

This presentation shares unreleased capabilities of an uncompleted SDA specification.

While the described features have reached consensus, the specification has not been completed or ratified.

Enjoy this preview!

Today's Theme: Kurosawa's Seven Samurai



“Danger always strikes when everything seems fine”

Kambei Shimada, “Seven Samurai” 1954, Toho Company

SD Memory Cards at a Crossroad

- Newer NAND technology no longer matches the assumptions that made sense in 2006 (SD 2.0 specification)

- The number of camera video recording options are increasing fast
 - New recording resolutions (4K, 8K, 3D,...)
 - New recording codec's (H.265/ HEVC, VP9,...)

NAND technology is still evolving



“This is the nature of war. By protecting others,
you save yourselves.”

Kambei Shimada, “Seven Samurai” 1954, Toho Company

New NAND technology

- Restating the obvious at Flash Memory Summit:
 - Cutting edge NAND technology is complicated and varies significantly by NAND vendor
 - Without SDA specification evolution, SD cards might run out of NAND sources

- Support for new native erase block sizes and multiples of native erase blocks (for parallel operations) was essential for video capture performance
 - New native erase block sizes are evolving with NAND technology
 - However, infinite Card option complexity was at odds with Host simplicity

- But we all negotiated and compromised...
 - End-users should never need to know how the sausage was made, other than that SDA engineers found a path for going forward

How can it be less expensive and faster?

- Optimal performance is when all the card's resources go saving into the data stream with zero write-amplification (one data, one write, one time)
- Creation of a minimized set of building block sizes and a new set of rules for using these sizes helps this work
 - Hosts restricted enough choices to enable design qualification
 - Card makers approved enough choices for future NAND evolution
- The draft allocation sizes run from 1 MB to 512 MB, and such large building blocks now can be used to efficiently hold multiple recordings

How can it be less expensive and faster?

- **Simplicity!**
 - SDA specifications ‘evolved’
 - the rules for different capacities (e.g., SDXC)
 - the rules for different interface speeds (e.g., SD UHS II)
 - the rules for different speed classes (e.g., C10, U1)
 - But this left hosts and cards with a collection of rules to implement for each capacity/interface/speed class combination
 - The new design acts identically across capacities and interface types for easier adoption

But, legacy speed class lives in interesting times

- The new Video Speed Class protocol enables more performance for the same card than the legacy speed class protocols (more bang for the buck!)
 - NAND has evolved to not always match the requirements of all SDA legacy speed classes
- The future is 'interesting' for SD Memory cards that support legacy speed classes
 - SD Card makers can continue legacy support as the market transitions
 - The drawback to supporting legacy speed class modes will be a new set of mixed marketing messages
 - Example: A card that meets Video Speed Class 30 (30 MB/s) may only meet the legacy UHS speed class 1 (U1 at 10 MB/s)

