

SPACE-BASED DATA CENTERS ROADMAP: THE CASE FOR CAUTION

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Text Box 1-2:

Software

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Google's early breakthrough in search was an algorithm called PageRank. It treated links between web pages as signs of authority and used them to rank results. PageRank ran on the same servers search had always used. The servers did not change. The idea did.

Data-center hardware depreciates quickly because each new generation makes the last one less valuable. On Earth, an operator can replace an outdated processor, add memory or install a new generation of graphics processing unit (GPU) accelerators. Hardware in orbit faces the same technological obsolescence without the same replacement cycle. Once launched, software becomes the principal means of improving its useful performance.

Software helps a machine in two different ways. It can tune what is already there: make an artificial intelligence (AI) model use less memory, eliminate unnecessary calculations, keep processors from waiting for data. These tunings let the same machine answer more requests, spend less power per answer or run models that once exceeded its limits. But software can also hand hardware a capability it never had, the way PageRank did not speed up a search engine's servers but gave them something new to compute. New ideas—like PageRank—are harder to develop but can break through a ceiling that tuning alone cannot overcome.

The market will not lower its expectations because a data center is in orbit. On Earth, operators meet the demand for better AI models and faster AI inference with better software and new hardware, generation after generation. An orbital data center faces the same demand with hardware that no longer changes. Software cannot add physical memory, repair a damaged processor or increase the power available from a spacecraft. It can extend the range and value of the machinery already there. In orbit, software must close the distance between what users expect and what the launched machine can deliver.

The useful life of a space-based data center (SBDC) might therefore be extended by continued software development, allowing satellites to operate for longer and reducing a range of impacts, including the number and pace of launches and impacts on the atmosphere from re-entry disposal. However this requires long-term software support and continued research into new algorithms – not just the kind that run leaner, but the kind with PageRank's leverage, unlocking capability the hardware was never built to have on its own.

On Earth, better software is an advantage. In orbit, its value is astronomical.