Start New Game:
HBS (High Bandwidth Storage/Solution)

PRESENTER
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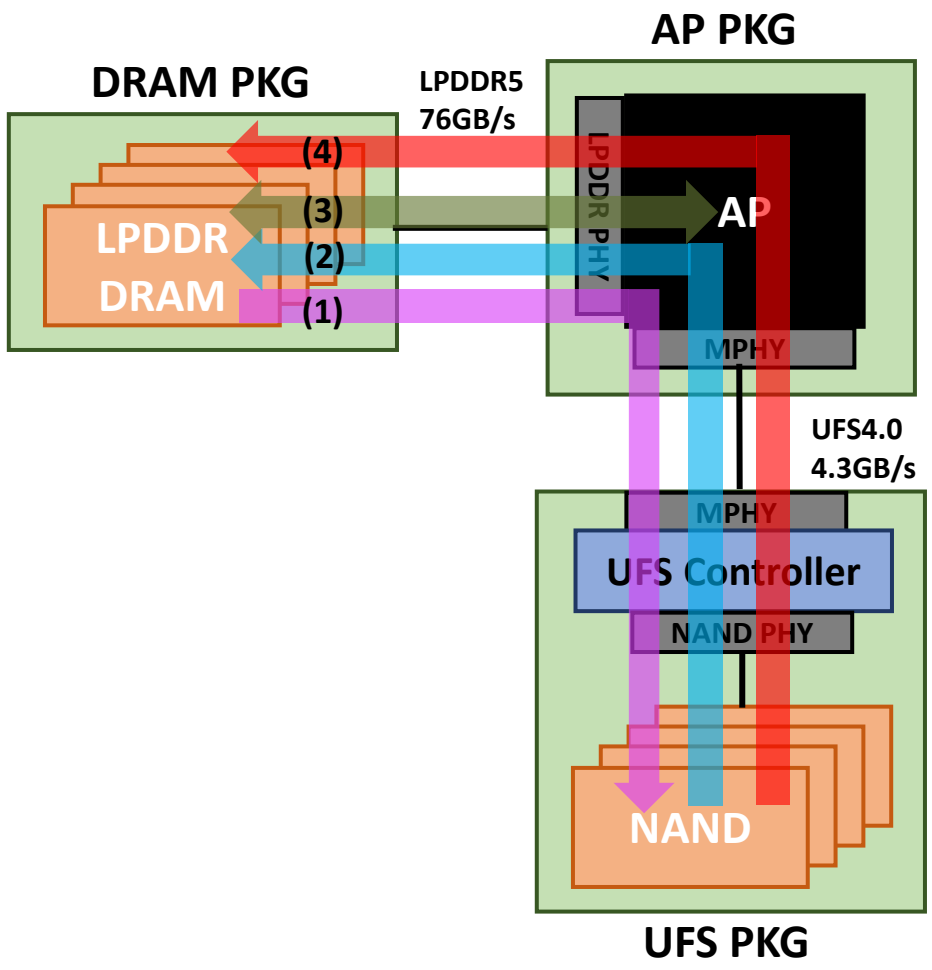
SK hynix

