UFS Tutorial

Presented by

Scott Jacobson

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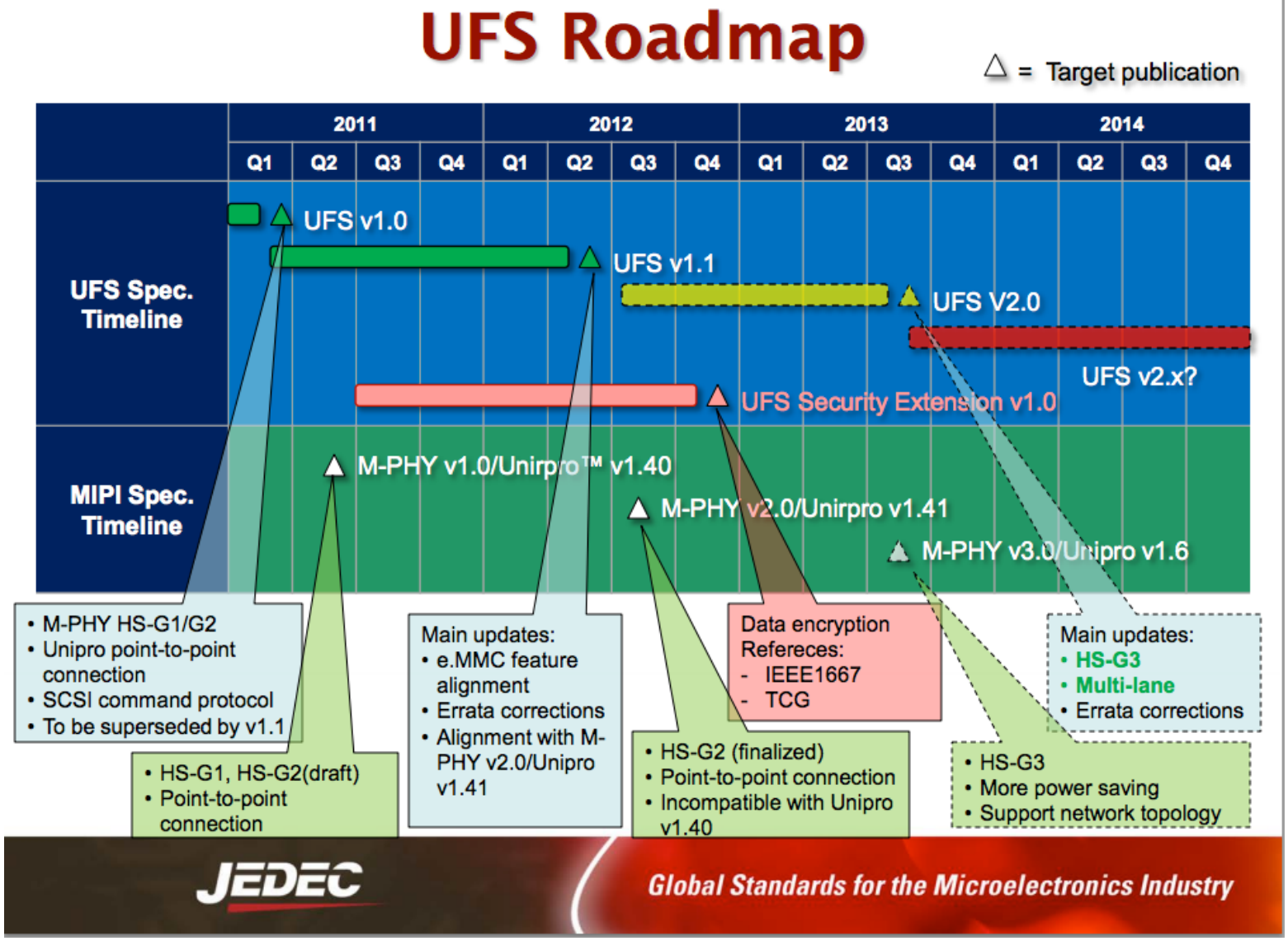
UFS – Universal Flash Storage Overview

- JEDEC UFS Roadmap
- What are the drivers?
- What is UFS?
- Why is UFS important?
- What are the details?

UFS Jedec Roadmap



The Mobile Revolution – A Golden Age for Consumers

Cell Phones Used By
1 of 1,000 Business People

Mobile Telephone smaller, cheaper

Mobile Computer simpler, mightier

Smartphones Used By
600 Million People Worldwide

But the Golden Age has Rocked the Ecosystem

AUGUST 15, 2011, 7:43 AM MERGERS & ACQUISITIONS

Google to Buy Motorola Mobility for $12.5 Billion

BY EVELYN M. RUSLI AND CLAIRE CAIN MILLER

9:16 a.m. | Updated

In a bid to strengthen its mobile business, Google announced on Monday that it would acquire Motorola Mobility Holdings, the cellphone business that was split from Motorola, for $40 a share in cash, or $12.5 billion.

The offer — by far Google's largest e acquisition — is 63 percent above th Motorola Mobility shares on Friday

http://dealbook.nytimes.com/201

SplatF w/ Dan Frommer Archives Creators

TUESDAY, DECEMBER 20, 2011 AT 12:19 PM

RIM's rise and decline: A 10-year view

BlackBerry maker Research In Motion is a classic example of a company that had one g grew huge because of it, but couldn't save itself as the industry moved on. And now for the first time ever, RIM's sales will probably shrink this fiscal year — despite continued rapid growth in the smartphone industry.

Its past is an impressive one: From $300 million in sales during fiscal 2003 to $3 billion four years later. RIM even continued to grow after Apple stunned the industry with its iPhone in 2007, peaking at almost $20 billion in sales during fiscal 2011, which ended this past February.

http://www.splatf.com/2011/12/rim-charts/

Apple soars 10% as profit doubles

CNNMoney

624 comments

By David Goldman @CNNMoneyTech April 25, 2012: 8:46 AM ET

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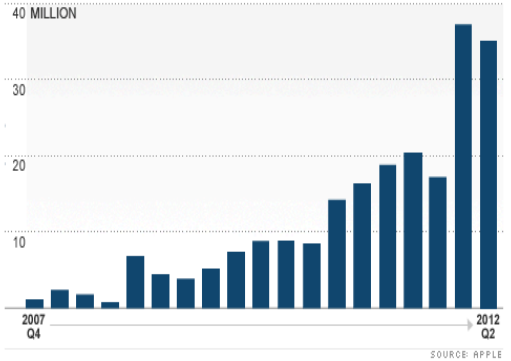
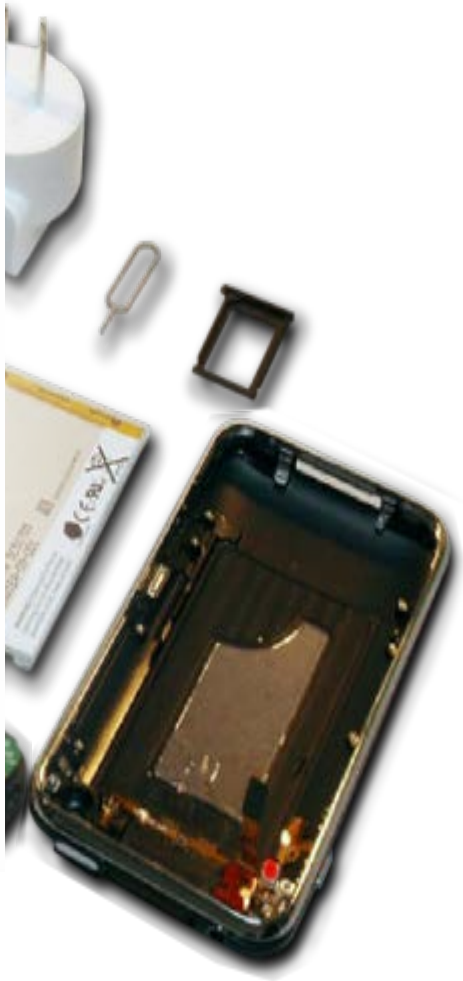
IPHONE SALES BY QUARTER



