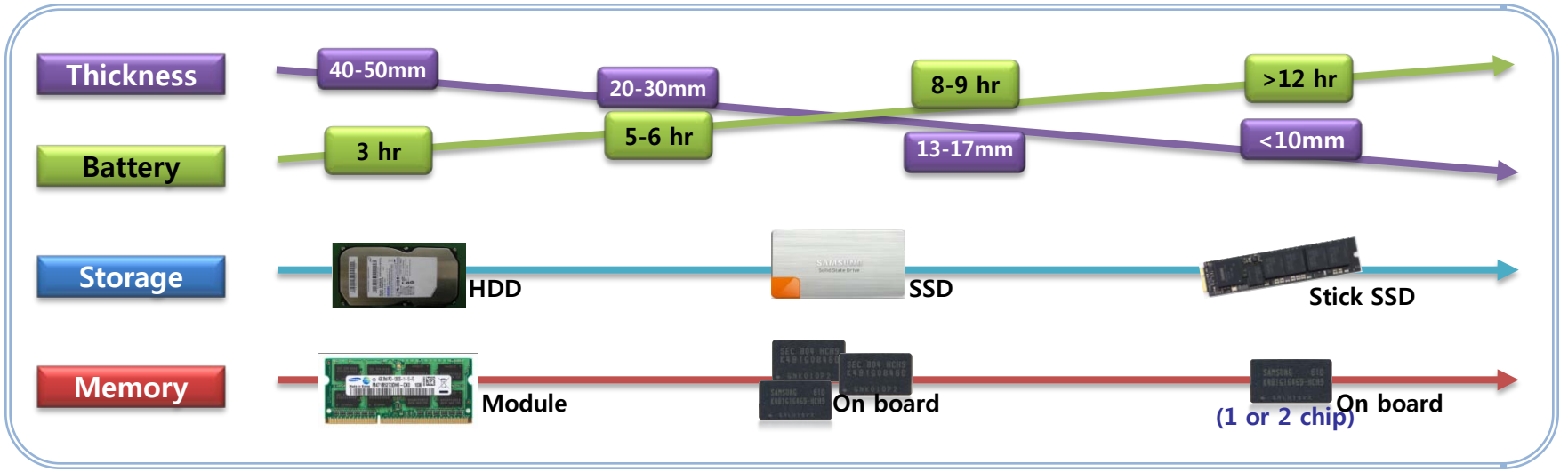


Low Power, Small, Thin & Light, Customized

Memory Devices for Ultrathin Notebook

Memory properties required by new transition





Memory Solution for Ultrabook™

Investigating various memory configurations

- 4Gb would be a best-fit in '12~'13 timeframe in capacity, power consumption, smaller board area, price, etc.

		'11	'12	'13	'14	System config.
Mobile DRAM	2GB		4Gb x32 — 4Gb DDP based 8Gb x64 Comp. 2ea			128bit System 2ch x64
	4GB		4Gb x32 — 4Gb QDP based 16Gb x64 Comp. 2ea	8Gb x32 — 8Gb DDP based 16Gb x64 Comp. 2ea		CPU
	8GB		4Gb x16 — 4Gb QDP based 16Gb x32 Comp. 4ea	8Gb x32 — 8Gb QDP based 32Gb x64 Comp. 2ea		x64 x64
EDP DRAM	2GB	2Gb Comp. 8ea — 2Gb x8	4Gb x16 — 4Gb Comp. 4ea			CS0 CS1 CS2 CS3
	4GB	4Gb Comp. 8ea — 4Gb x8	4Gb x16 — 4Gb Comp. 8ea; 4Gb — 4Gb DDP based 8Gb x16Comp. 4ea; 4Gb x16 — 4Gb DDP based 8Gb x32 Comp. 4ea			
	8GB	4Gb Comp. 16ea — 4Gb x8	4Gb — 4Gb DDP based 8Gb x16Comp. 8ea; 4Gb x16 — 4Gb DDP based 8Gb x32 Comp. 8ea			