4K & 8K Video support



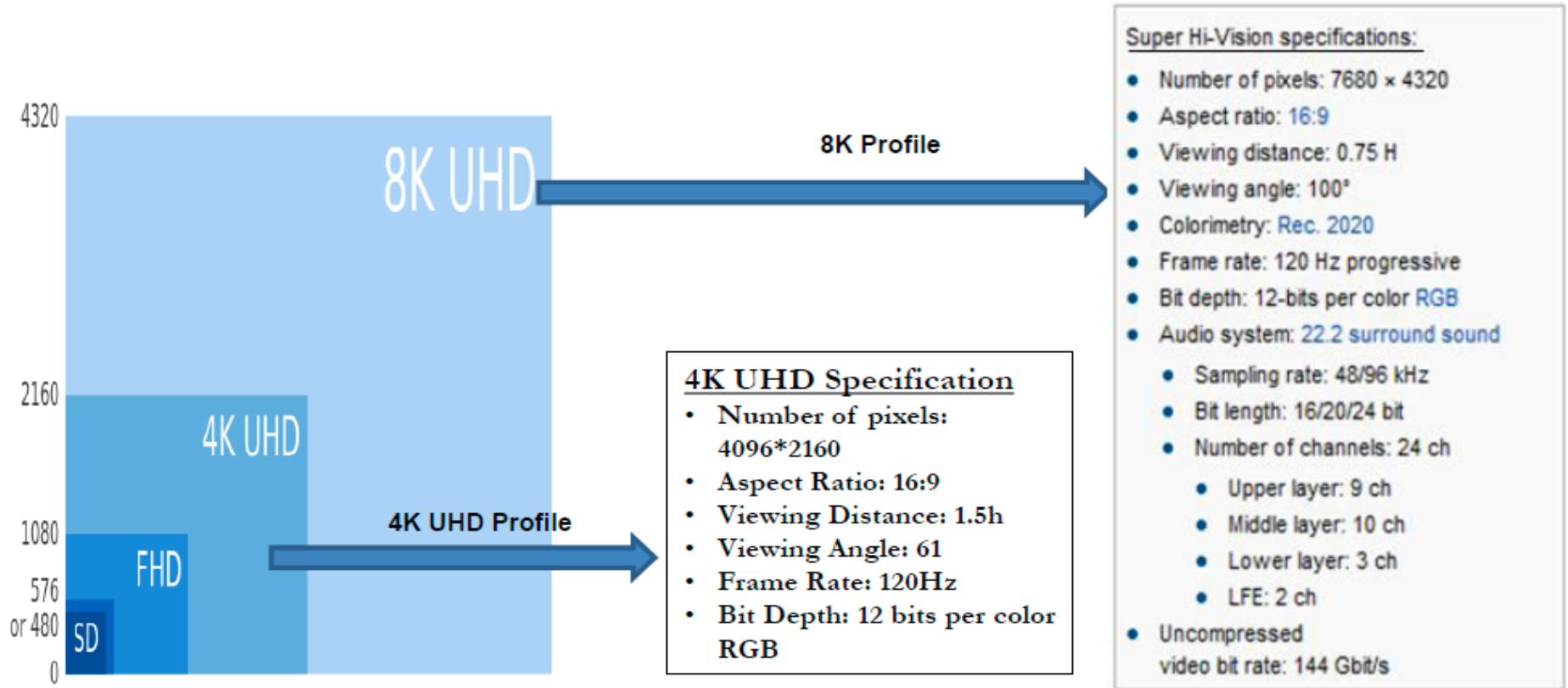
“A good fort needs a gap. The enemy must be lured in. So we can attack them. If we only defend, we lose the war. “

Kambei Shimada, “Seven Samurai” 1954, Toho Company

What speed is needed for 4K? (8K?)

- Today there are 4K Video hosts that work with 10 MB/s SD Cards, and 4K cinematographers that want 500 MB/s
 - Raw uncompressed 4K video is around 1200 MB/s
- What works for one vendor's 4K/8K/... solution may not be the same for another vendor
 - And the speed needed this year may be relaxed next year if the CODEC is improved
- SDA can't specify infinite application requirements
SDA will define minimum speeds
 - for camera makers to specify
 - for card makers to support

A simple view of upcoming complexities



Source: Samsung



A deep dive into two H.265 examples (please don't expect me to explain!)

4K/8K Bandwidth Calculation Explained:

Video frame size in bytes = Light part + Color part where:

light part = $4096 * 2160$ pixels

Color part = 2 parts (U part, V part), both are $1/4^{\text{th}}$ subsampled part of light (4:2:0 Format).

4K UHD:

$(4096 * 2160 + (4096 * 2160) / 4 + (4096 * 2160) / 4) * 16$ (Bits per Pixel)

$(4096 * 2160 * 1.5) * 16 = 212336640$ bits per Frame

If FPS = 30, Data Rate = $212336640 * 30 = 6370.0992$ Mbits/sec = 6.4 Gb/sec (Raw Data Rate)

Compressed Data Rate (90:1): 8.85 MB/sec

To consider other overheads 2 times of Compressed Data Rate can be considered: $2 * 8.85$ MB/sec = 17.7 MB/s.

Hence New Speed Class can be mapped to 30 for 4K UHD

8K UHD (Super Hi-Vision):

$(7680 * 4320 + (7680 * 4320) / 4 + (7680 * 4320) / 4) * 16$ (Bits per Pixel)

$(7680 * 4320 * 1.5) * 16 = 796262400$ bits per Frame

If FPS = 30, Data Rate = $796262400 * 30 = 238878720000$ bits/sec = 23.8 Gb/sec (Raw Data Rate)