NEW YORK (CNNMoney) -- Much stronger-than-expected iPhone sales helped Apple nearly double its profit last quarter.

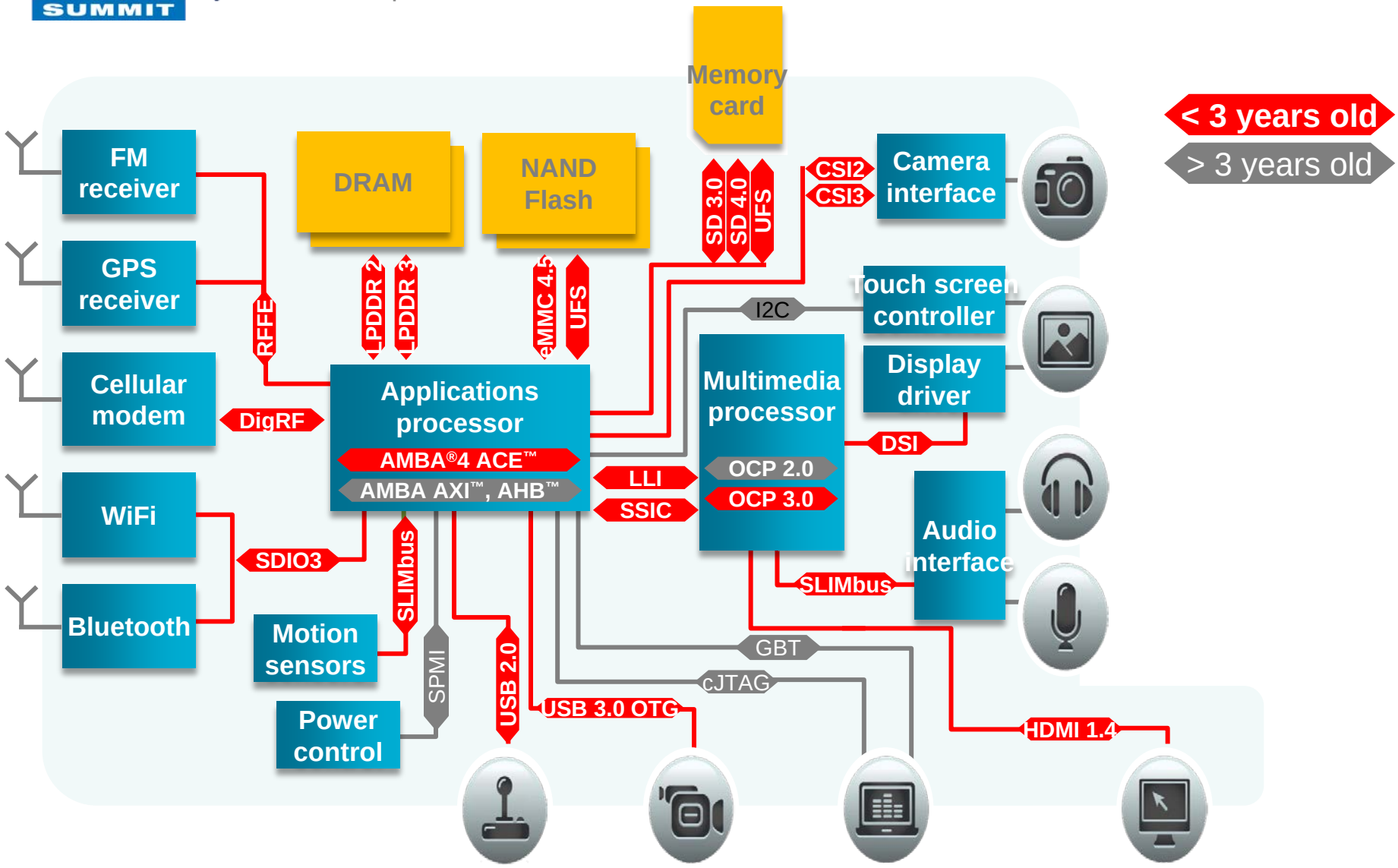
http://money.cnn.com/2012/04/24/technology/apple-earnings/index.htm

What's Enabled the Mobile Revolution?