On-device AI Operations



(1) Memory allocation

- Move some applications from DRAM to NAND

(2) LLM loading

- Move LLM application and data from NAND to DRAM

(3) AI operations

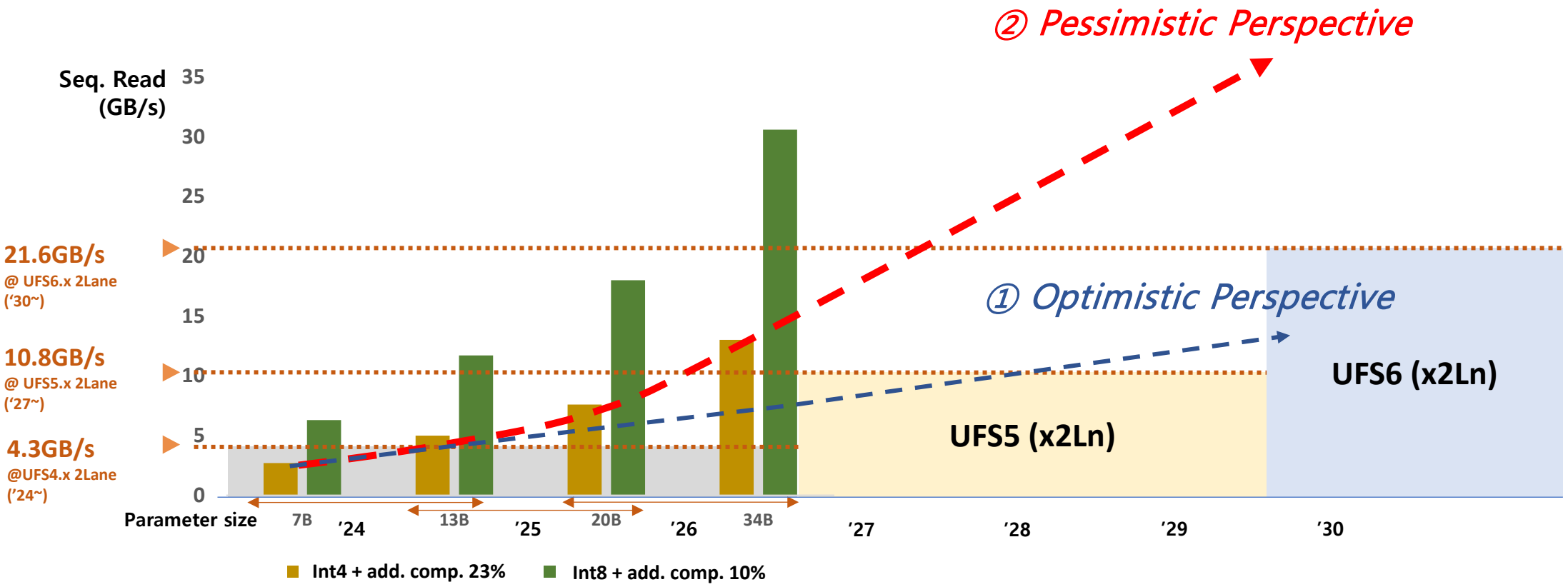
- AP reads LLM data from DRAM and performs AI operations

(4) Back to previous status

- Move the applications and data from NAND to DRAM

➔ Data transfer from NAND to DRAM must be completed within 1 second for better user experience

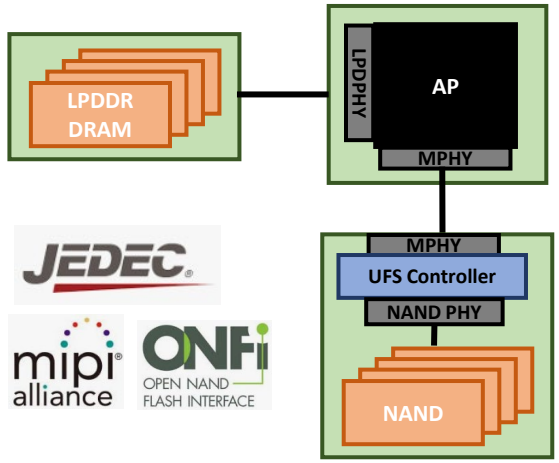
UFS Bandwidth



- Optimistic Perspective: UFS BW will be sufficient due to the reduction of model size
- Pessimistic Perspective: UFS BW will be insufficient to satisfy the requirements for flagship smartphone

