

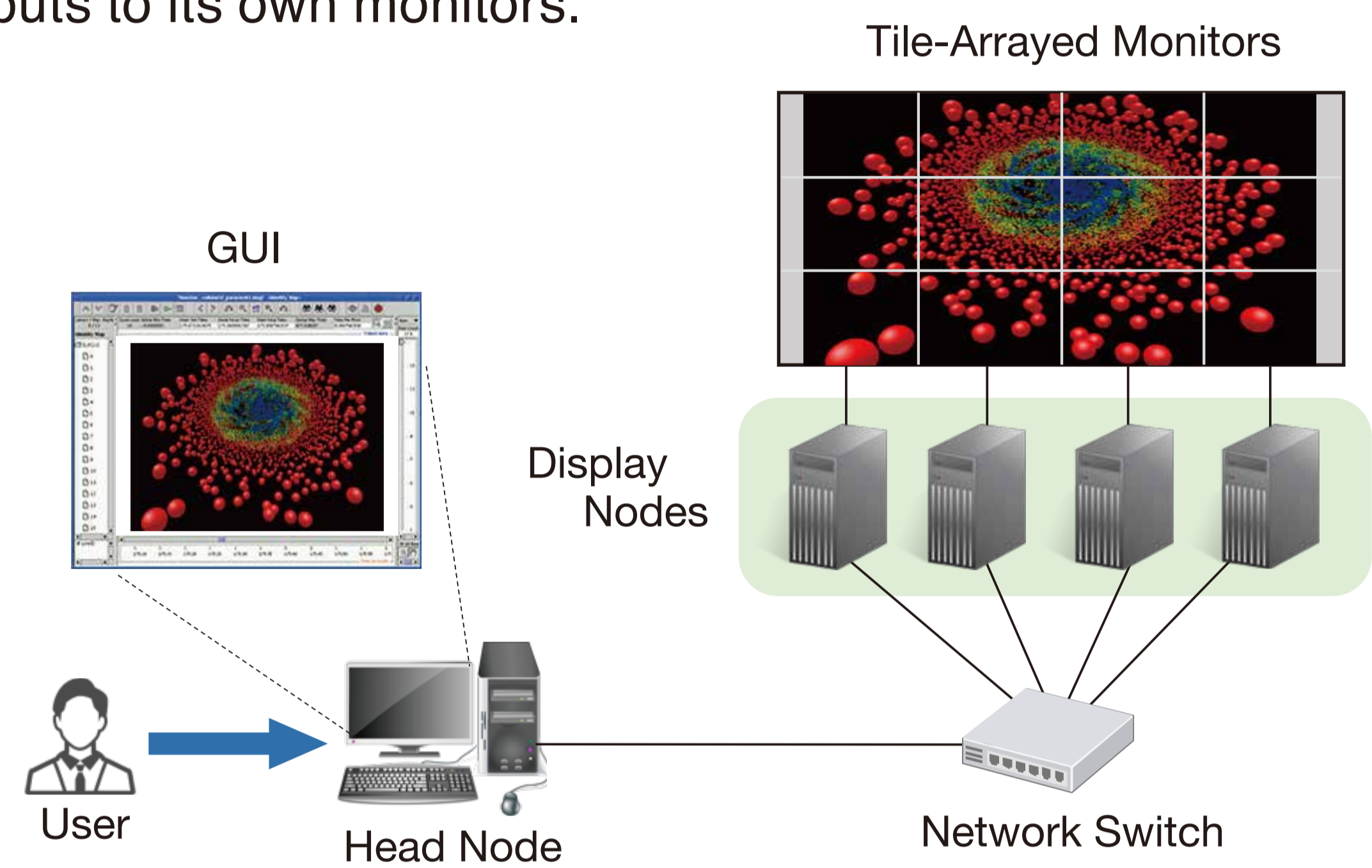
Novel Mechanisms to Support Scientific Visualization on TDW

What is Tiled Display Wall (TDW)?

- A Tiled Display Wall (TDW) is a scalable visualization system, which can provide a virtual high-resolution screen **by combining multiple sets of computers and monitors**.
- A TDW is often **leveraged for scientific visualization**.
 - A TDW can visualize large quantities of scientific data without a lack of information. (e.g. *simulation results, network graph etc.*)
 - A lot of researchers can observe visualized data simultaneously and exchange ideas with each other on the spot.



- A general TDW has a **cluster-based architecture**.
 - The head node and the display nodes are cooperated by dedicated visualization software. (e.g. *SAGE2, ParaView, COVISE etc.*)
 - The head node provides a GUI of the TDW to users.
 - Each display node renders the fragment of visualized data and outputs to its own monitors.