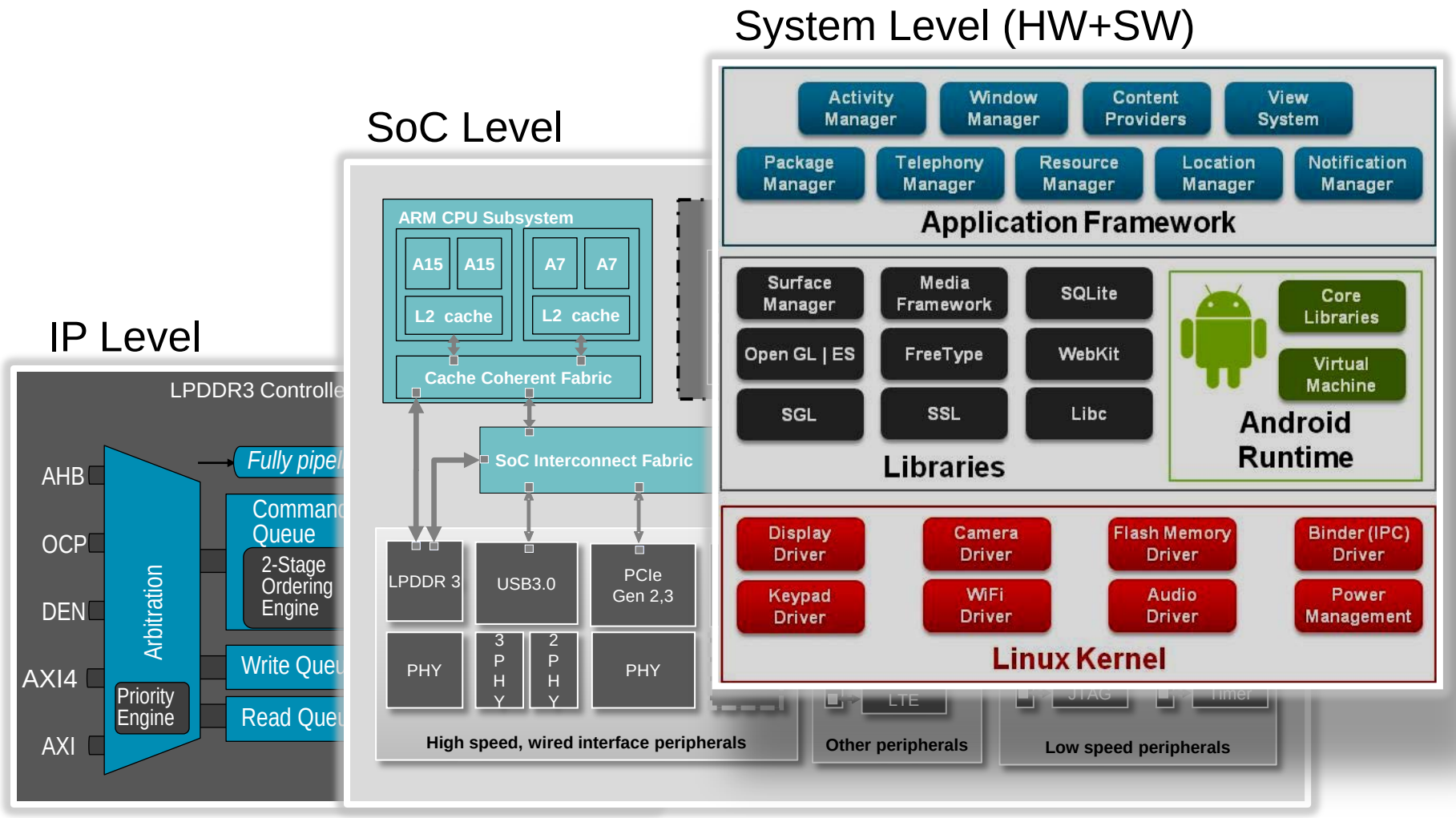
Many New Mobile Protocols

New protocols enable advancement and drive need for advanced verification IP



Full Product Verification

Each development stage has unique VIP requirements



IP Verification Challenges

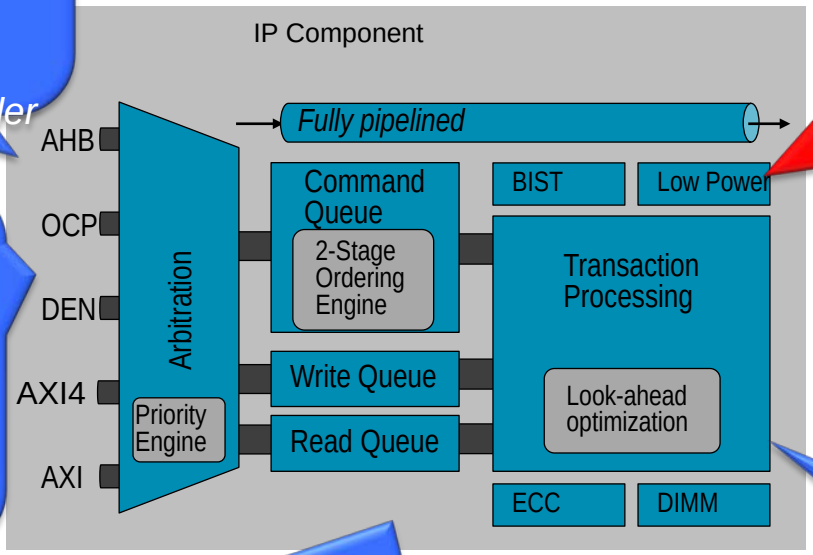
Custome

"My 3rd party SLIMbus IP was shipping in silicon, but it still had bugs. My application was different than the others. I wish I had done my own compliance checking."

- Cellular SoC Provider

"Our SATA controller has to talk with my competitor's chip. They deviate from the spec but I still have to make it work. I need to make sure my chip will handle non-compliance gracefully."

- Leading Hard Drive Company



"The UFS spec is not fully baked, but if we delay development we'll be late to market. I need early access to memory models and rapid incorporation of spec updates."

- Mobile Device OEM

"Moving from SATA 3G to SATA 6G cost me 2 engineers for 6 months to develop the VIP. Protocol expertise is an expensive commodity."

- Storage Chipset Leader

"Our IP blocks connect via an OCP fabric. The verification team is short handed so the designers need to catch some of their own bugs. The assertion-based VIP we use really helps with that. The designers run a quick formal analysis to verify compliance. That speeds up our overall verification."

- Leading DSP Company

"I'm developing a USB3 device. We know there will be a number of bugs. I need stable VIP that works. I can't afford to debug that too."

- Mobile SoC leader

SoC Verificatio

Customer feedback

"The protocol interfaces are only half the problem. My memory interfaces are just as complex. I need to make sure they will work, regardless of the memory vendor my customer uses."