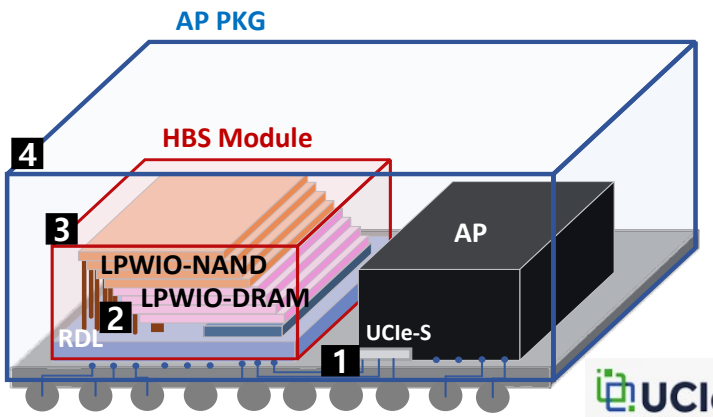
HBS (High Bandwidth Storage/Solution)

- Novel architecture to increase bandwidth for on-device AI without power increment

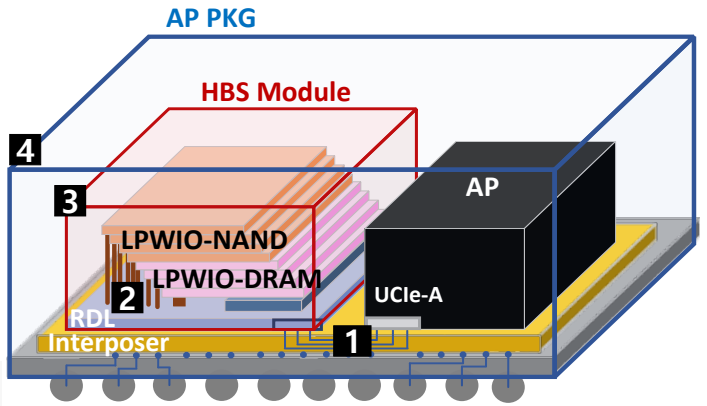


Proposed Architecture

< AP-HBS PKG w/UCIe-STD >



< AP-HBS PKG w/UCIe-ADV >



UCIe Universal Chiplet Interconnect Express

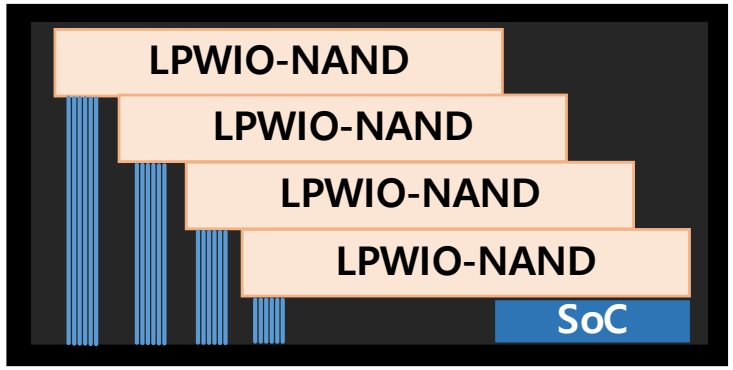
- DRAM I/F: LPDDR (JEDEC)
- UFS Host I/F: UFS/UniPro/MPHY (JEDEC, MIPI)
- NAND I/F: ONFI (JEDEC)
- PKG: Wire Bonding

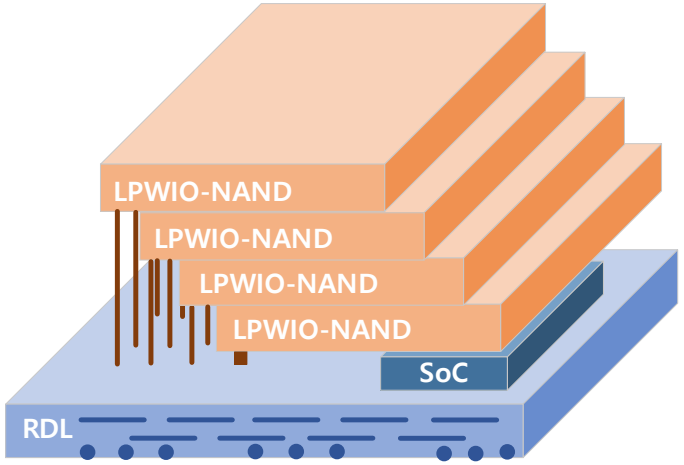
- All: Chiplet D2D I/F (UCIe, etc)
- PKG: Vertical wire Fan Out (VFO)

