"High Performance Future Mobile Storage Requirements & The Importance of Random Operations"

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Santa Clara, CA USA
August 2009

(The information contained herein is subject to change without notice)

Definition

Handset , handheld, mobile devices are referred those such as Netbook*, MID, PMP, Mobile Phone, Smart Phone, Smartpad that consist of *NAND Flash storage I/F as a storage solution*

Outline

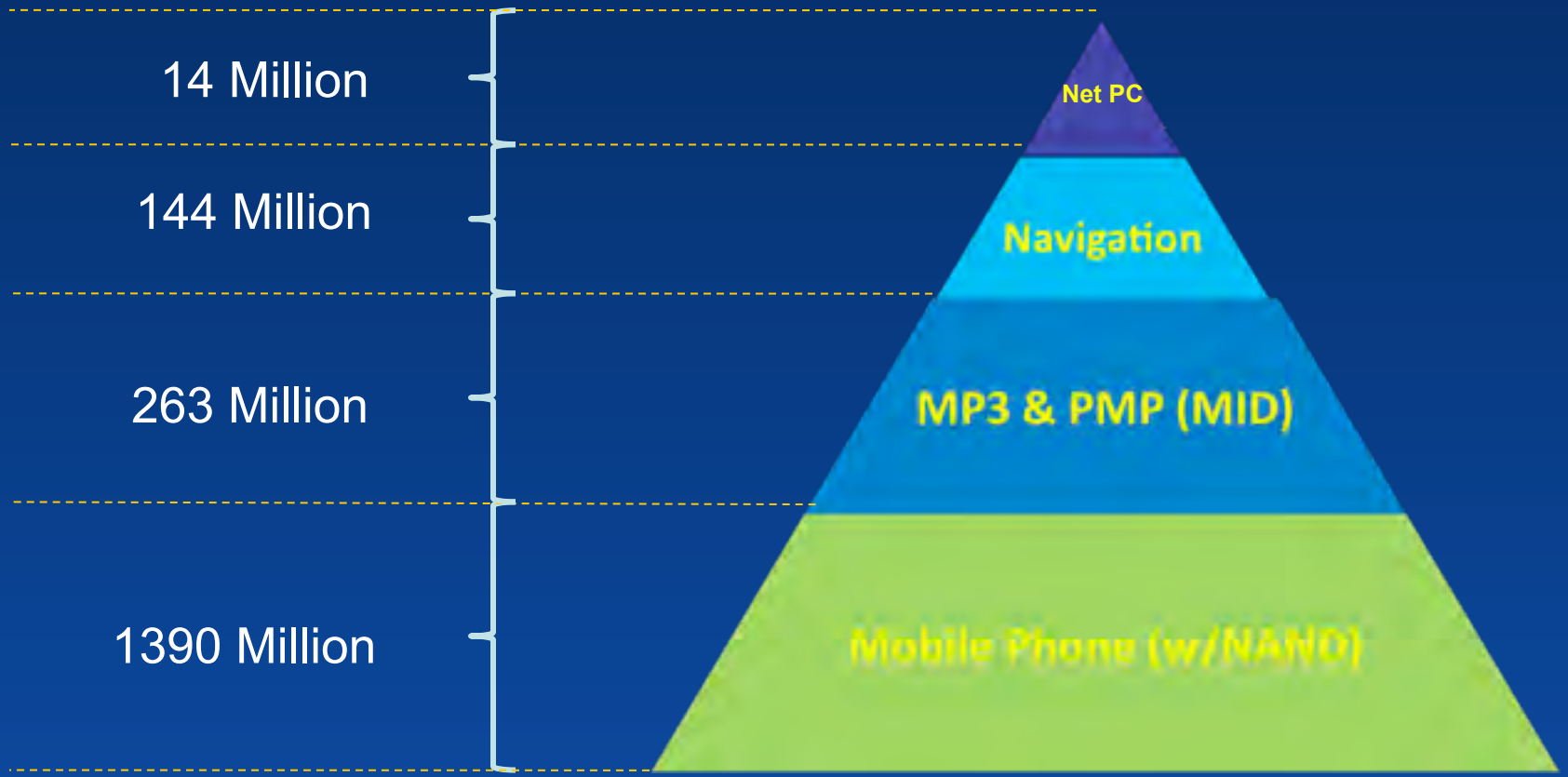
- Fact or Fiction
- Harry Potter & Sherlock Holmes
- The 3 𝔄's
- The Green Car
- True Lies
- Tinkerbell
- The $1 Question

Flash Memory SUMMIT

Fact or Fiction?

Market Opportunity

" TAM for Handheld mobile storage opportunity"



Based on TAM in quantity

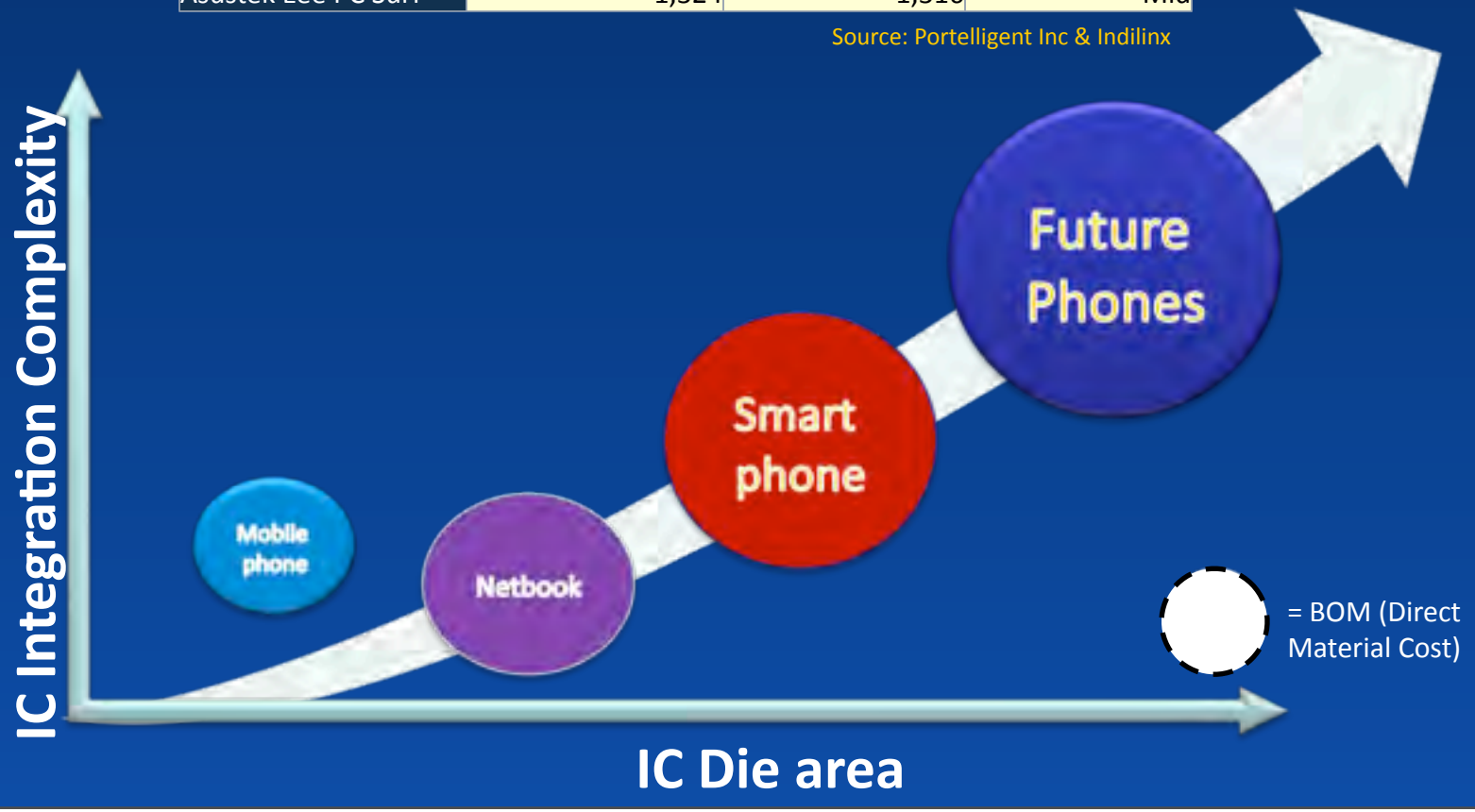
(Source: INDILINX, Strategy Analytics, Berstein analysis, & Samsung forecast)