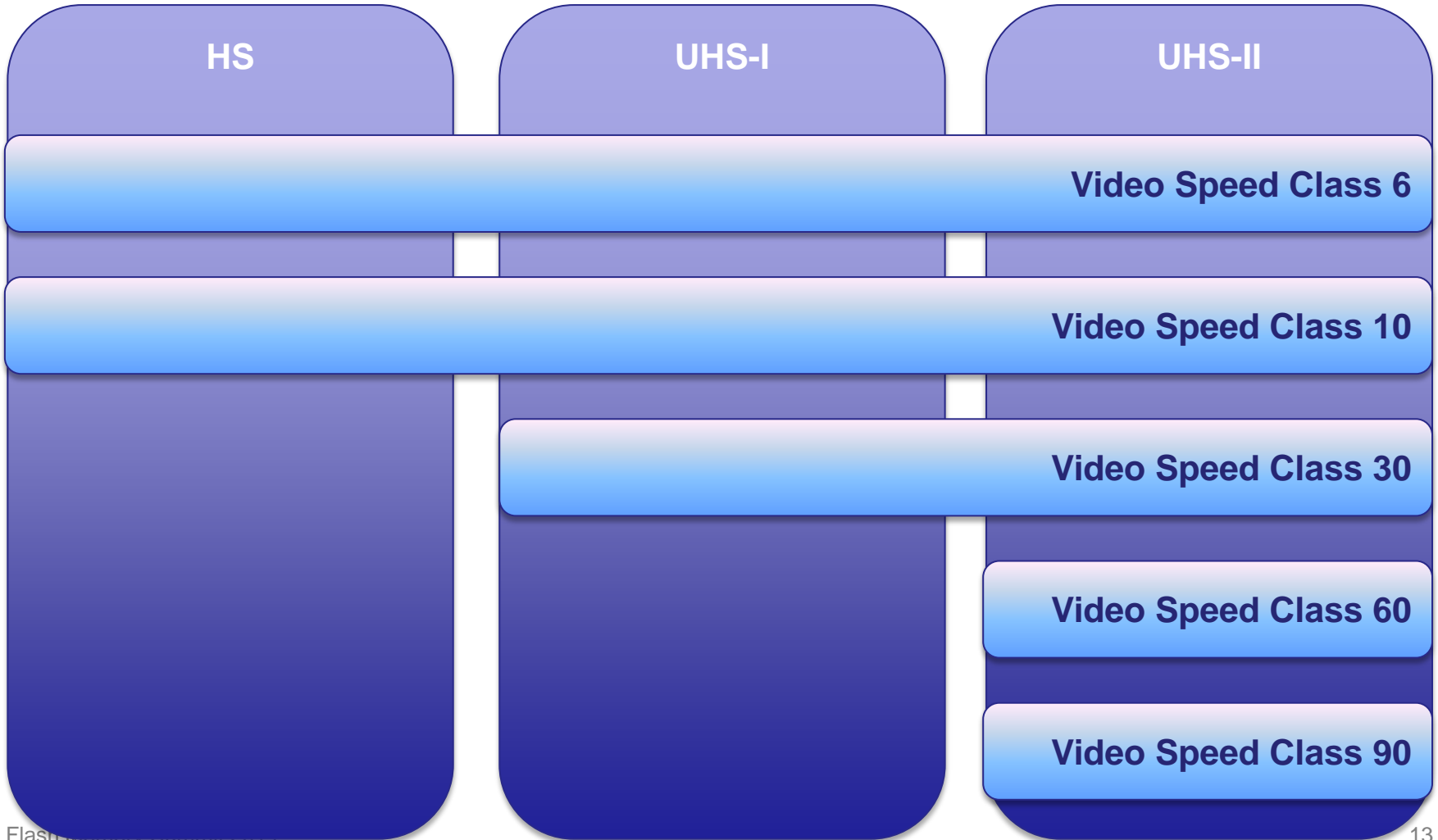
Compressed Data Rate (100:1): 29.86 MB/sec

To consider other overheads 2 times of Compressed Data Rate can be considered: $2 * 29.86$ MB/sec = 59.72 MB/s.

Hence New Speed Class can be mapped to 60 for 8K UHD

Source: Samsung

Draft approved new speeds (by interface)



So what is next?

- The SDA Board has set the publication target for the SD 5.0 specification by the end of 2014
- The specification may still change, but
 - the support of new NAND technology should enable SDA card technology for years to come
 - the new capture protocols should enable host and card manufacturers to support optimally designed products for years of a changing video 'picture'
- Join the SD Association for the full details



Thank You



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