



Implementation Issues of Mobile Devices storage

Jay Lee
INDILINX

Mobile Phone Storage

- **Mobile phone storage 5 yrs ago: simple!**
 - **NOR/SLC NAND**
 - **SW FTL running in baseband**
- **MLC came, ECC in HW.**
- **Densities are growing.**
- **Different access pattern.**
- **TLC is coming**
- **eMMC to reduce the host burden.**

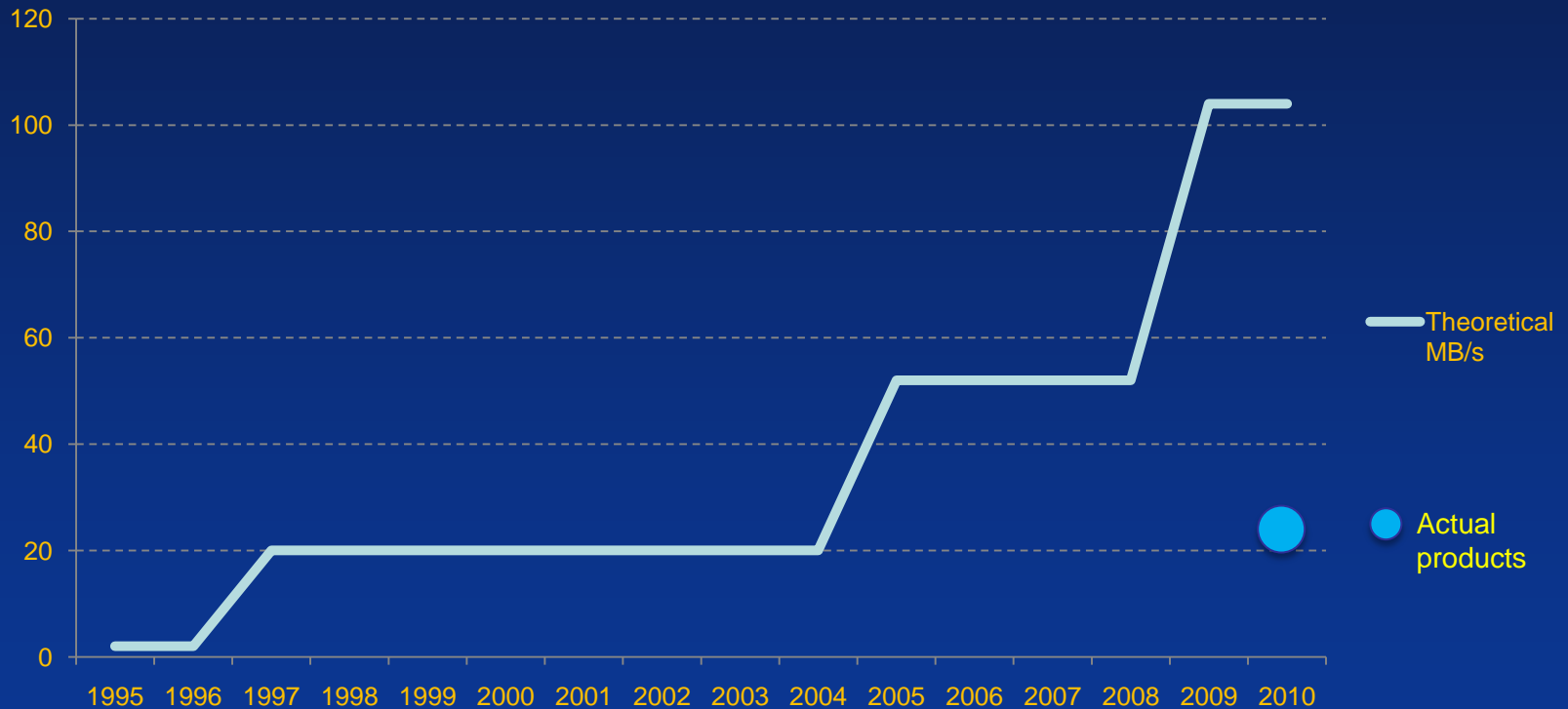


Aiming low..