Complexity Trend

The complexity of handset (mobile) devices

Cost and Complexity: Smart Phone vs. Netbook			
Product	IC die area (sq. mm)	Component Count	IC BOM Segment
Original iPhone (2007)	1,542	783	Mid-High
iPhone 3G (2008)	1,768	1,016	High
Asustek Eee PC Surf	1,324	1,316	Mid

Source: Portelligent Inc & Indilinx

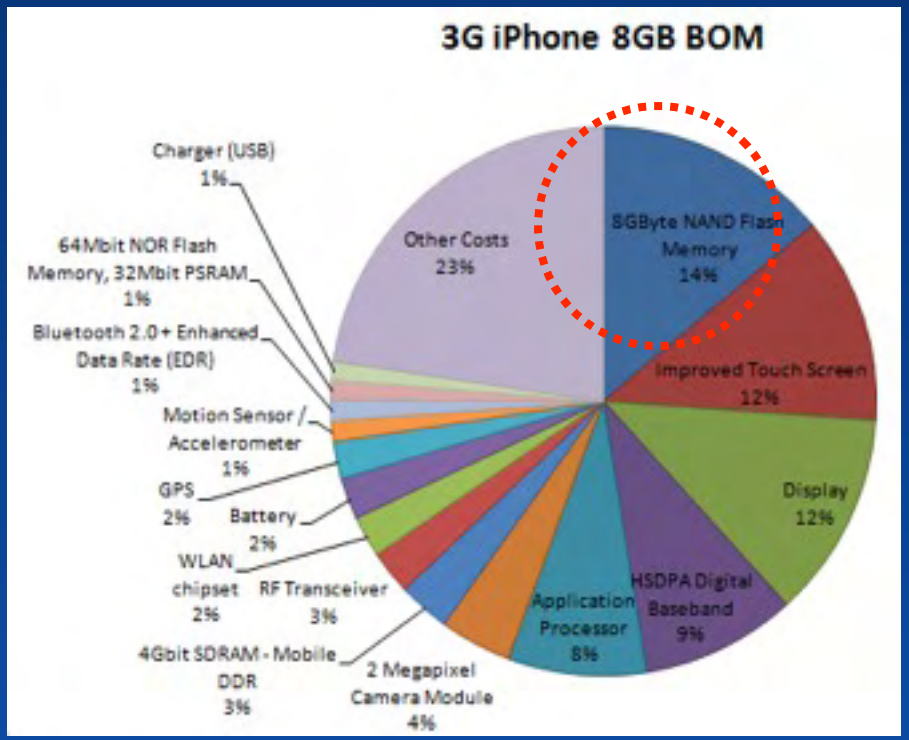


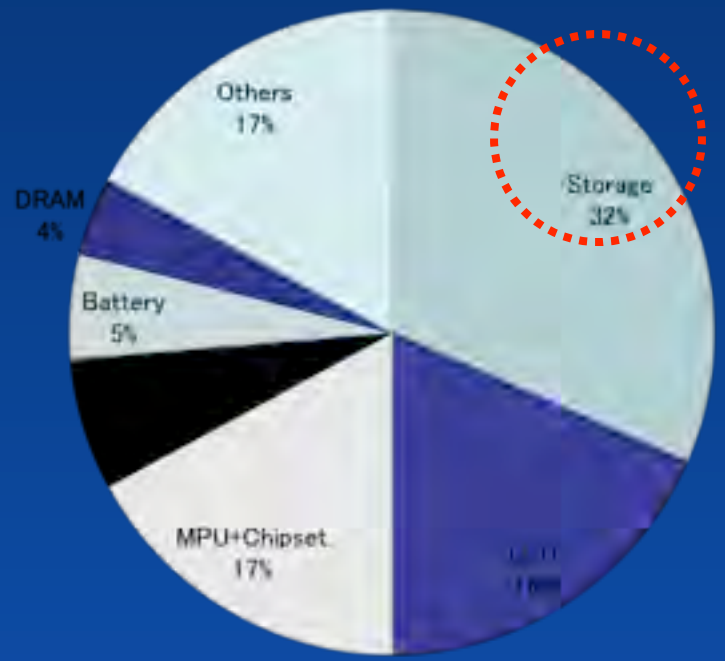
Power - Interface

Handheld devices demand strict power requirements

Mobile Device BOM Analysis

"The Handset/Mobile storage is the highest portion of BOM with the least bandwidth"

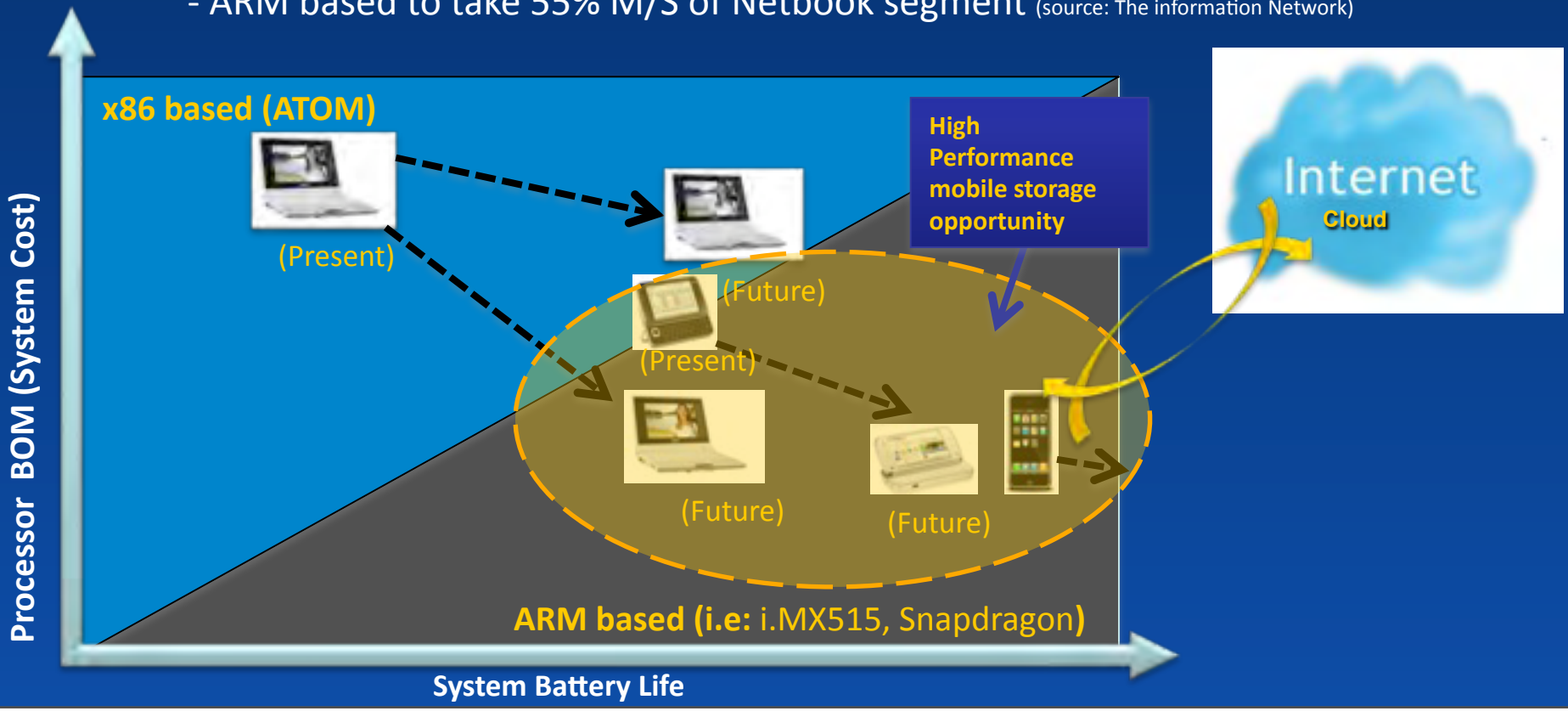




Source: isupply, Sandisk, Portelligent, & Indilinx

The Trend

- New trend in computing: Netbook, Smartbook, MID…
- Application run from web server -> Cloud Computing
- ARM deployment in Netbooks/MIDs
- Convergence of MID to high-end Smartphone
- Mobile devices getting smaller with increased design complexity
- ARM based to take 55% M/S of Netbook segment (source: The information Network)



