CUDA-supported real-time DXT compression of HD video: design and implementation

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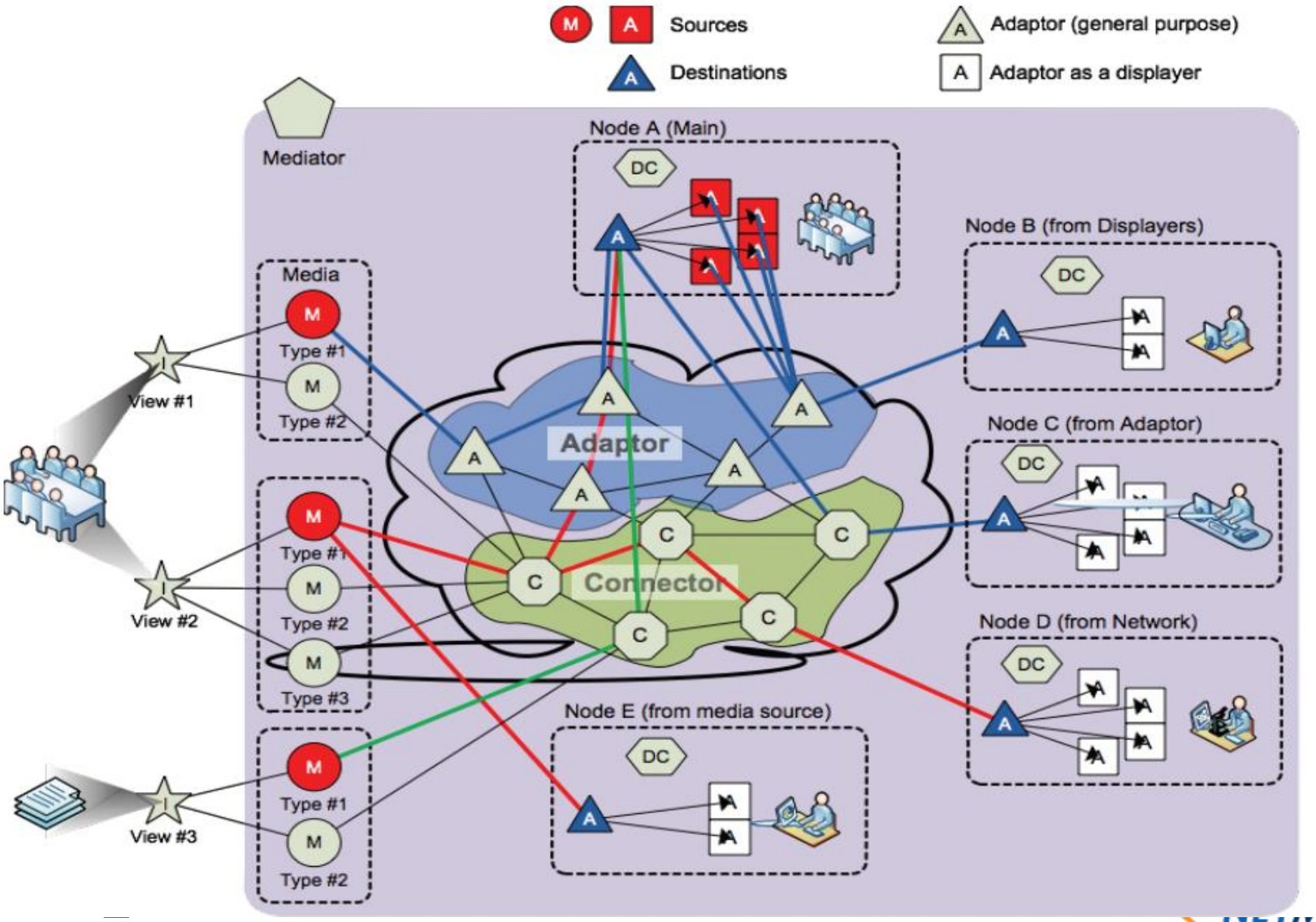
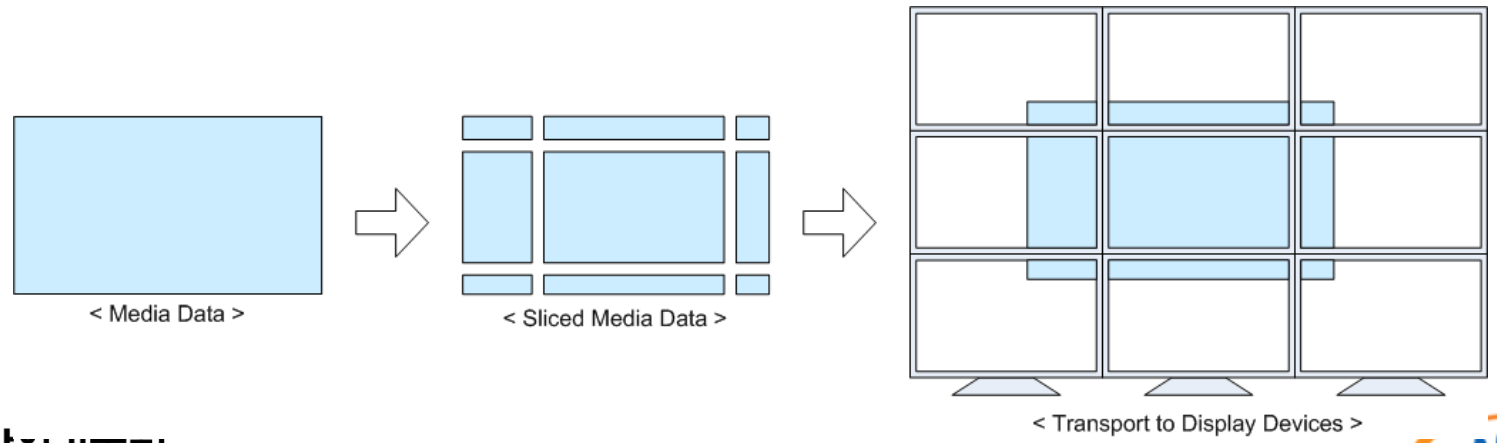
Abstraction for Multi-party Visual Sharing