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SAMSUNG

TURN ON TOMORROW

Paradigm Change from PC to Mobile Device

PC Era

Desktop → Notebook

Performance

- Personal, Passive
- Intermittent Connectivity
- **Always Plugged-In**

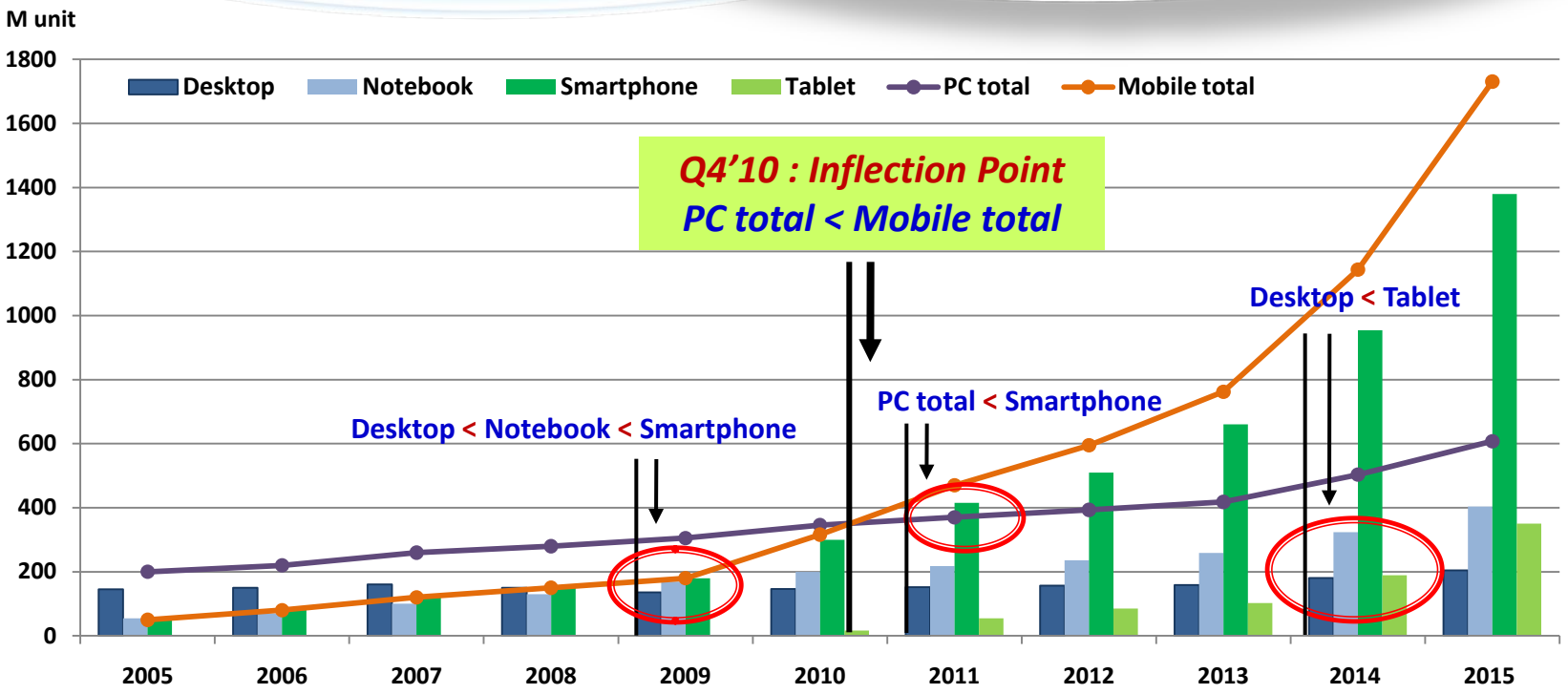
- On/Off plug-in
- Limited mobility

Mobile Era

Smartphone/Tablet→ Mobile Computing

Watt/Bandwidth

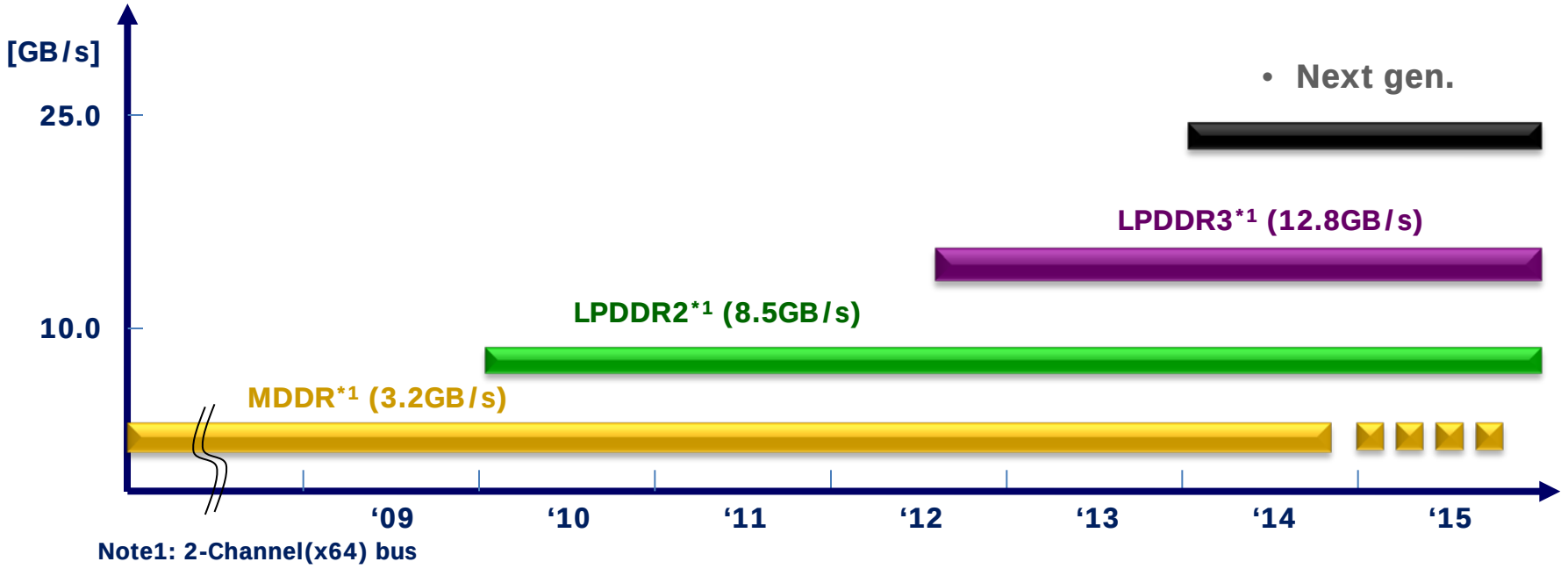
- Shared, Interactive
- Always Connected/On
- **Instant on**