- **Transfer rate \sim 20MB/s.**
- **Random IOPS $<$ 200**
- **Are these valid for high end phones**
- **Disagreed.**

Historical Trend – Handset Storage

Sequential Read MB/s





Consumer Experiences - Performance

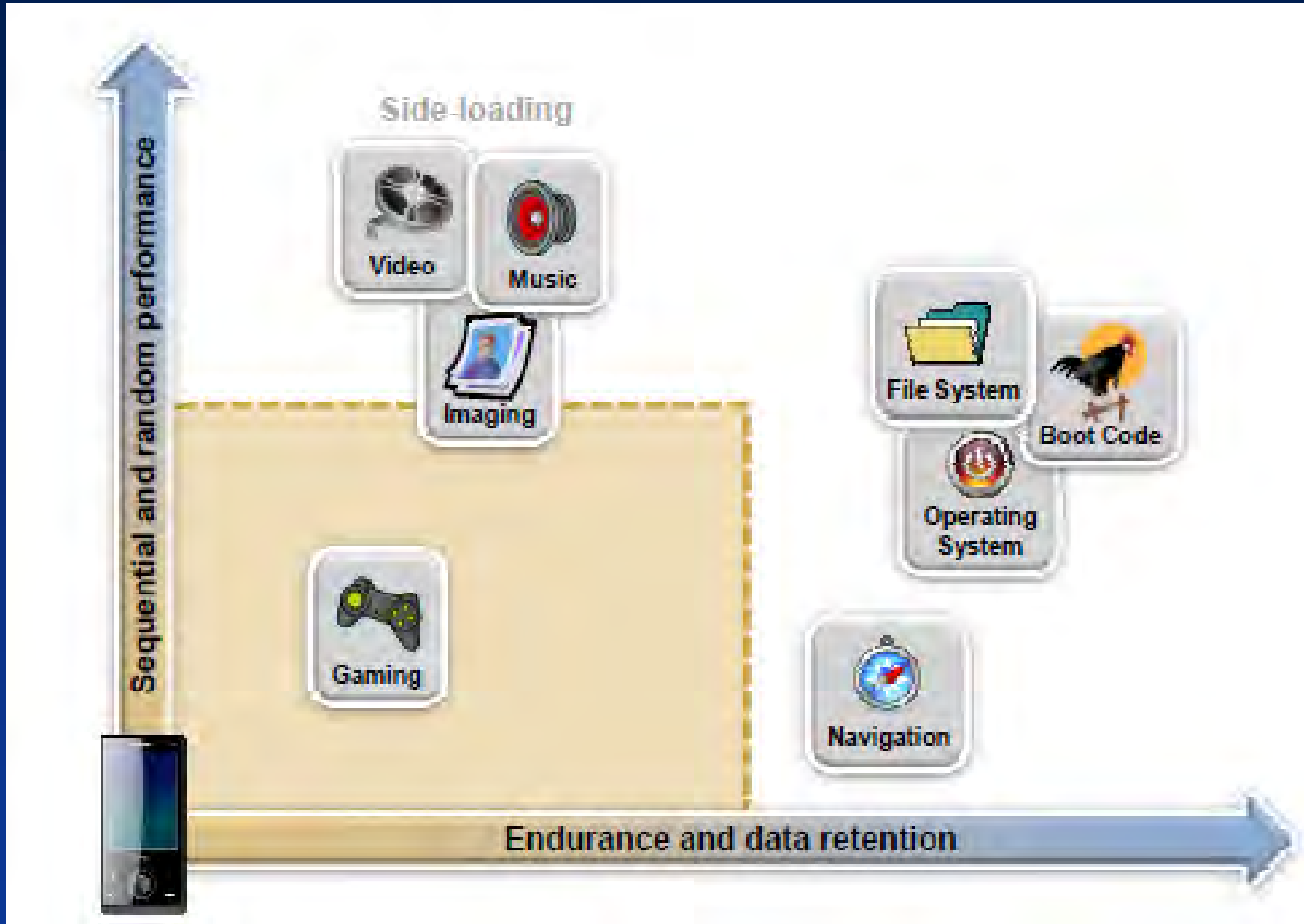
- **Capacity continues to rise**

- Camera 2MP -> 5MP :
one picture takes 2+MB!
- Video 720p -> 1080p
20+MB/s@30fps

- **As increases capacity, data transfer rate needs to go up.**

- copying 8GB with 20MB/s will take 4+ min.