NeTD: Networked Tiled Display

- A networked display system using multiple tiled display devices to form a large logical display wall
- Provides ultra-high resolutions and large physical display sizes
- SAGE: Scalable Adaptive Graphics Environment
  - An "Operation System" for tiled-display environments
  - Manages the parallel graphics streams between the rendering nodes and tiled display nodes

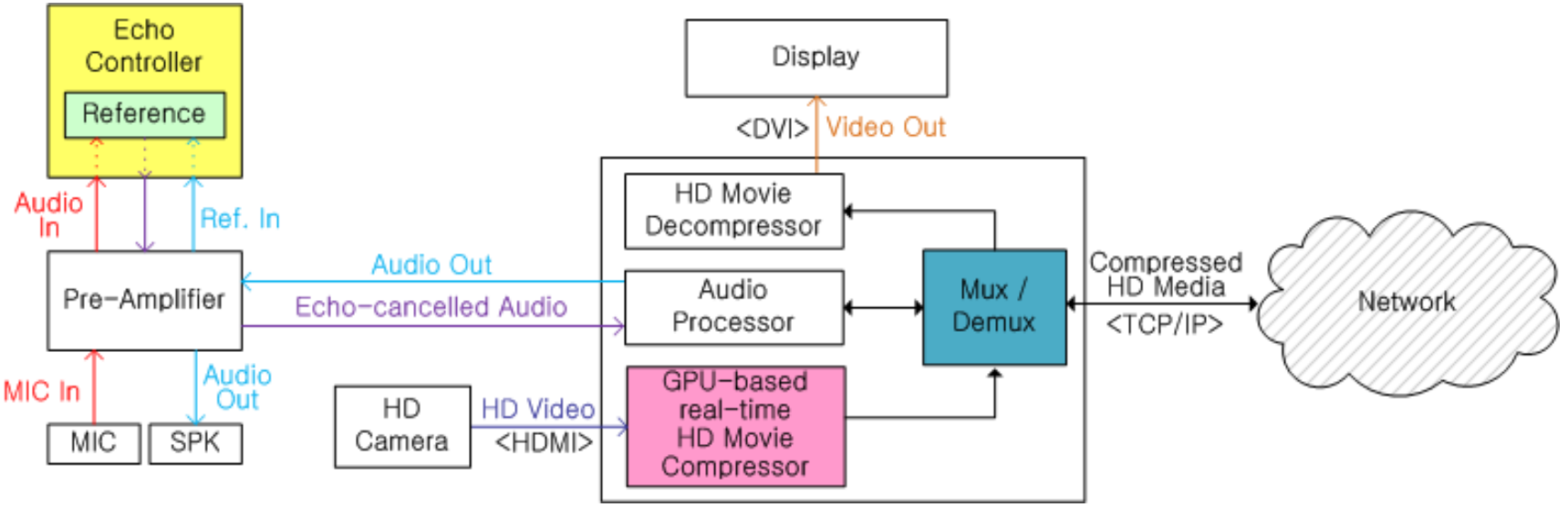


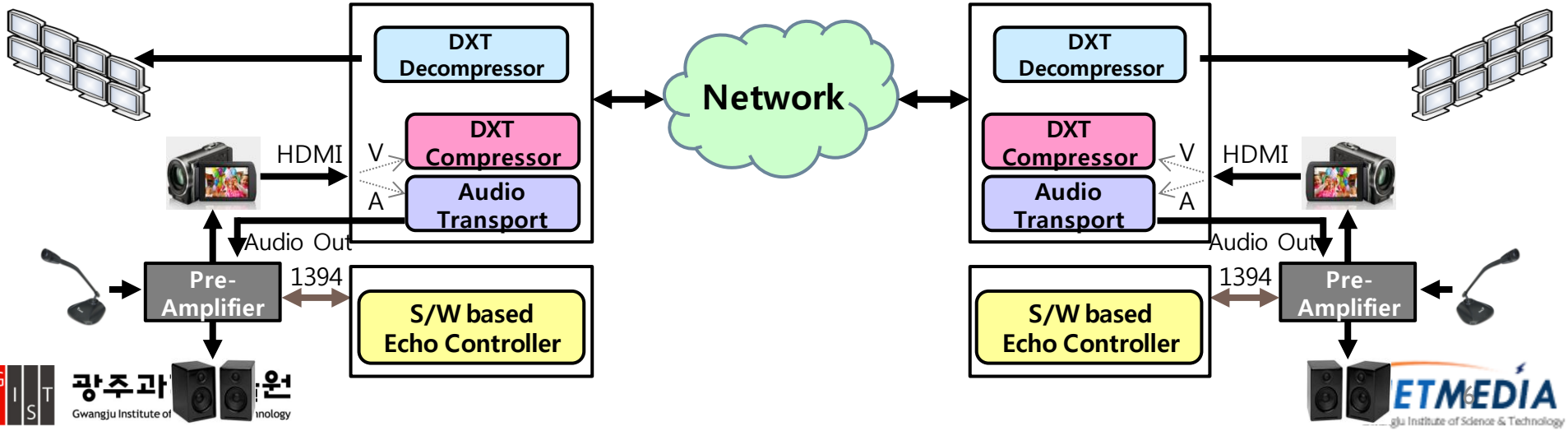
SAGE Visualcasting for Multi-party Collected Collaboration

HD Media Compression

- Many codecs for HD Media Compression
  - MPEG2, MPEG4, H.264, etc.,
  - Hard to realize real-time support
- DXT
  - S/W based light-weight lossy compression algorithm
  - Most of VGAs support H/W accelerated DXT-decompression
  - Each pixel block is independent of other blocks