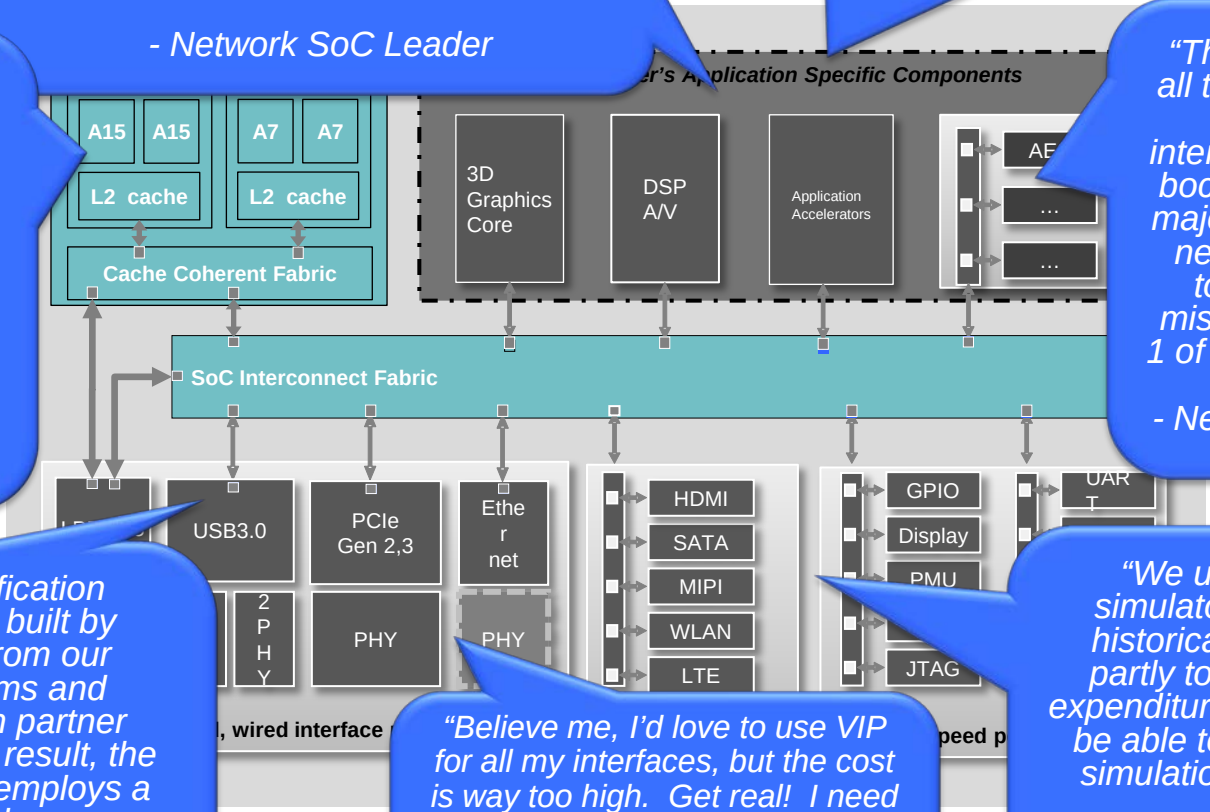
- Major Server Developer

"My chip is big. Simulation is orders of magnitude too slow for functional coverage collection. The best I can do is run toggle tests."

- Network SoC Leader

"My SoC has a multi-core CPU, but so does my competitor's. We can't beat their performance with SW-based cache coherency. We need to manage coherency in HW. We need VIP that understands this."

- Mobile Chipset supplier



"The IP blocks are all tested. I need to verify the interactions between bocks. There are 8 major interfaces that need to be tested together. If I'm missing VIP for any 1 of those, I'm toast."

- Networking Leader

"The SoC verification environment is built by contributions from our worldwide teams and sometimes from partner companies. As a result, the testbench often employs a mix of verification languages and methodologies. That's just reality."

- Global Semi Provider

"Believe me, I'd love to use VIP for all my interfaces, but the cost is way too high. Get real! I need licensing that matches the needs of SoC verification."

- Server SoC Start-up

"We use a mix of simulators, partly for historical reasons an partly to optimize our expenditures. We need to be able to utilize all our simulation resources."

- Communications Chipset Company

The System Verification Problem

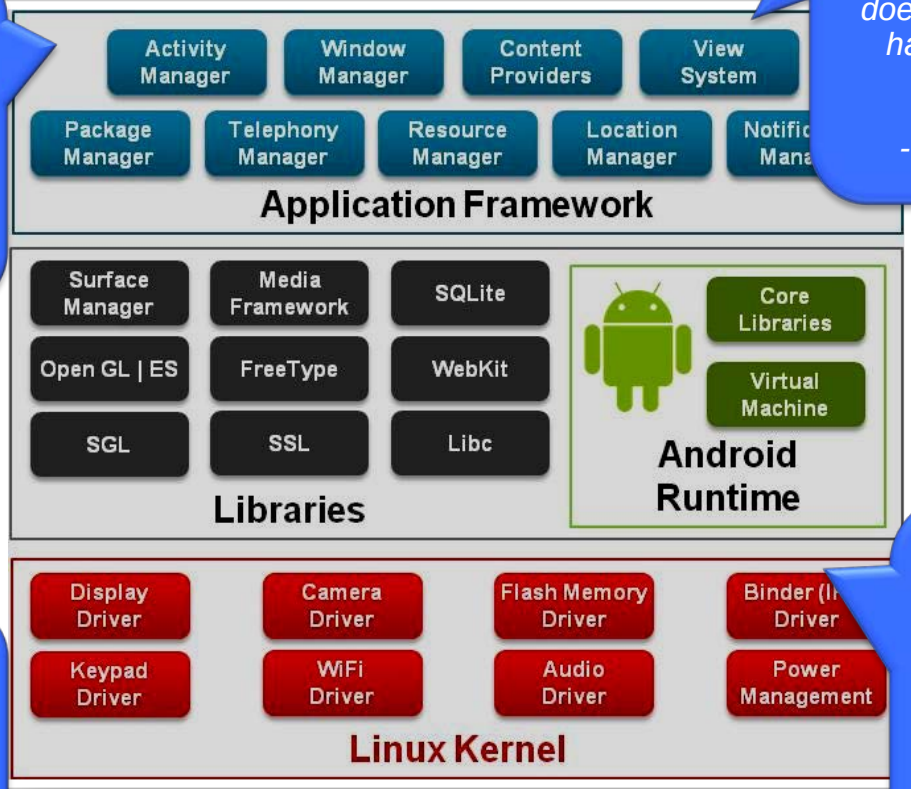
Customer feedback

"We do it all the analysis we can - system modeling, RTL simulation, simulation acceleration, emulation, and prototyping. Each fills a need, but each is incomplete by itself."

- Global Telecomm Co.

"The hardware in my product is state of the art, but the software is what the customer sees. If it doesn't work flawlessly with the hardware, we'll drop market share – fast."

- Mobile Device Company



"Early HW/SW integration is a must. In the past it was a serial process that cost us 2 quarters in time to market."

- Applications Processor Leader

"The hardest bugs to find are the HW/SW corner cases. We spent 3 months in the lab to get rid of 2 bugs on one baseband processor. During that time we lost the customer."

- Baseband SoC Provider

UFS overview

What is UFS?

- Next generation flash storage that provides the low power of eMMC with the high performance of SCSI SSD
  - JEDEC Standard JEDS220