Paradigm Shift of Handset/Mobile Phones

OS

CPU

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OS

CPU

Flash Memory SUMMIT

Harry Potter & Sherlock Holmes

An Example – old era

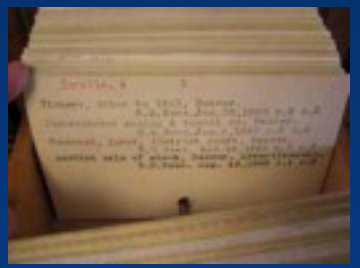
Random Search slow process

Indexing shows the location

But how many times readers go through the same category of books?

An Example – old era

Random Search slow process



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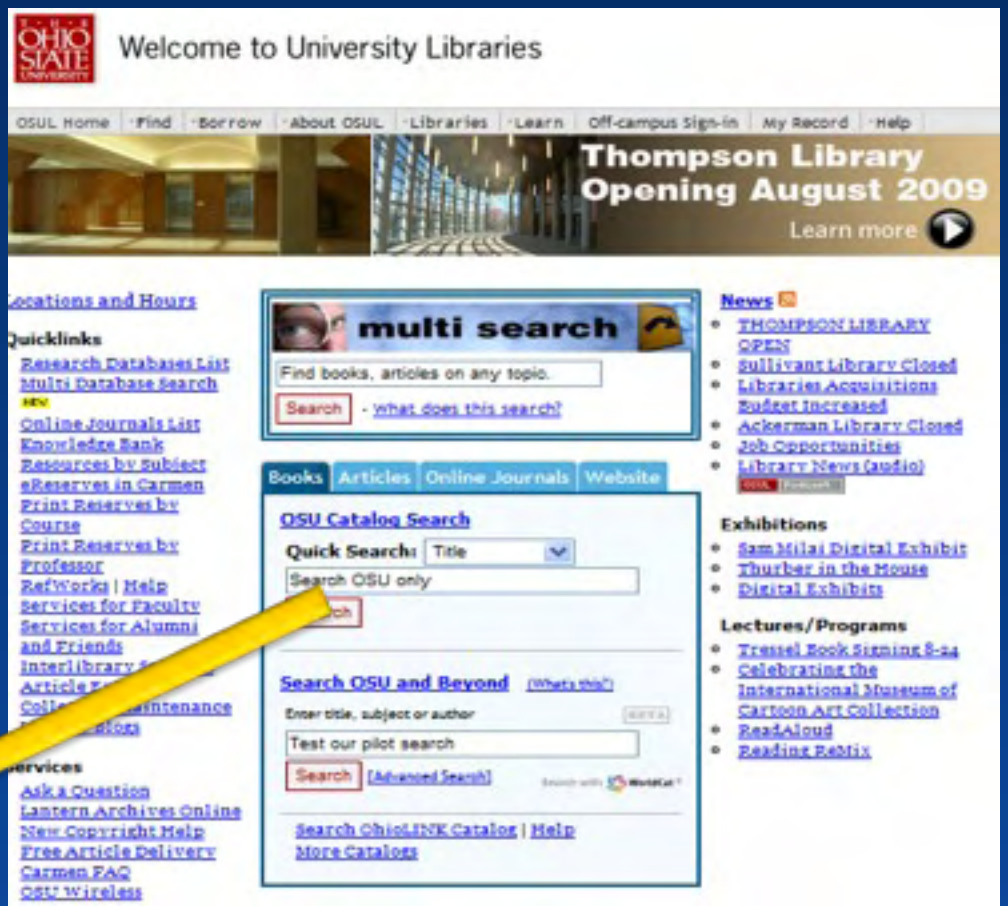
But how many times readers go through the same category of books?

An Example – new era



Most of the users seek books randomly in daily livess

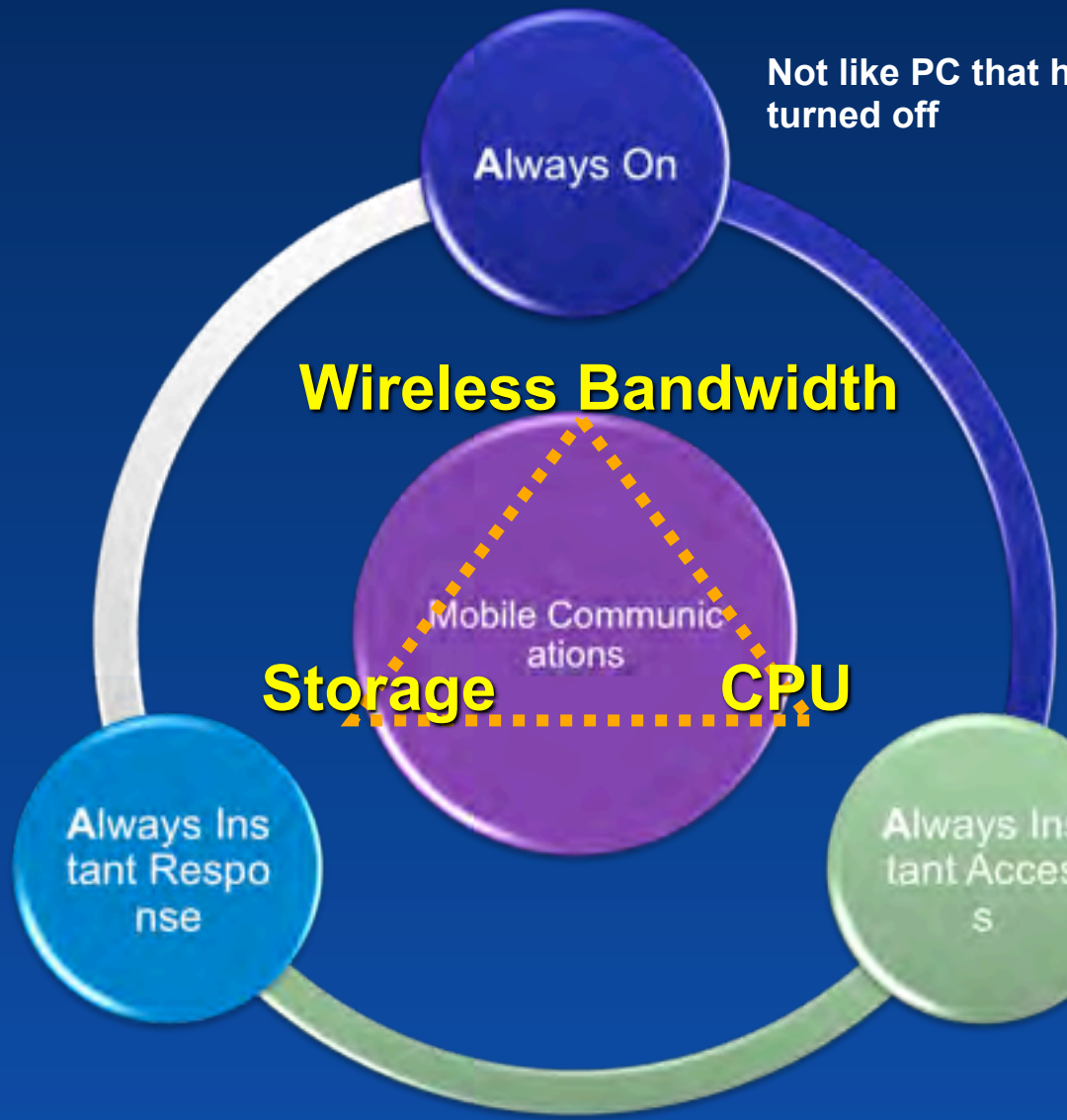
The 3 A's

Not 

Not 

Not 

The 3 A's



Not like PC that has to be turned off

Fast feedback

High wireless bandwidth, CPU, high performance storage will enable instant access