Mobile Phone Application





Consumer Experiences – Application Scenario

- **Social Networking & Location Based Service**
 - **GPS & Compass + Networking**
- **Push applications**
 - **Push App + User App**
- **Music + email**
- **Captured access pattern shows...**

Consumer Experiences – Access Pattern

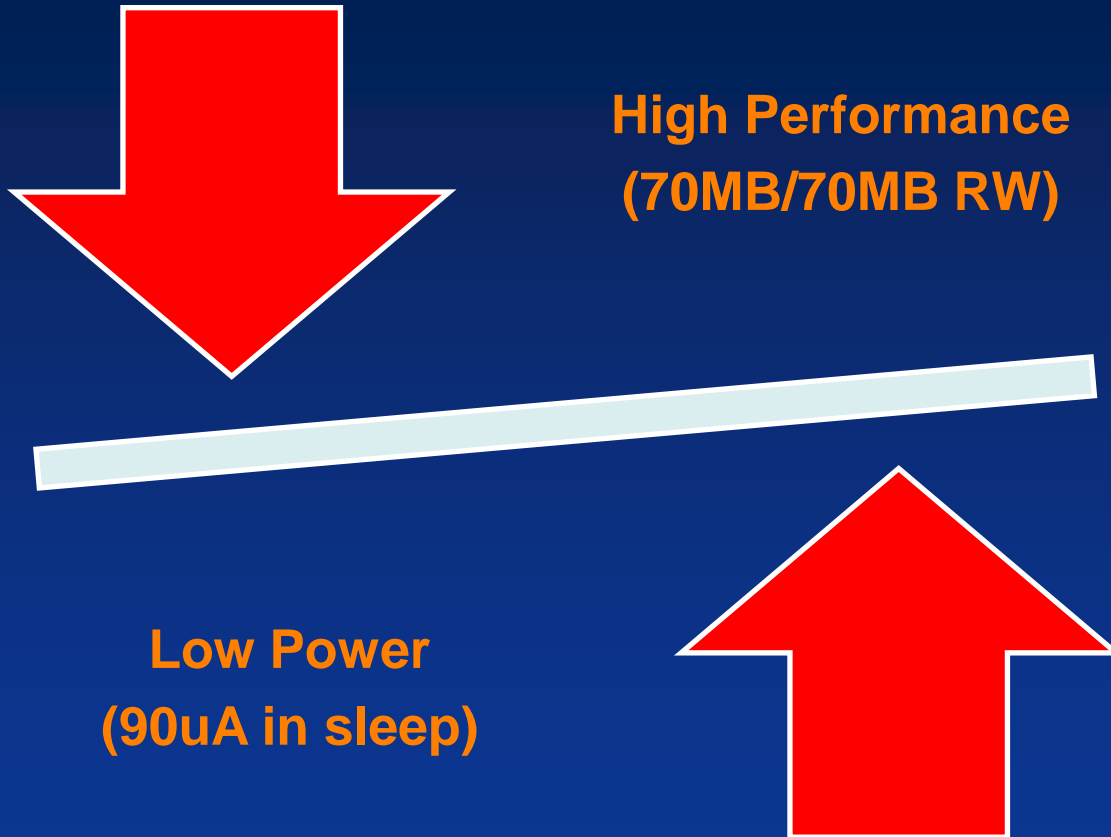
- **Not nice shaped but shows almost random.**



Distance from previous block

- **Transfer rate $> 70\text{MB/s}$.**
- **Random IOPS needs to be $> 5,000$.**
- **NAND support:**
 - **4xnm, 3xnm, 2xnm**
 - **ONFI, Toggle, Async**

But not sacrificing Low Power.



Remember that we're in Mobile.

Performance Numbers

minimum density	page mapping(YES!)				block mapping(NO!)			
	SW	SR	RW 4KB	RR 4KB	SW	SR	RW 4KB	RR 4KB
8GB	19.9	82.8	282.3	5609.2	19.00	83.0	28.0	2773.0
16GB	39.7	100.3	453.9	5608.7	39.00	100.0	45.0	2773.0
32GB	79.5	104.0	797.3	5609.5	79.00	100.0	80.0	2773.0

- **After 100% filled(precondition). Sustained.**
 - fully fragmented, not burst(sustained speed over long period)
- **Tr = 80us, Ter = 1.5ms, Tprog = 1.3ms, 10% OP**

- **eMMC not only for Mobile Device Storage, also for HDD replacement**
- **removing 52MHz DDR constraint,**
 - **200MB/s by doubling clock.**
 - **this requires host interface change...**

- **Current eMMC is aiming low.**
- **Mobile device' storage requirement is changing**
 - **transfer rate**
 - **application access pattern**
 - **NAND interface is changing rapidly.**
- **70MB transfer rate and high random RW is needed**
- **HDD replacement.**