1. AP ↔ storage/memory interface: UFS/LPDDR → UCIe
2. Controller ↔ media Interface: wide-IO & D2D interface
3. Controller-DRAM-NAND: VFO package
4. AP-storage-memory: 1-PKG integration

LPWIO-NAND (Low Power Wide-IO NAND)

- Increasing # of channels, DQs, planes, and page size for higher bandwidth
- D2D interface for lower pJ/bit
- VFO package technology for wide-IO connections



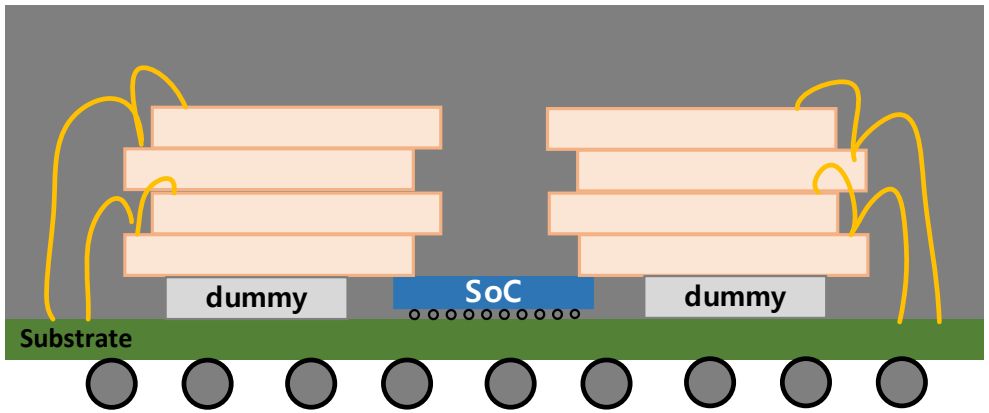


* VFO (Vertical wire Fan Out)
* RDL (Re-Distribution Layer)

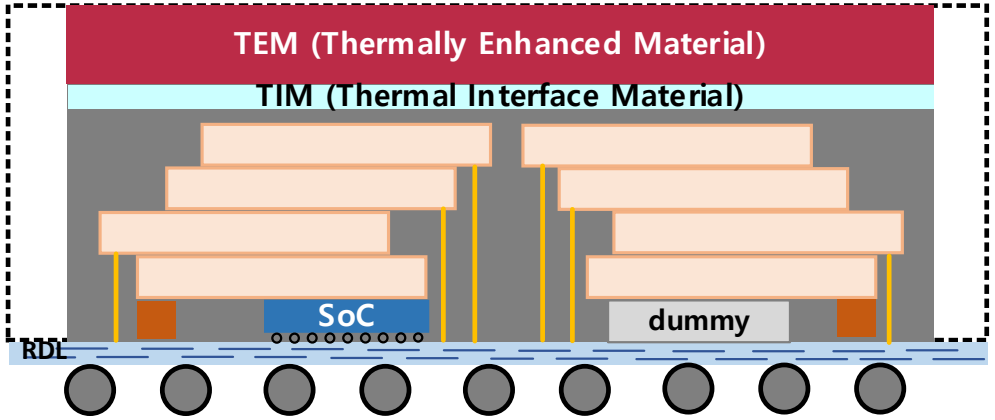
VFO (Vertical wire Fan Out) Package

- VFO package is an integration technology of vertical wire and FOWLP
- VFO shows a remarkable 27% reduction in z-height[1)]
  - Redundant space in WB package can be removed
  - Thermal resistance can be improved by TEM/TIM

* FOWLP (Fan-Out Wafer Level Package)
* RDL (Re-Distribution Layer)