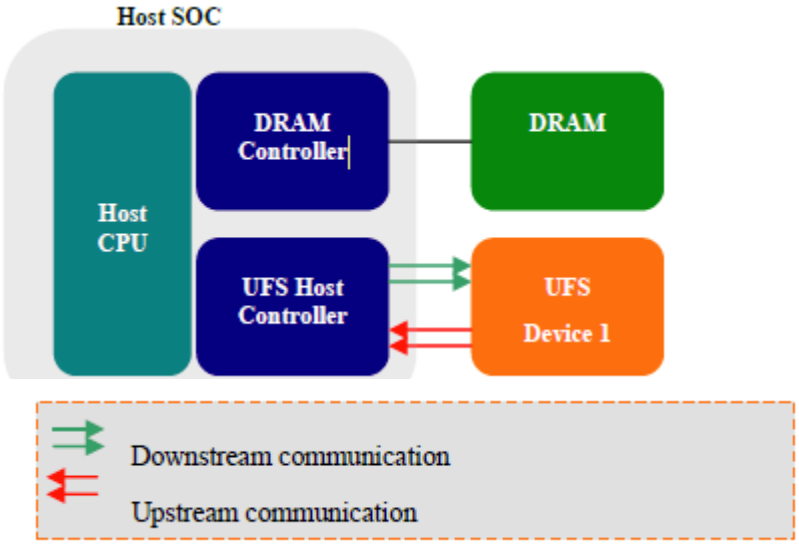


Figure 10-1 — UFS System Diagram

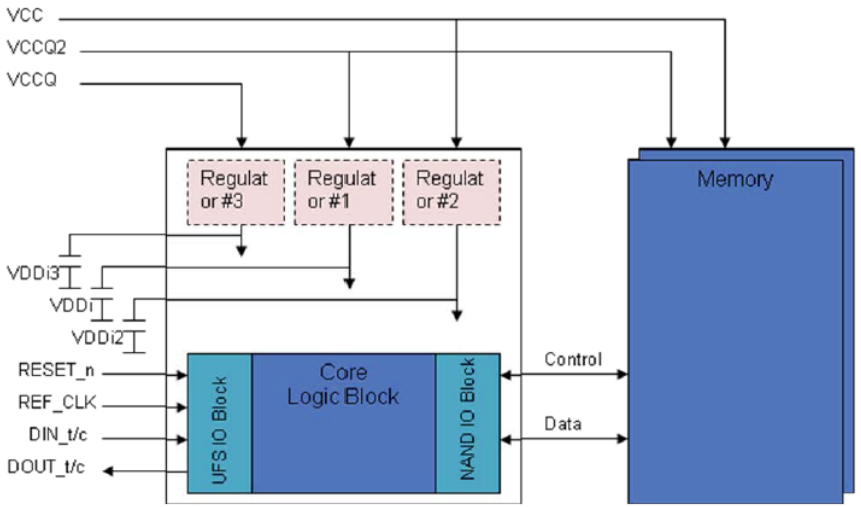


Figure 3-1 — USF Device Block Diagram

UFS overview

What is UFS?

- Built on MIPI interface standards, M-PHY and UniPro, for interconnect layer
  - For UFS, UniPro stack treated as a black box to maximum extent

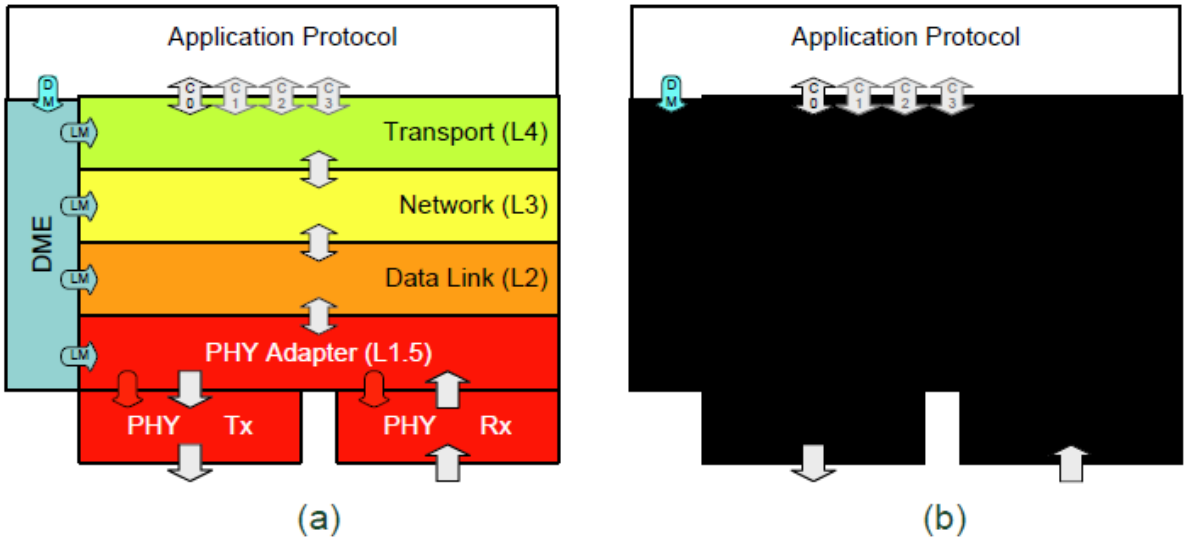
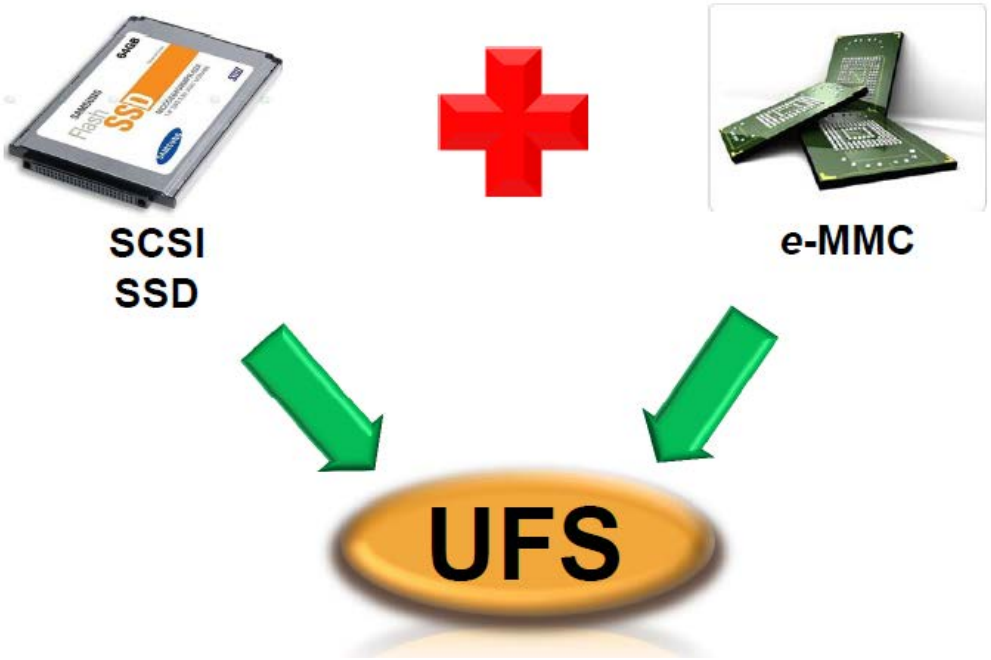


Figure 6-1 — UniPro internal layering view (left) and UniPro Black Box view (right)

UFS overview

What is UFS?