* Source : Global Unit shipment by IDC, Morgan Stanley Research_Feb'11, 2014/2015 forecast based on 2005~2013 CAGR

LPDDR3, Next Mobile DRAM Interface

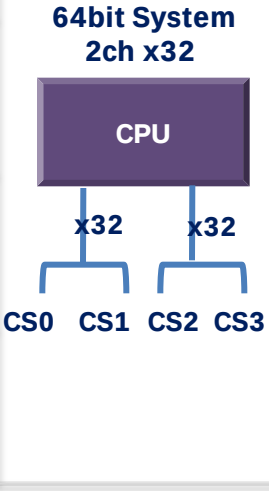
- **LPDDR3 (Low Power DDR3), next DRAM I/F for mobile application**
  - Successor of LPDDR2 : Low VDD(1.2V), Low IDD6
  - Spec under definition in JEDEC



- **LPDDR3 JEDEC draft spec will be available in Dec. '11**

Memory Solution for Tablet/Smartphone

- **Smartphone : 512MB/1GB/2GB LPDDR2, Tablet : 2GB/4GB LPDDR3**
  - LPDDR3 from '12 (4Gb, '12 → 8Gb, '13)
  - Supporting both POP (2chx32) and discrete (1chx32 or 2chx32)
  - PKG height ≤1.0mm (up to 4-stacks)

	Application	'11	'12	'13	'14	'15	System Conf.
512MB	Smartphone	2Gb x32 — 2Gb DDP based, 4Gb x64 Comp. 1ea					
1GB		4Gb x32 — 4Gb DDP based, 8Gb x64 Comp. 1ea					
2GB	Smartphone /Tablet	4Gb x32 — 4Gb QDP based, 16Gb x64 Comp. 1ea		8Gb x32 — 8Gb DDP based, 16Gb x64 Comp. 1ea			
4GB	Tablet	4Gb x16 — 4Gb QDP based, 16Gb x32 Comp. 2ea		8Gb x32 — 8Gb QDP based, 32Gb x64 Comp. 1ea			

Contents

SAMSUNG

TURN ON TOMORROW

Samsung DRAM Long Term Forecast

- **Samsung builds up the product lineup for all segments**
  - Low power memory LPDDR2/3 for mobile device
  - Standard DDR3/4 for computing device

		'10				'11				'12				'13				'14				'15			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Mobile (LP)	Interface VDD/VDDQ	LPDDR2 1.2V/1.2V								LPDDR3 1.2V/1.2V								LPDDRx							
	Bandwidth	6.4GB/s (800Mbps)				8.5GB/s(1066Mbps)				12.8GB/s (1600Mbps)								25.6GB/s+ (?)							
EDP (DDR3)	Interface VDD/VDDQ	DDR3 (1.5V/1.5V, 1.35V/1.35V, 1.25V/1.25V)																DDR4 (1.2V/1.2V)							
	Bandwidth	10.6GB/s(1333Mbps)				14.9GB/s (1866Mbps)				17.1GB/s (2133Mbps)								25.6GB/s (3200Mbps)							

Additional Sources of Information on This Topic:

- **Other Sessions – LRDIMM end to end Q&A right after this session in this room**
- **Demos in the showcase – Samsung, Hynix, and Inphi showing DDR3 and LRDIMMs**

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