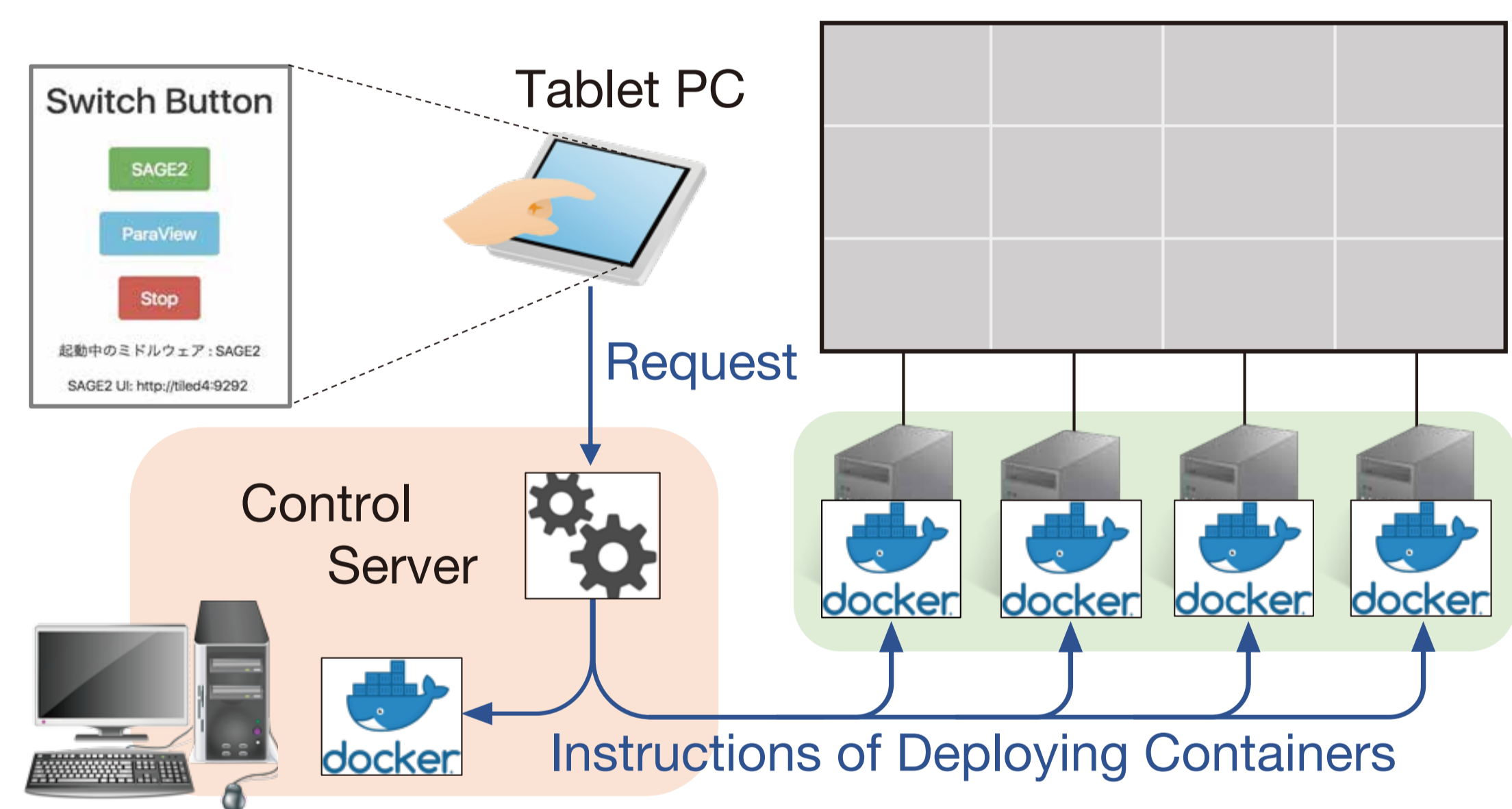
Switching Mechanism of Visualization Software for the Visualization Service

- The TDW in the Cybermedia Center (Osaka University) is leveraged by a lot of researchers as the Visualization Service.
- **Problem:** Frequent conflicts of dependent library versions
 - Researchers require to **install various visualization software** on the TDW in response to their analytic styles and data formats.
 - Most visualization software **depend on the particular versions** of system libraries and graphic libraries.
 - The administrators often **suffer from the complicated operations** for the conflict avoidance.

- **Our approach:** Switching mechanism using Docker
 - *Docker* separates the visualization software environments from each other with little overhead.
 - All the Docker containers are deployed **automatically in a single operation** on the tablet PC.