- Two form factors
  - Embedded SSD
  - SD Card



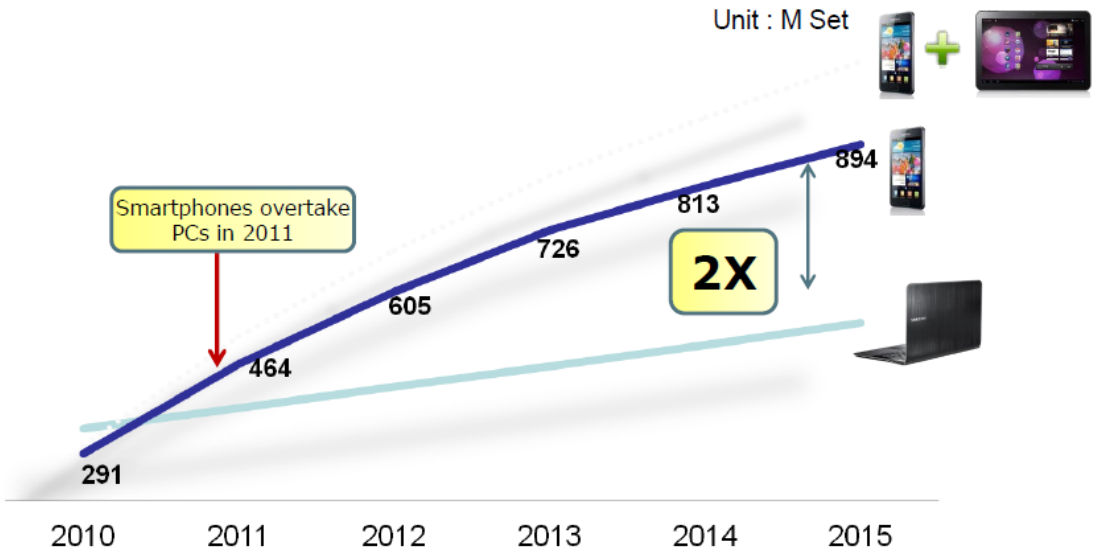
UFS overview

Why Is UFS Important?

– Mobile Device demands are driving new requirements

● **We're going *'Mobile!'***

• From '11, Smart-phones overtake PC Shipments and Tablets will add to the gap significantly

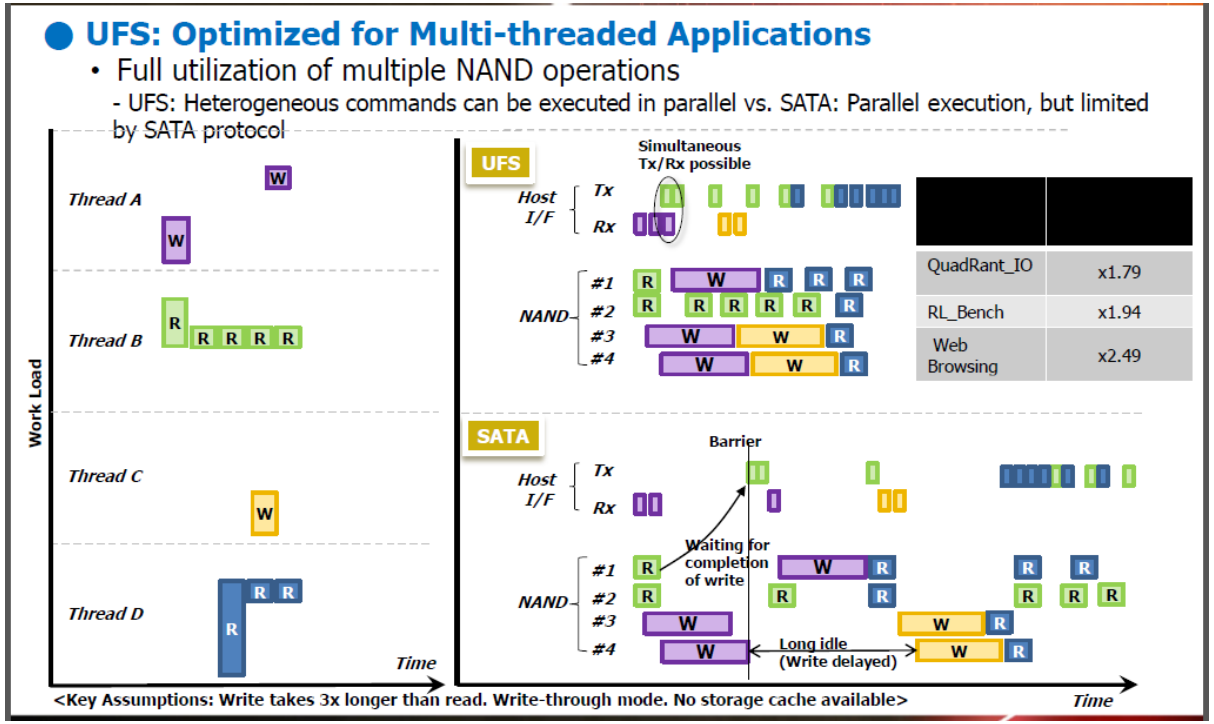


Source: Samsung Marketing, 3Q11

UFS overview

Why Is UFS Important?

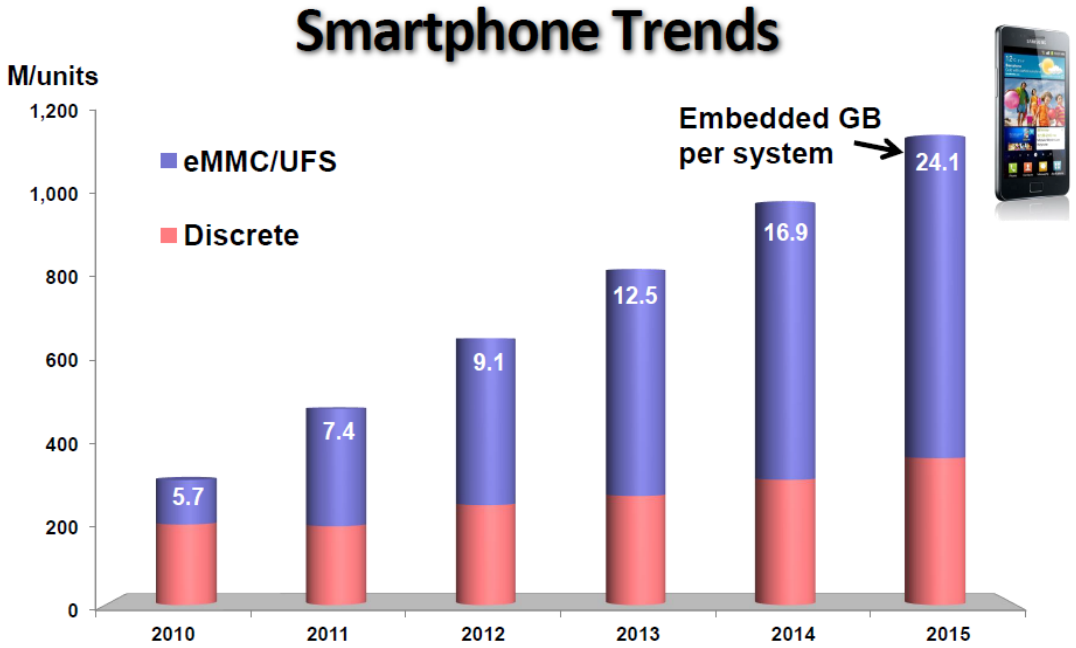
- Mobile Device demands are driving new requirements
  - Higher computing demands
    - Dual Core
    - Multi Core



UFS overview

Why Is UFS Important?