< Wire-Bonding PKG >



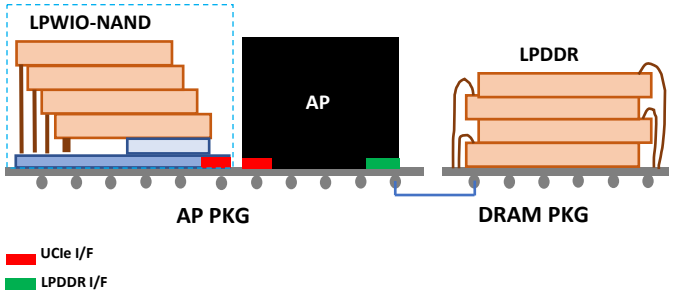
< VFO PKG with TEM/TIM >

* 1) 2024 ECTC_Vertical Fan-Out (VFO) package with enhanced form factor and performances for mobile applications

HBS (High Bandwidth Storage/Solution) Options

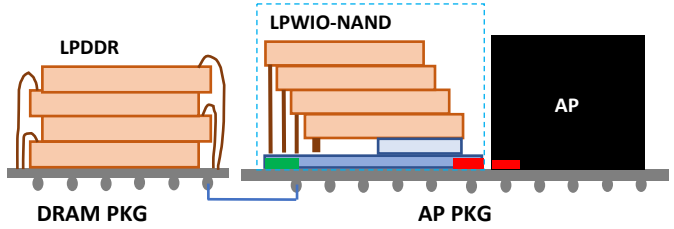
Option#1

Storage BW x4 (Chiplet)



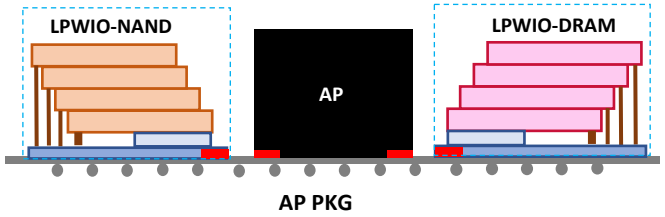
Option#2

+ DRAM BW x2



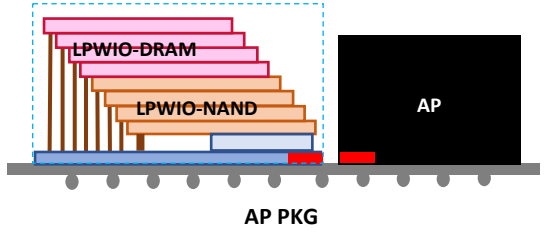
Option#3

+ DRAM BW x4 (Chiplet)



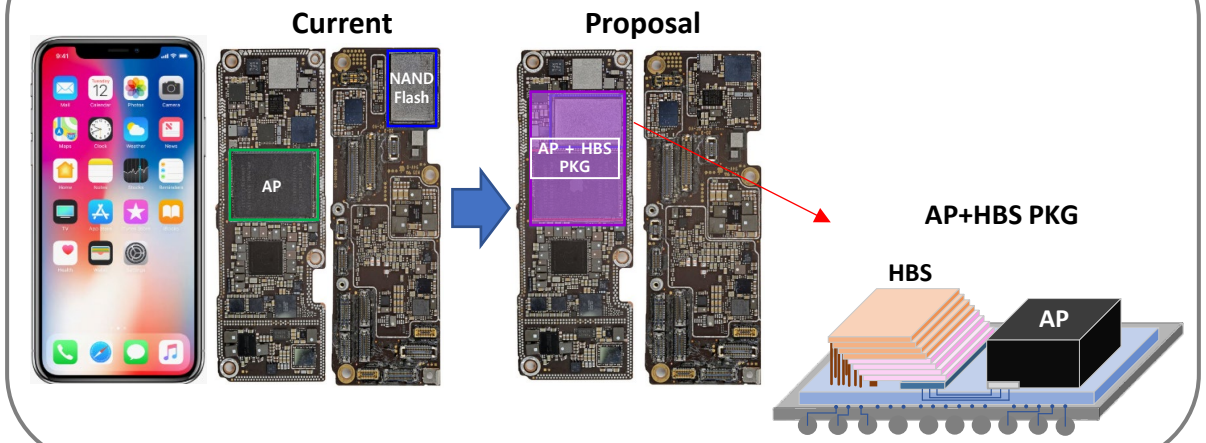
Option#4

All-in-One Solution (SCM)

