project cairn founder thesis & memo

off-grid self-maintaining edge compute containers
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// problem

today compute is moving towards power, the fastest interconnect, the strongest grid, the most labor. the key issue between all these driving factors is that none of them are available where edge inference is needed the most. securing interconnected power takes 24 to 72 months, and up to 7 years in heavily constrained markets. ERCOT, tracking roughly 410 GW of large-load interconnection requests, shows 87% of them to be data centers, about 5 times the installed generating capacity of the grid they are joining. more importantly, remote edge sites already have a heavily constrained grid, not limited by a queue but by sheer capacity. as the centers, and the accelerators themselves, begin to demand more power than is available, these sites lose accessibility to edge compute.

more important than securing an independent power supply is the ability to maintain an edge site without excessive labor costs. compute is running out of land, and the industry's answer is to push centers into agricultural, residential, and other 'human-critical' land. or the other option is to go to the ocean or space. either way, compute is being pushed to the edges of what our society can handle. similar to these remote sites, edge inference has grown in demand. from industrial settings to construction to disaster response, the ability to access compute in any location, rapidly, and with 0 human-involved maintenance is a staple of our future society.

the limiting component is the ability to maintain without the need for a human technician. accelerators and other hardware have consistently been shown to fail, and need fixing. meta's llama 3 cluster logged numerous unexpected interruptions across a 54-day trial, 78% notably being hardware-based. to fix over 300 hardware problems at a remote site requires either an on-site technician or a consistent charter crew. the problem becomes worse when we move off land or into situations with limited personnel.

the problem is clear: accessible, independent edge inference should not be limited by access to a technician or power. it is a far cry from today's industry reliance on exactly these 2 limiters.

// current solutions

obviously the explosion of ai did not let the entire compute industry forget about this, but nobody has come together for a complete solution. right now there are 4 credible options that offer some sort of mediation to the problem.

nvidia mgx and vera rubin solved the blind-mate system, allowing easily serviceable compute, reducing a technician's job and increasing service by nearly 18 times over previous generations. however, the replaceable unit is a tray, requires a technician, and is a capital-heavy task to replace without one.

data center robots like exclaim, boost, and watney have all worked with existing racks and 0 infrastructure changes, relying on teleoperation fallbacks requiring a remote technician. none adapted to their own hardware, and an edge site lacks the ability to use bandwidth and remote operators.

software resilience has been demonstrated by zededa and submer, showing that routing workloads around existing racks with 0 changes to any hardware preserves the task at hand, not the capacity. 24 dead cards are 24 dead cards.

modular container vendors like armada have built similar form-factor compute containers specifically for edge inference but lack independent power (besides larger form-factor models) and self-maintenance. the only answer here is to rely on the 40,000-person field workforce, more than 95% unable to access remote sites without being 24/7 on-site.

each solution draws a consistent pattern. everyone is either building a robot for human hardware, or hardware for humans to service.

// our solution

instead of building another competitor, cairn is inverting the market. with the technology accessible today, it may seem a daunting task to build a robot which can autonomously service edge inference sites, but by using a traditional lens and applying similar past problems against a modern one we get a unique solution.

cairn is not just building a robot, nor are we just building a container of compute. we are building the intersection of both, and building it for the future. there is no reason to rely on the technology

of today when we are building for tomorrow. instead of using human-oriented hardware, cairn is designing its own carriers, nodes, racks, and mechanisms to maintain compute.

instead of developing a completely new remedy from scratch, we are taking the essential elements from an old fix. an LTO tape library is a cabinet of cartridge slots, a robotic picker on a rail, and drives in a mail slot. most of these have run completely unattended since the '90s. the core concepts behind cairn are not unproven. we are building the adaptation of old technology for modern tools. nobody built the cartridge for an accelerator, much less one for a robot.

the general system is simple fundamentally: 2 shipping containers (transport and deployment efficient), 1 with the compute and the other with power. either one has its own self-reliance systems built into the hardware. the robot simply supports the maintenance actions which can't be passively integrated. the 40ft compute container carries 96 passively cooled cards at 75 watts or less, a sealed internal air loop, a roof air-to-air heat exchanger, and a double-door airlock. the accompanying 20ft container carries a 25kw generator, 500kwh of battery, switchgear, and a roof-mounted 150 kwp folding solar wing, and a method for existing power/grid interconnect. importantly, cairn's solution is building deep card-level granularity. 12 months of unattended autonomy needs 16 spare cards, whereas the same autonomy at an 8-gpu sled granularity can use nearly 40 times the amount of capital.

finally, human involvement is kept to a minimum, with only 1 interface. a courier opens and pulls dead cards, puts in new ones, and leaves. less than 15 minutes, no tools, no training, no entry into the compute space. this is not a faster technician. it's just a delivery driver. the same goes for the deployment. set up the containers, configure, and the entire system is deployable and operational in under 8 hours.

//status

the robot is still being designed in the very early prototyping phase
the carrier is prototyped, and the interposer and node are in progress

the path ahead is deliberately cheap before ambitious, given the naturally capital-heavy nature of the compute industry. milestones are specifically designed to get a mature and usable product in some form factor by the end of each one, allowing for repurposing or pivot.

//founder ethos and closing

obviously compute isn't that enticing of an industry to most founders. that's not to say that the topic isn't infinitely more interesting than a gpt wrapper. i think the cause for me to go into building something in this industry comes from, as silly as it is, a tv show. here's a short excerpt from another essay i wrote which i feel has a direct correlation to this:

'there was a tv show i used to watch way too much growing up as a kid. i believe it was called Voltron. there was a planet (it was a space show) called altea. on that planet there was this amazing society, where nature and environmental support coexisted with the industrial and technological capabilities. so not only did they take amazing care of their planet but they continued to build advanced technologies that would further improve their lives. ever since then i knew i wanted to build that world, where we could enjoy everything our planet has to offer, while building better technology alongside. i think i continue to hang on to the belief that we are destined to reach this level of society in some way or another. it seems counterintuitive to what i'm building, but i think modular data centers, which can go anywhere, allow us to step away from building huge mega-facilities that encroach on our communities and beautiful land, furthering us towards the naturalist ideal, and i'm going to keep working toward that end goal no matter what.'

in short, i believe that the future doesn't just rely on humans or technology but on the intersection between both that allows the earth to thrive.

also in closing, i appreciate you taking the time to read this. not really a whitepaper per se, just some explanations, thoughts, and what cairn even is.