- Mobile Device demands are driving new requirements
  - Higher Storage Capacity

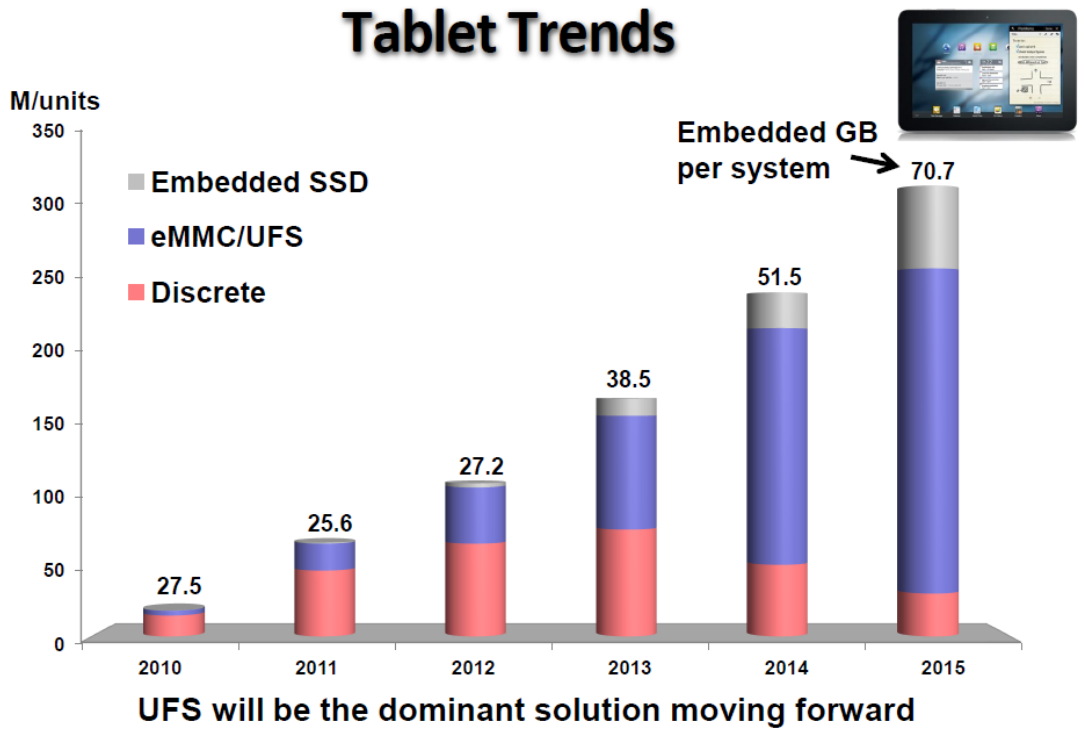


Source: Gartner December, 2011
"Forecast: Semiconductor Consumption by Electronic Equipment Type, Worldwide, 4Q11 Update"

UFS overview

Why Is UFS Important?

- Mobile Device demands are driving new requirements
  - Higher Storage Capacity



Source: Gartner December, 2011
"Market Trends: Media Tablet Functionality Forces Flash Storage Evolution"

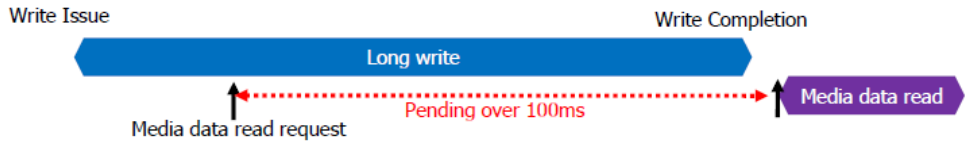
UFS overview

Why Is UFS Important?

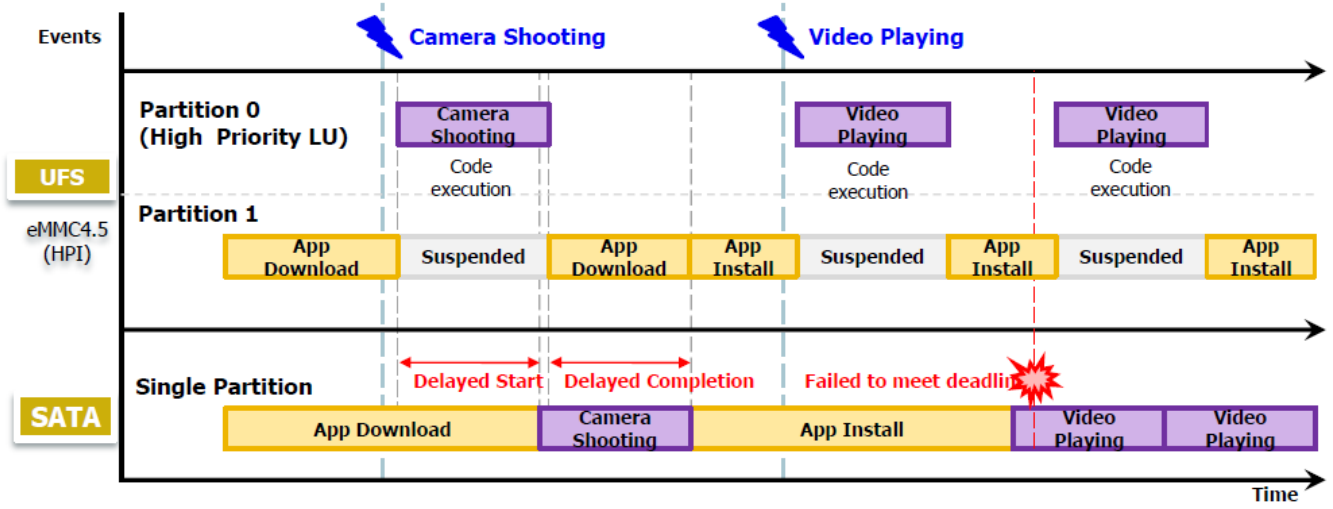
- Mobile Device demands are driving new requirements
  - Lower Latency and High IOPS

UFS: Time-critical Applications

- Worst UX: Request delay due to Storage Write Busy



- Better User Experience: High Priority LU for time-critical application



UFS overview

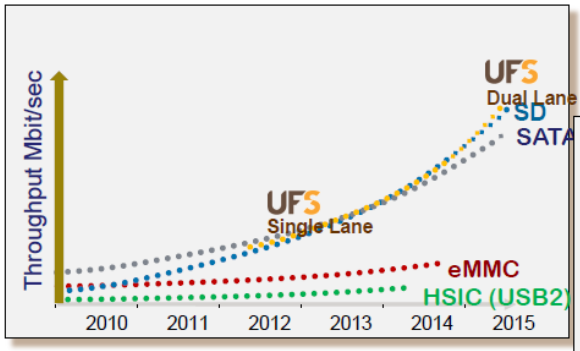
Why Is UFS Important?