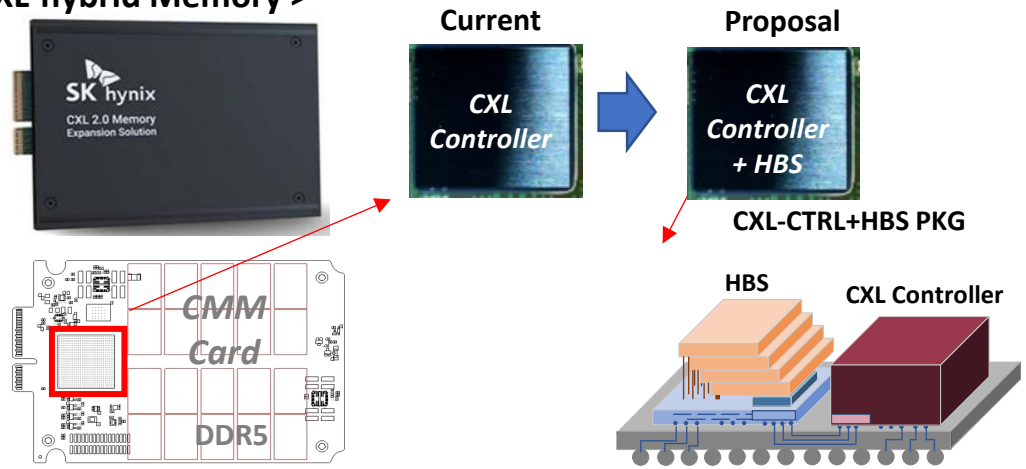


Example of HBS Applications

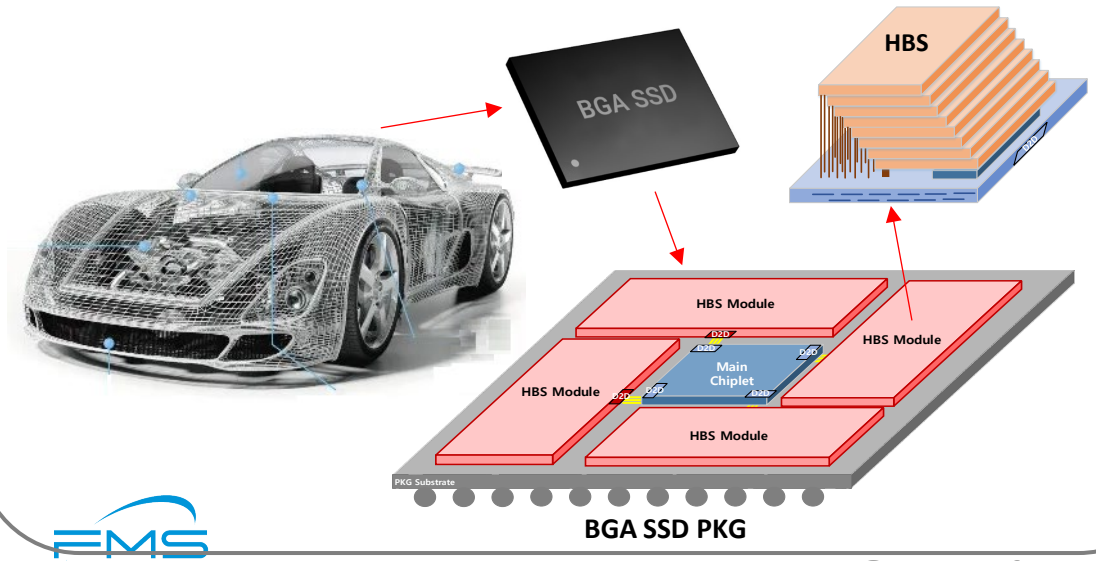
< Smartphone >



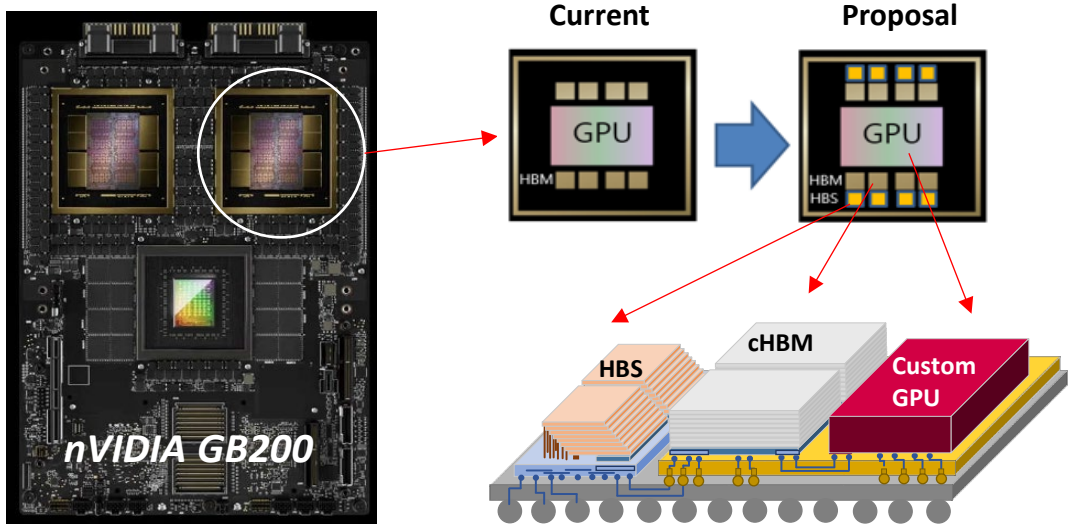
< CXL-hybrid Memory >



< Automotive >



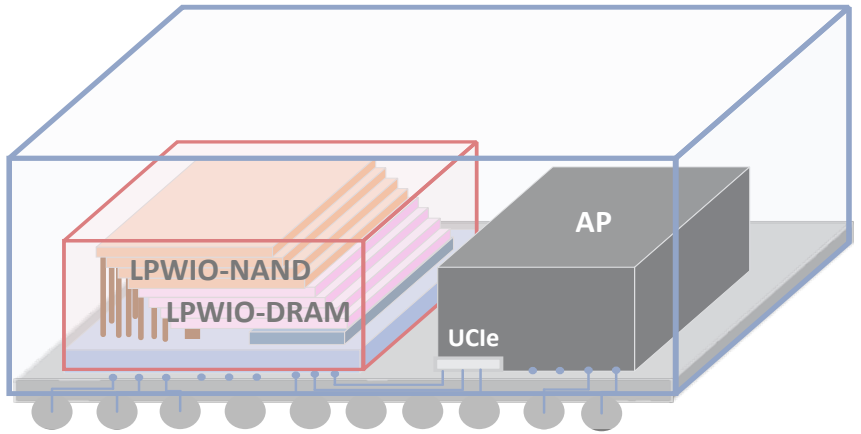
< GPU >



Summary

- Novel HBS (High Bandwidth Storage/Solution) architecture is proposed to address the limitation of storage bandwidth and power optimization challenges
  - Expand DQ pins of NAND flash memory → LPWIO-NAND
  - Apply D2D interface between LPWIO-NAND/LPWIO-DRAM and the controller
  - Use VFO package technology for wide-IO connections
  - Apply UCIe interface between host and HBS module

- Further study is required
  - D2D LPW-media interface specification and protocol
  - Storage stack framework, etc



Thank You

Booth #207

Meet the future of memory.
Just steps from the entrance.

Innovation starts here,
Literally.

SK hynix