Historical Trend – CPU & Wireless

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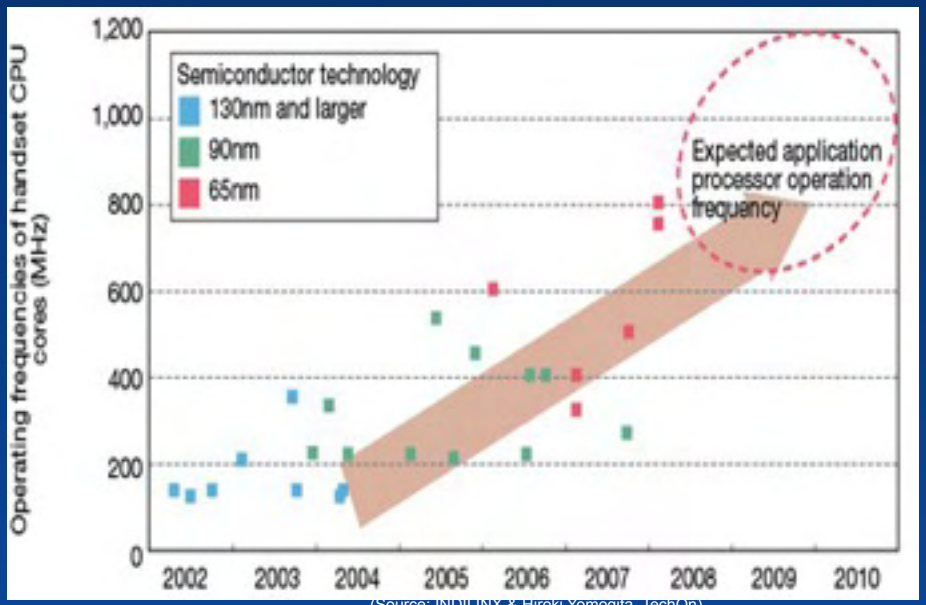
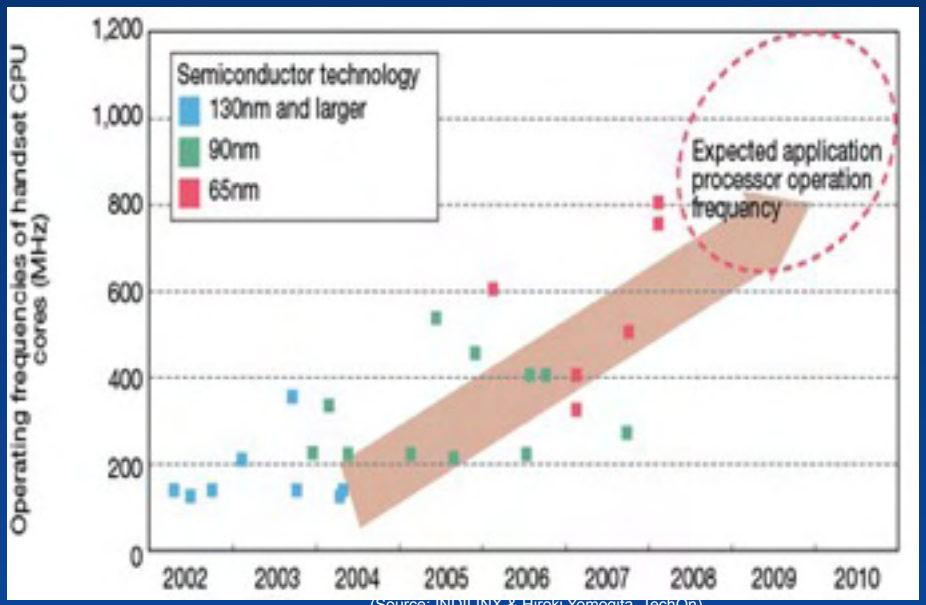
2002 – 2010 Handset CPU Core Operating Frequencies

Historical Trend – CPU & Wireless



(Source: INDILINX & Hiroki Yomogita, TechOn)

Historical Trend – CPU & Wireless



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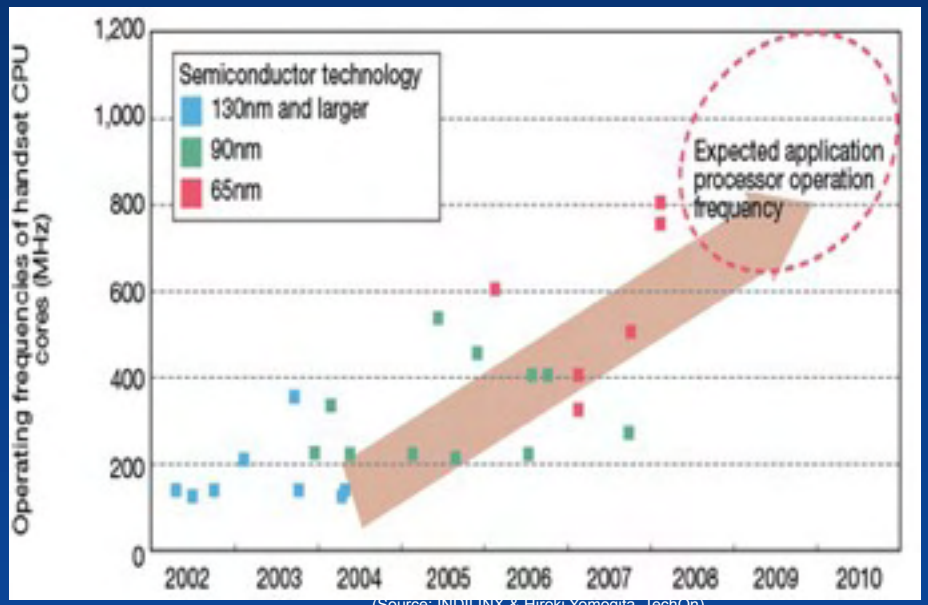
1980 – 2010 Handset Wireless Average Throughput

Historical Trend – CPU & Wireless



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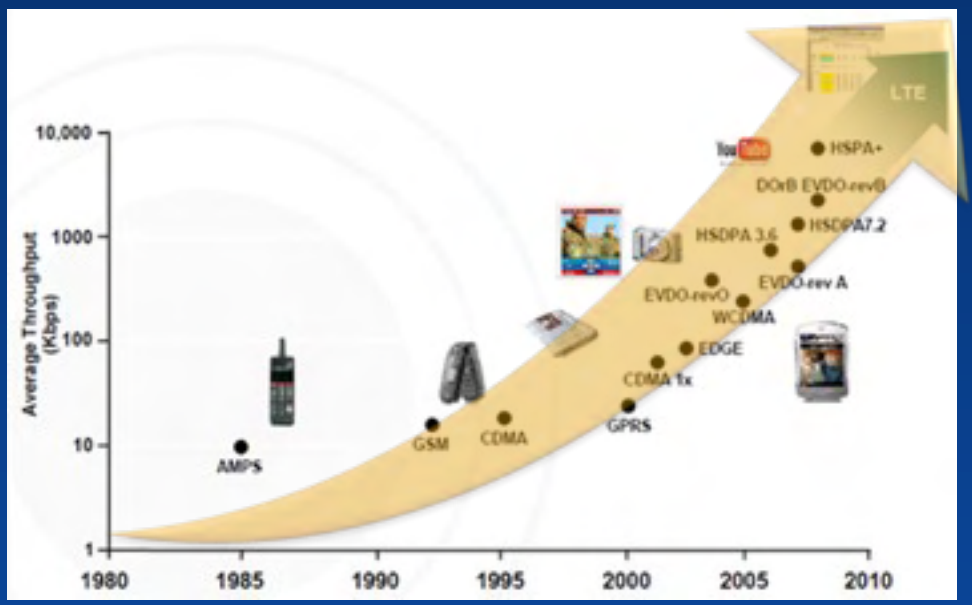