HDMI-based HD Media Transport System



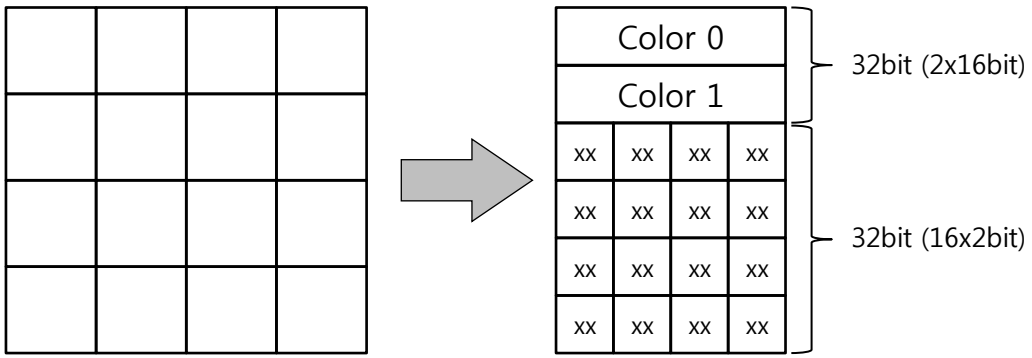


DXT: DirectX Texture Compression

- 4x4 block of pixels (512-bit or 384-bit) to a 64-bit or 128-bit quantity

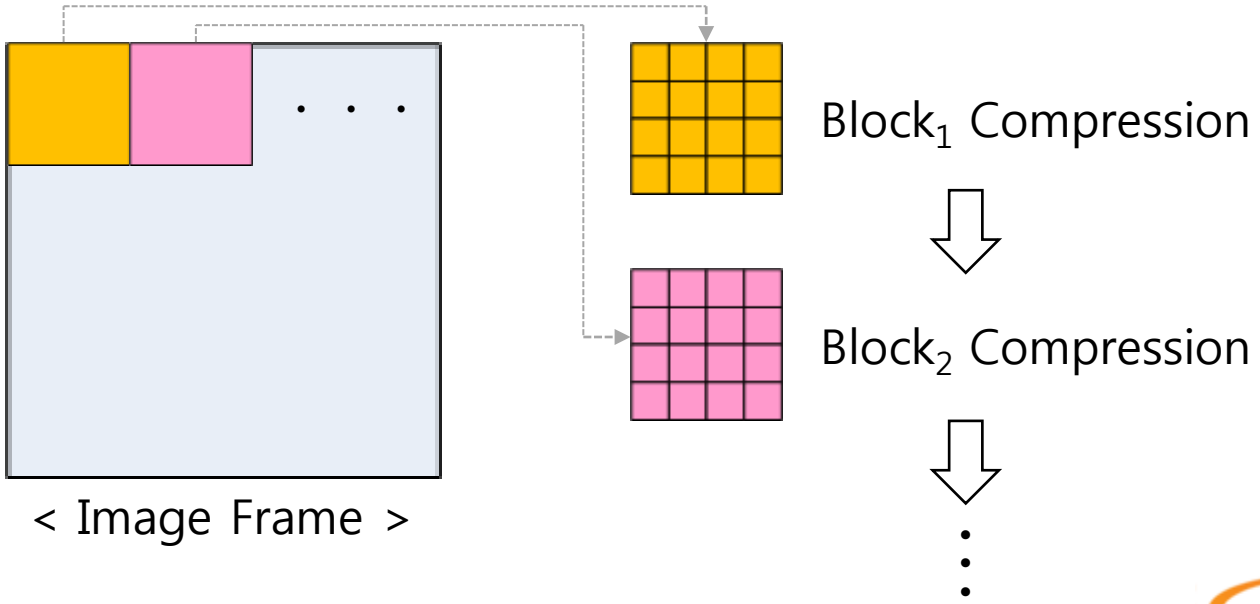
FOURCC	Description	Comp. ratio	Texture
DXT1 (BC1)	1-bit Alpha / Opaque	8:1 or 6:1	Simple non-alpha
DXT3 (BC2)	Explicit alpha	4:1	Sharp alpha
DXT5 (BC3)	Interpolated alpha	4:1	Gradient alpha

- Select DXT1 for HD Media Compression
  - HD Media does not include alpha channel

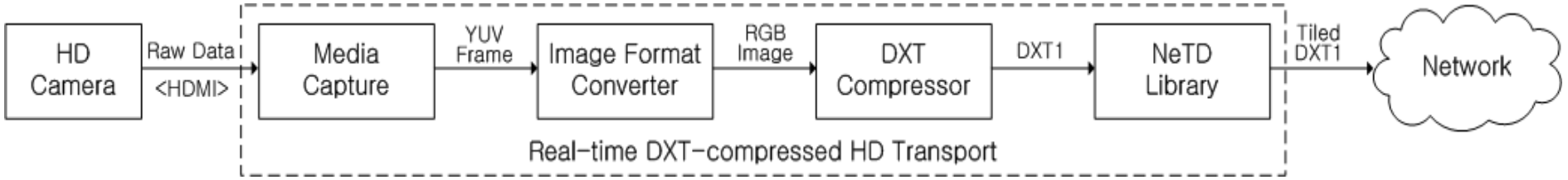


FastDXT: Realtime DXT Compression

- Focused on compression speed rather than quality
- Using Multi-Threads (2 or 4) for DXT Compression
- Optimized with SSE2 instruction-set
- Sequential compression processing each 4x4 pixel block