- Mobile Device demands are driving new requirements
  - Higher Bandwidth & High IOPS

UFS: High Bandwidth & High IOPS

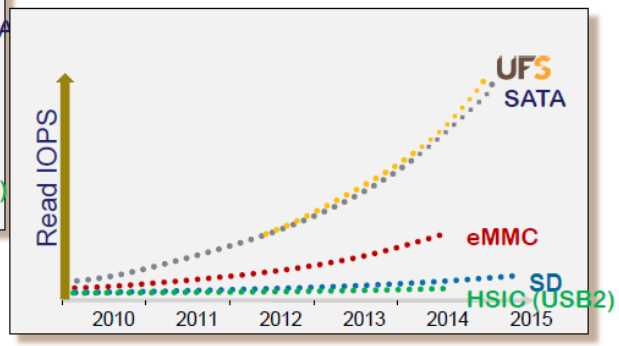
- Sequential Performance: Separate R/W channel + Scalability by/through Multiple Lanes (x1/x2/x4) and Gears (3.0Gbps, 6.0Gbps)
- Random Performance: Asynchronous Protocol (Command Queuing)

▪ Sequential Performance



UFSA Estimates

▪ Random Performance



UFSA : UFS Assoiaction

UFS overview

What are the details?

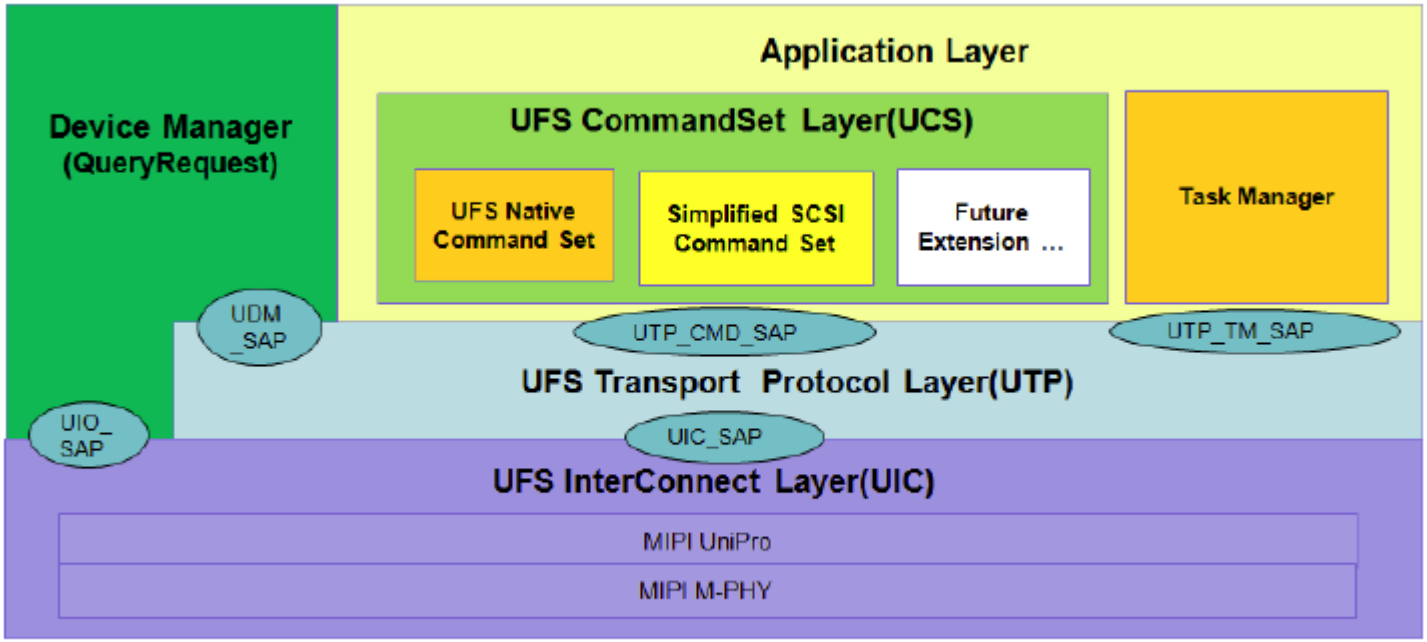


Figure 2-1 — UFS Top Level Architecture

UFS overview

What are the details?

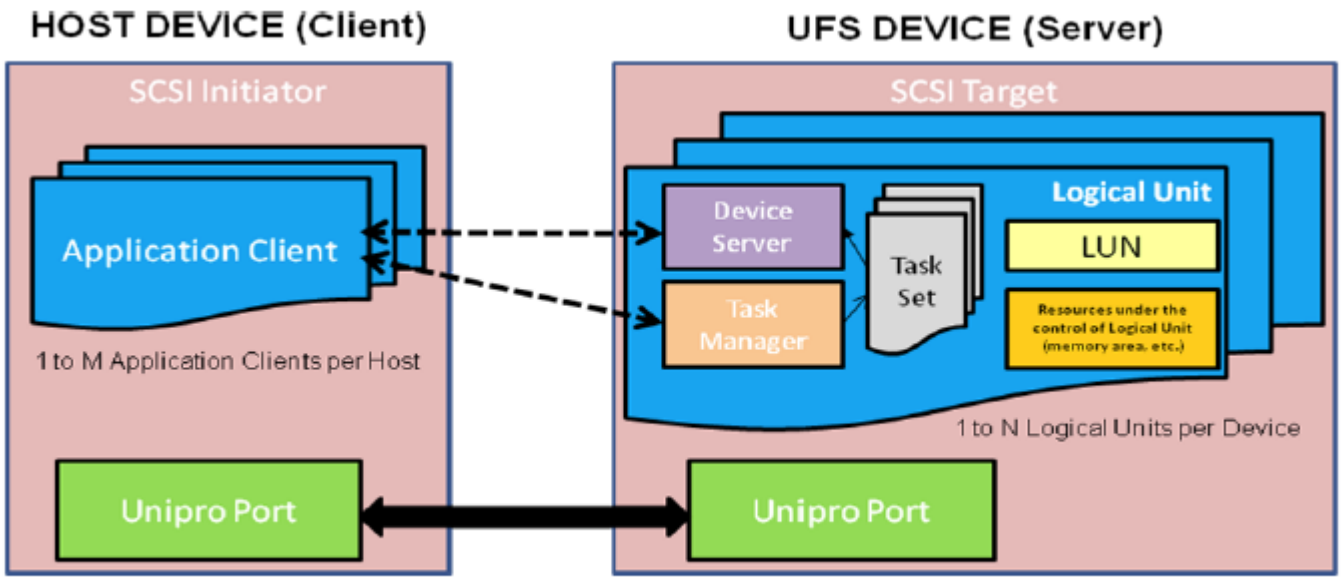


Figure 7-1 — UFS SCSI Domain

UFS overview

What are the details?

- Specified as Application layer on Unipro Protocol Stack
  - Multiple Layers
  - UCS layer
    - Uses SBC and SPC commands
  - UTP layer based on SCSI Architecture Model (SAM-5).
    - Command queuing
    - Multi-thread operations
  - UIC layer based on MIPI standard protocols
    - Interface and DME layers using MIPI Unipro protocol
    - Physical layer based on MIPI M-PHY

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