(Source: INDILINX & Qualcomm)

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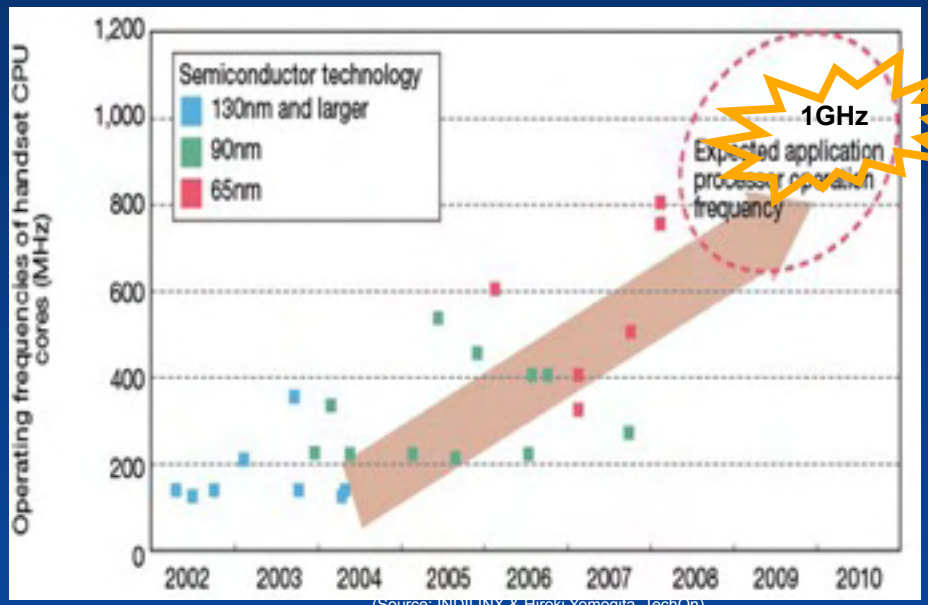

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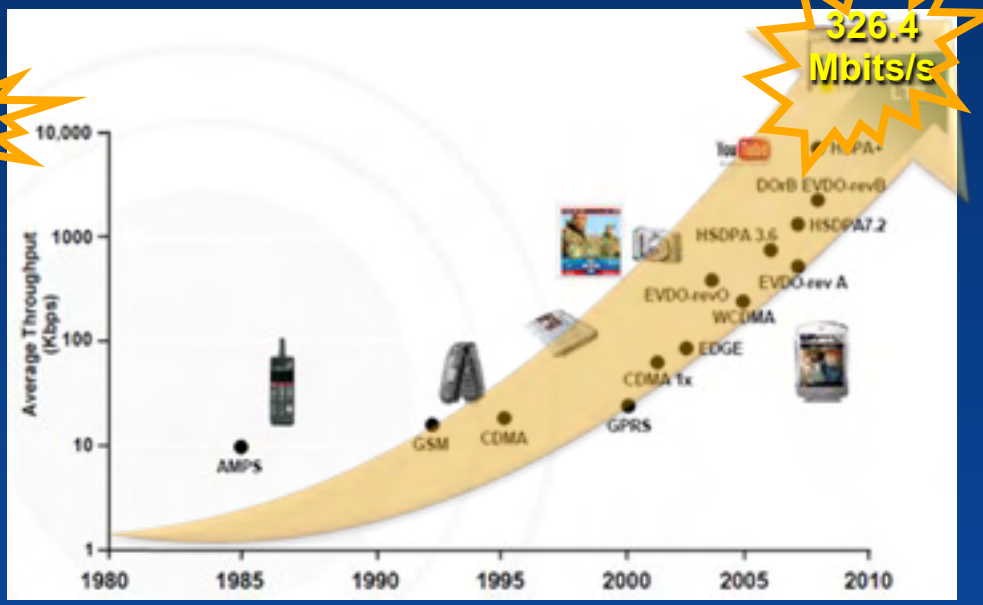

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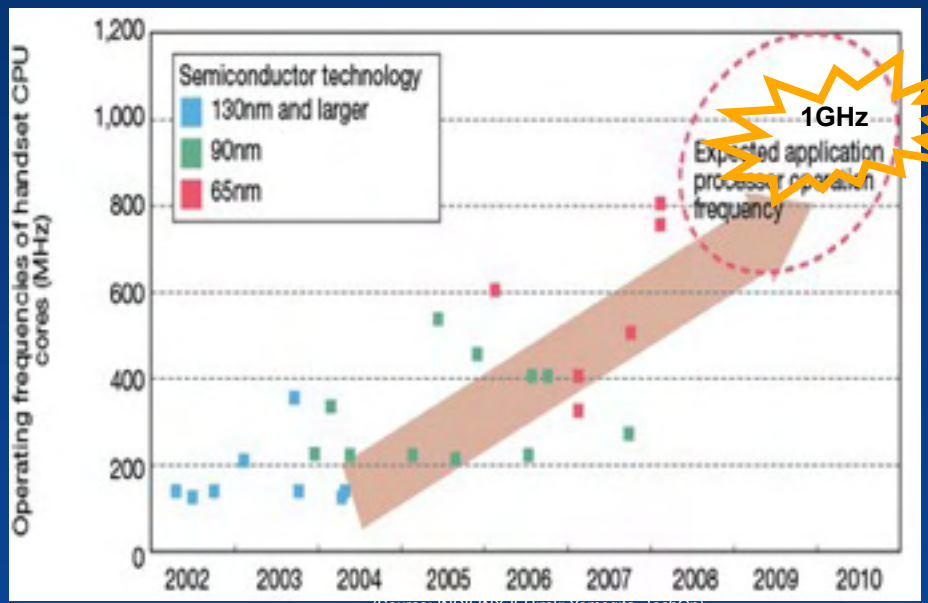