Performance of FastDXT for SAGE



- Using Decklinkcapture (HDMI Transport Application) by VisLab@UQ
- Performance

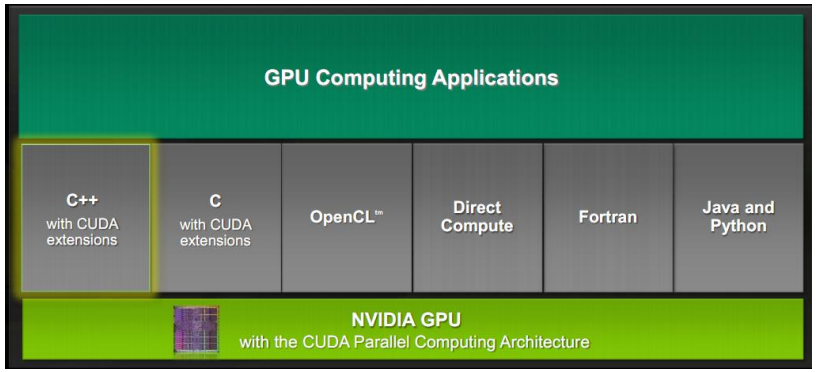
Machine	O/S	Compression	fps	B/W(Mbps)	CPU usage	MTU
Dell Precision 670 (single core)	Ubuntu 10.04.1 x64 (64bit)	DXT	12~13	105~110	75%	8900
		Uncompressed	23~24	730~750	35%	8900
Dell Precision T3400 (quad core)	Ubuntu 10.04.1 x64 (64bit)	DXT	30	260~270	85%	1450
		Uncompressed	13	440	8%	1450

GPU acceleration approach

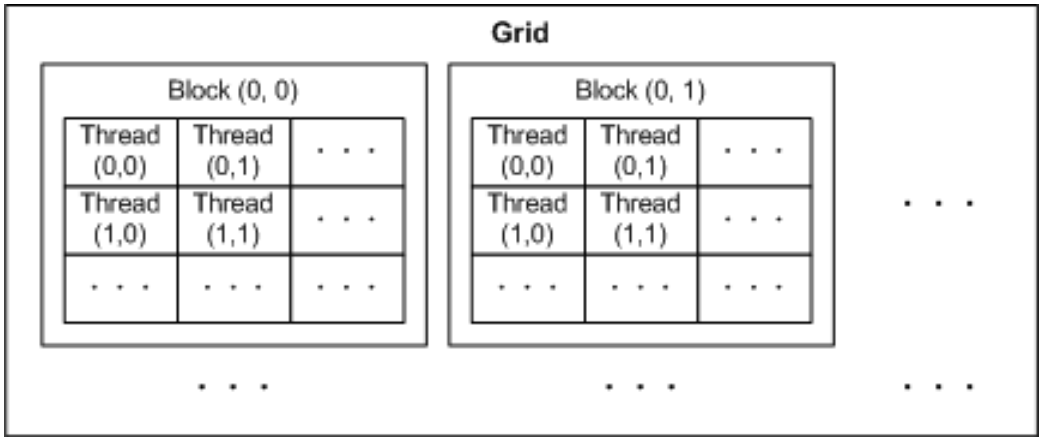
- OpenGL/Cg
  - high-level shading language developed by NVIDIA
  - suitable for GPU programming and it does not replace a general programming language
  - Cg compiler outputs DirectX or OpenGL shader programs
- CUDA: Compute Unified Device Architecture
  - parallel computing architecture developed by NVIDIA
  - gives developers access to the virtual instruction set and memory of the parallel computational elements in CUDA GPUs

CUDA Programming Model

- Parallel portions of an application are executed on device (GPU) as kernels
  - One kernel is executed at a time
  - Many threads execute each kernel
  - Kernels are lunched in grids



- Threads and Blocks have IDs
  - Each Thread can decide what data to work on



DXT Compression using CUDA

- Each pixel block is processed by CUDA Thread Block
  - Many pixel block compression simultaneously
  - Enables CUDA performance scalability
- CUDA Thread processing
  - Unpack color space each pixel
  - Compute DXT color index each pixel
- Apply FastDXT algorithm
  - Min/Max Color selection
  - Emit color indices

Reference

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Thank you!

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