Software	Dependent Libraries
SAGE2 (v3.0.0)	Node.js (v10.0 or newer), FFmpeg (v3.0 or newer), ImageMagick (between v6.0 and v6.9)
ParaView (v5.6.0)	Qt (between v5.6 and v5.9), FFmpeg (v2.3), Python (v2.7)
COVISE (v2018.9)	OpenSceneGraph (v3.2 or newer), VTK (v6.0), Python (v3.5 or newer)

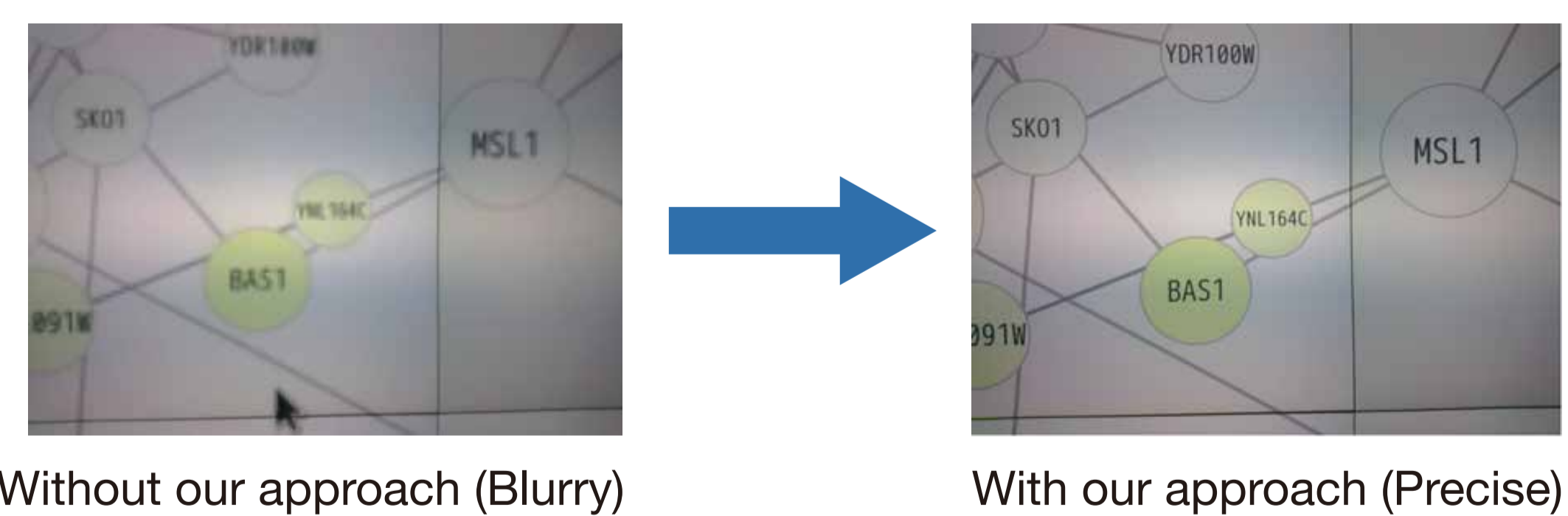
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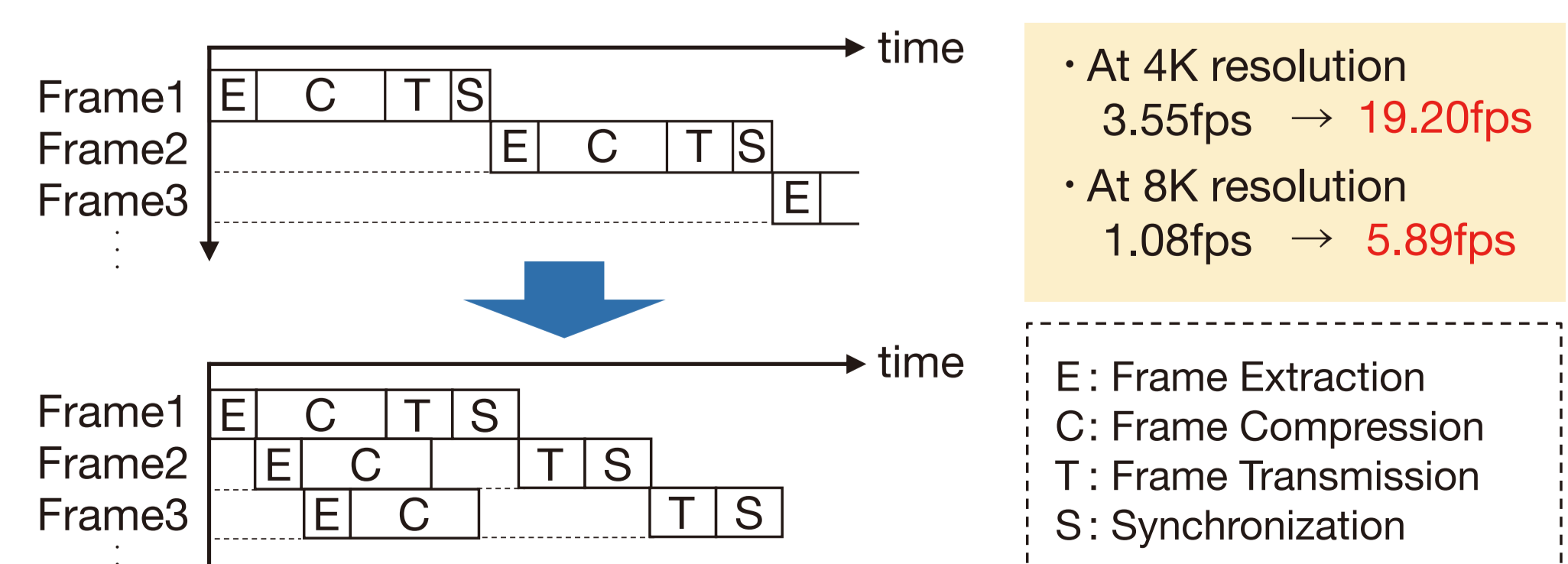
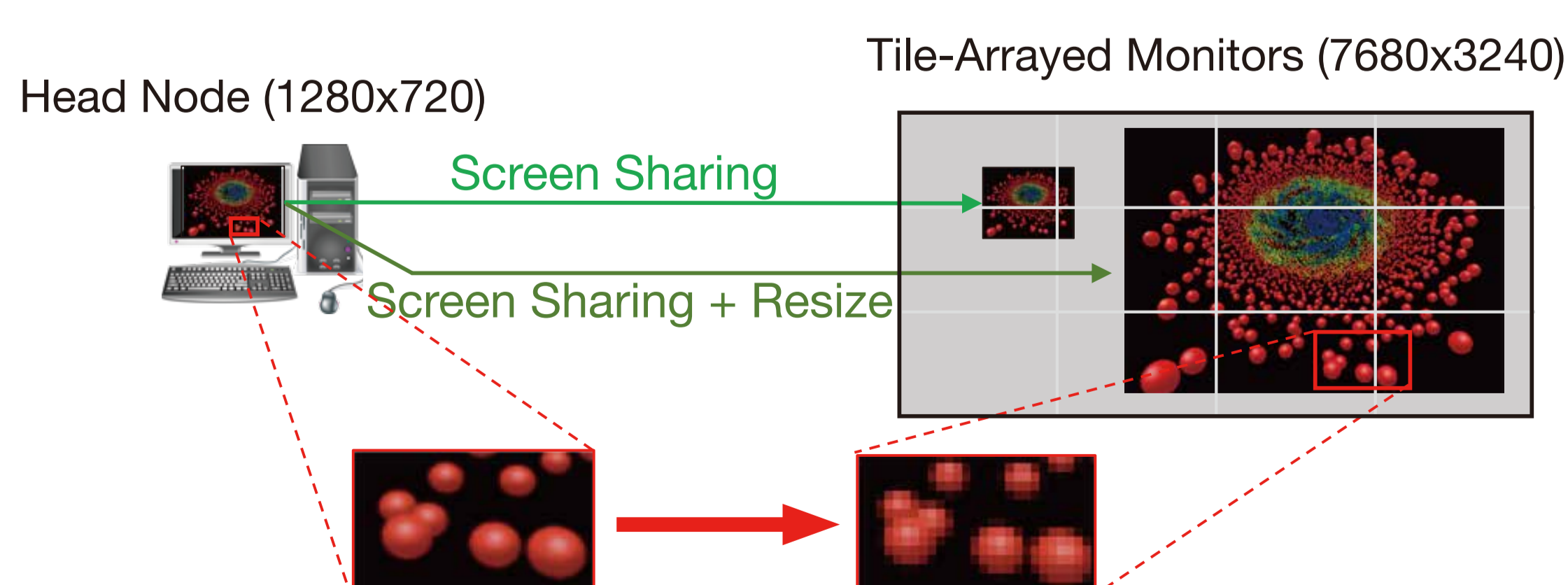
High-Resolution Streaming Functionality in SAGE2 Screen Sharing

- To use existing desktop applications on a TDW, users are required to modify the source code.
- *SAGE2* (popular visualization middleware) provides **Screen Sharing**, which is the function to stream user's desktop contents to a TDW.
 - Screen Sharing allows users to display a wide range of desktop applications on a TDW **without redevelopment**.
- **Problem:** Resolution constraint
 - The desktop contents are displayed at the **same resolution as the monitor of the head node**.
 - Large difference in the screen resolution will **deteriorate the visibility of desktop applications**.

- **Our approach:** Xvnc and Pipeline streaming
 - *Xvnc* creates the virtual desktop screen **at an arbitrary resolution** on the head node regardless of the specifications of its monitor.



- To improve the frame rate in the high-resolution streaming, **the streaming process is pipelined**.



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