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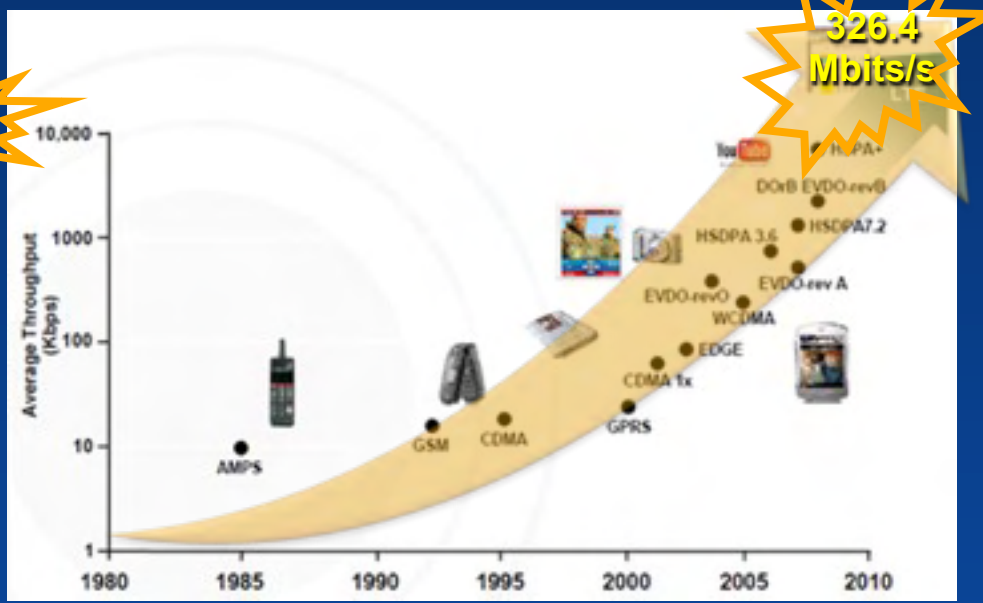
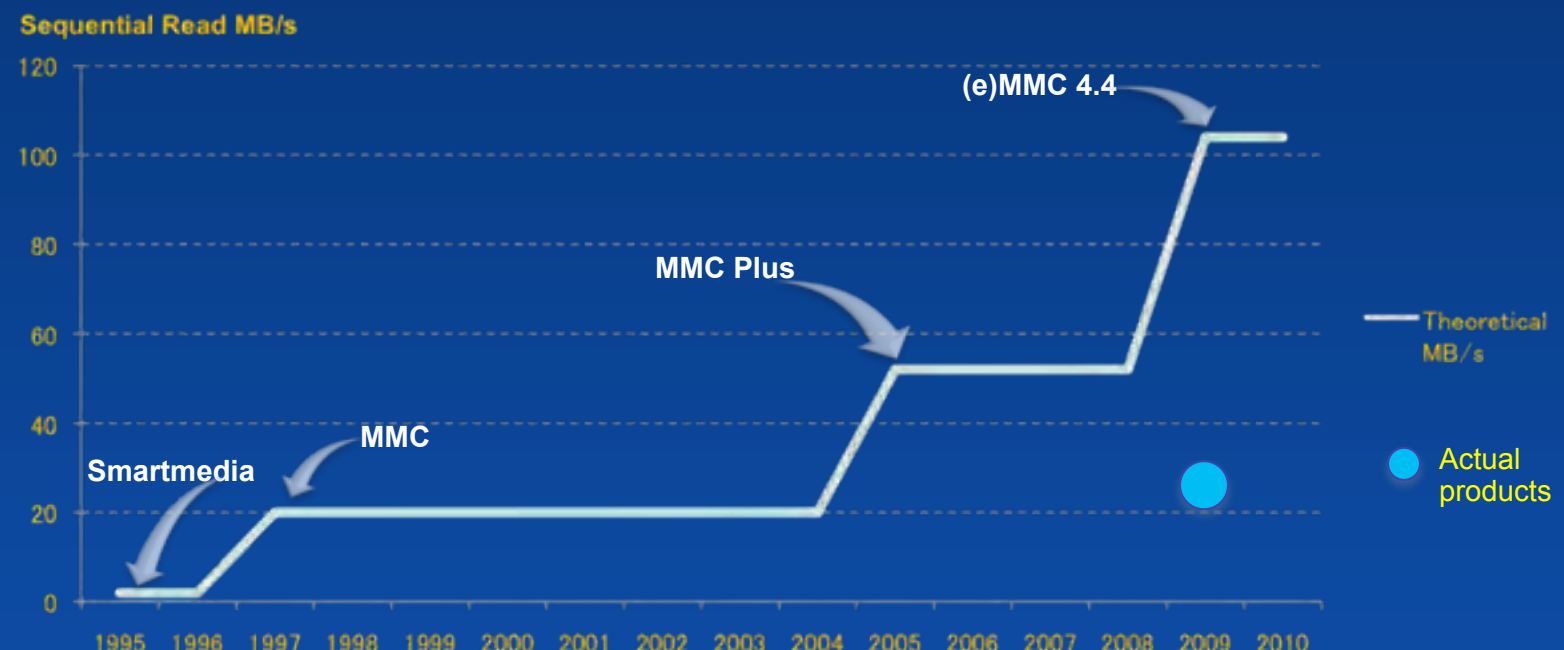


(Source: INDILINX & Qualcomm)

How about handset storage devices?

Historical Trend – Handset Storage

- Actual performance of handset device storages lag far behind the theoretical transfer rate
- Currently most of the handset storage devices optimized for sequential operations -> Poor Random
- Need to close the gap of theoretical bandwidth for both sequential & random operations



(Based on SmartMedia & MMC products)

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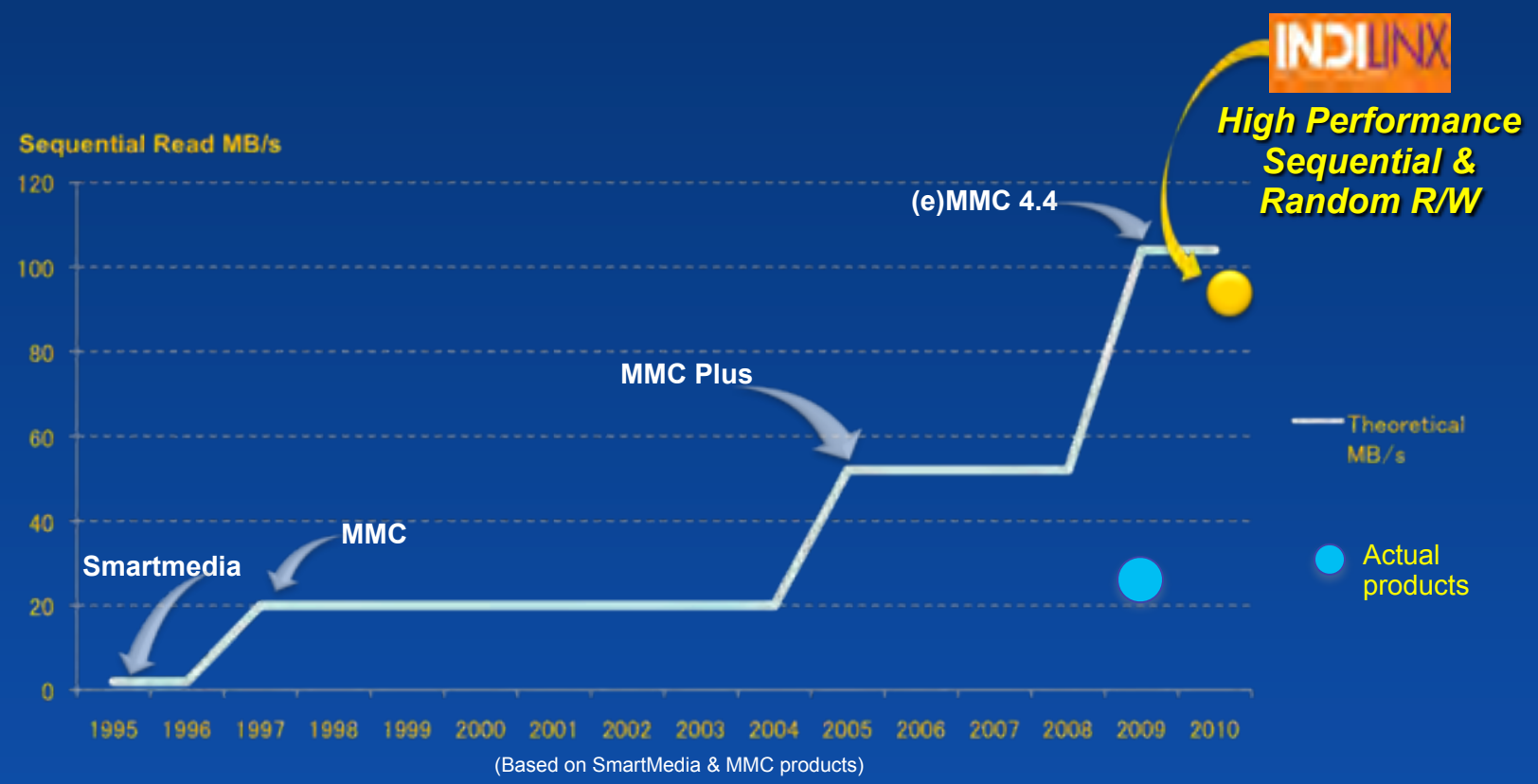
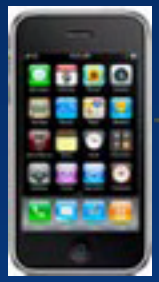


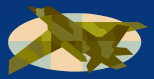
The Green Car

The Green Car



Simple Block Diagram

Are we happy with the Green Car?



LPDDR1
LPDDR2

NAND
Handset
Storage

Based on LPDDR1/LPDD2
(estimated > 2GB/s)

Transceiver

Digital
Baseband
Processor

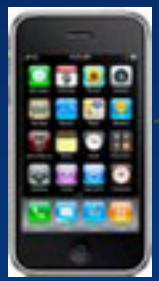
Applications
Processor

USB

Audio
Codec

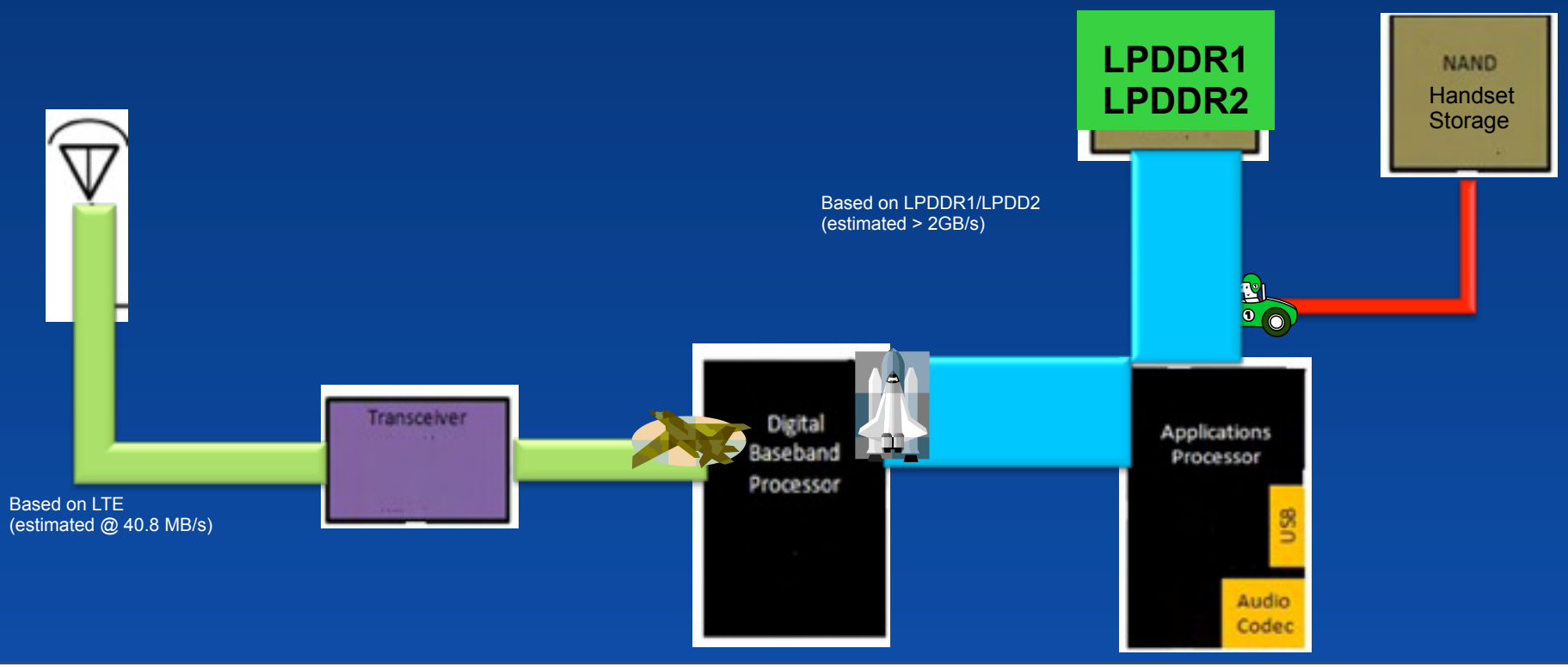
Based on LTE
(estimated @ 40.8 MB/s)

The Green Car



Simple Block Diagram

"Let's tow away the Green Car"



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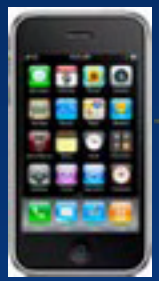

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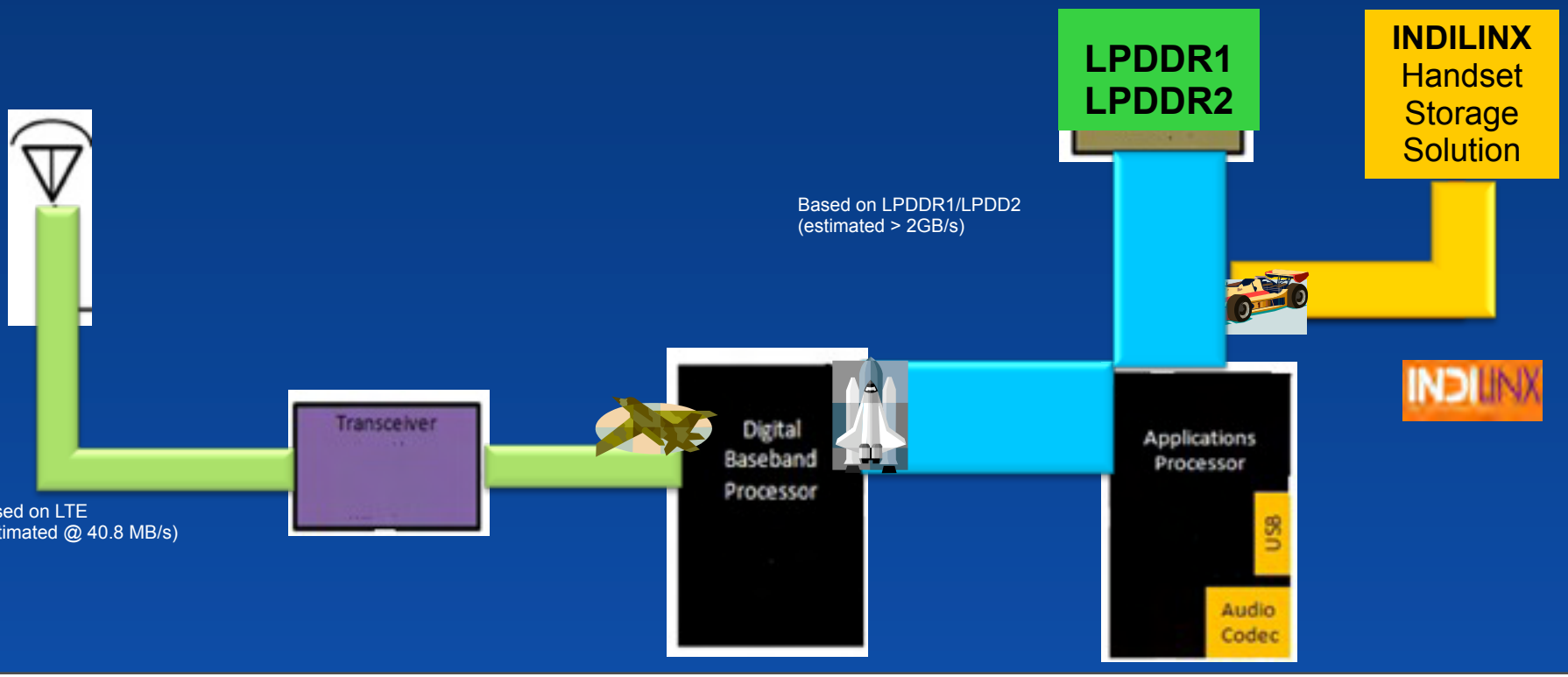


Few Prospective Applications

- Location Based Service & Online Social Network
  - GPS + Digital Compass
- HDTV
  - High performance Codec (inside AP)
    - Pixel count: 1920x1080 pixels (1080p)
    - Frame rate: 30 to 60 frames/s
    - Encoding: multiple such as H.264, MPEG-4, VC-1

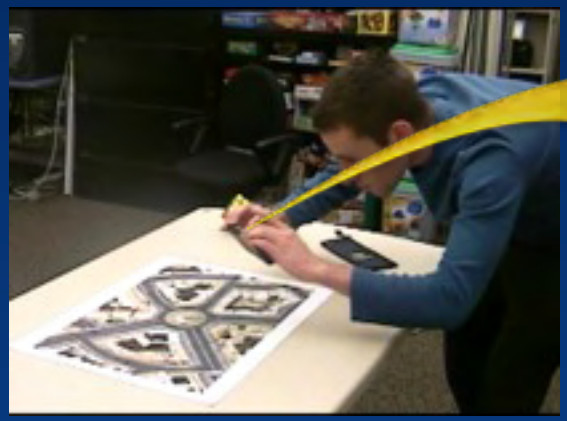
178 MB/s @ 24-bit color mode, 30FPS (raw data)

- Games + Augment Reality + Flash Player
  - High performance GPU (inside AP)
    - Polygon draw rate: over 10,000 polygons/s
    - Pixel draw rate: over 200 million pixels/s

17 GB/s @ 24-bit color mode, 30FPS (raw data)

(Source: INDILINX, Hiroki Yomogita, TechOn)

ARhrrrr!



- Shooting Game using Mobile Camera Devices
- Merges graphics with physical world by overlaying 3D
- Nvidia Tegra platform

http://www.augmentedenvironments.org/lab/research/handheld-ar/arhrrrr/

User perception

The overall system level performance improvement will benefit the customers in the following ways:

- ~10% increase is noticeable
- ~20% is very noticeable
- ~30% is significantly noticeable

The overall system level performance are mainly due to:

- Time to productivity
- Application response
- Data movement

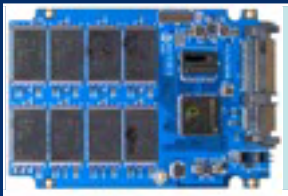
In general customers **do not want to wait** in front of they computer devices -> Faster productivity

(Source: Munif Farhan, DELL Inc.)

True Lies

Solid State Random Performance?

	Read	Write
Sequential	✓	✓
Random	✗	✗

	Read	Write
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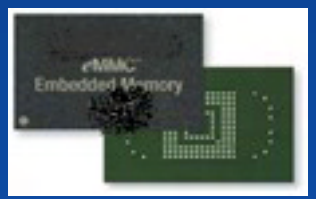
How about Solid State Storage Devices (not Solid State Drives)



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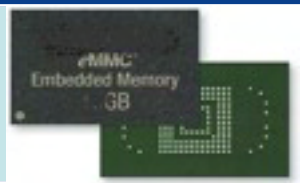


	Read	Write
Sequential	✓	✓
Random	✗	✗

Need for High Performance Storage & Random I/O

The need for high performance Random Operation in Storage Devices

- *Outstanding random operations* will help the performance on windows 7

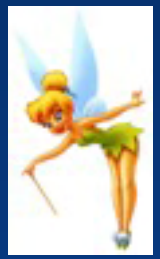
-Pagefile:

Pagefile operations are ***mostly small random reads*** or large sequential writes
Pagefile.sys read to write ratio = 40 to 1
Pagefile.sys read size of =< 4KB ~ 67%

- PC applications such as constant internet search, Email applications, Instant Messaging, Games require high performance Random I/O (r/w)

- Handset system Boot Code, File System, OS requires high performance Random I/O (r/w)

(Source: Engineering Windows 7, MSDN Blog, SandDisk, Intel)



Tinkerbell

Tinkerbell

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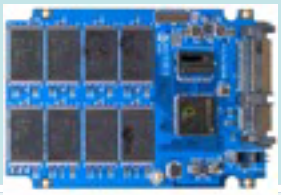	Read	Write
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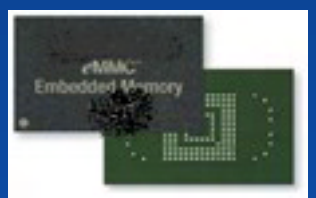

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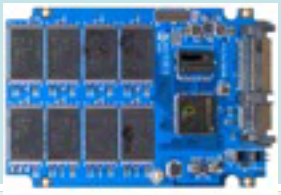	Read	Write
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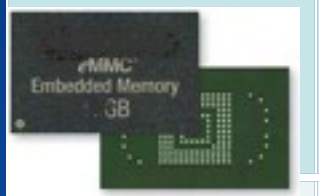	Read	Write
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Tinkerbell

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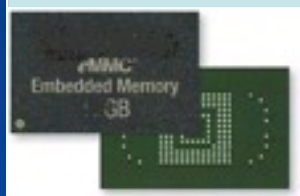	Read	W
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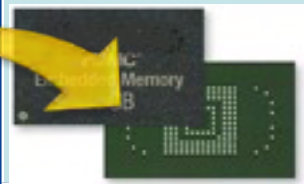
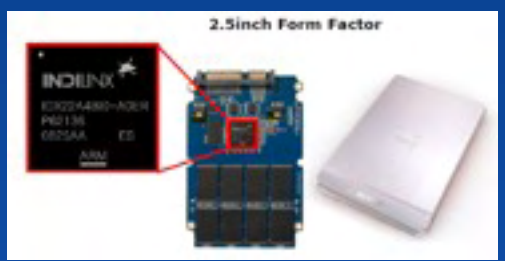
	Read	Write
Sequential	✓	✓
Random	✓	✓

The sky is the limit?

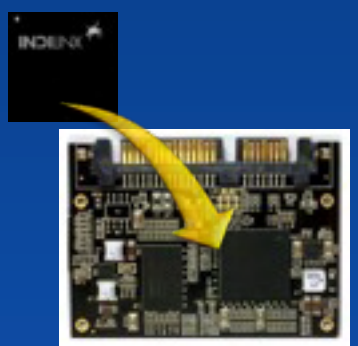
- Moving forward, INDLINX will change the dynamics of storage in the handset/ mobile spaces -> Change the paradigm of mobile device usage

- INDILINX is currently developing High performance (e)MMC 4.4 controller (Tinkerbell) that are to be used in Handset/Mobile systems such as Smartphone, MID, PMP, Netbook, Smartbook...

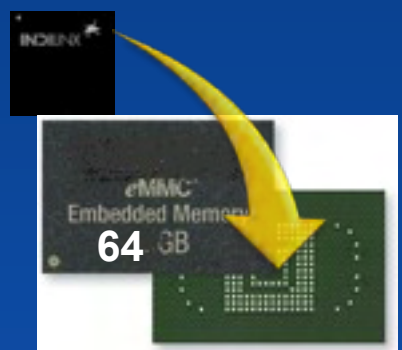
- INDILINX will dictate the change on how consumers use the handset/mobile devices such as Smartphone as an ordinary computer



INDILINX Barefoot Controller for 2.5”



INDILINX Amigos Controller for module



INDILINX Tinkerbell Controller for eMMC/UFS

The $1 Question

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What is common among these?

- Fact or Fiction
- Harry Potter & Sherlock Holmes
- The 3 𝔄's
- The Green Car
- True Lies
- Tinkerbell

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These were *RANDOMLY* generated words and ideas