Episode Book

EPISODE #6677

How AI Memory Demand Pushed Raspberry Pi Prices to $385

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SYNOPSIS

A seven-fold surge in LPDDR4 memory costs has turned $40 hobbyist computers into luxury items, pushing the 16-gigabyte Raspberry Pi 5 to $385 and the Banana Pi BPI-M4 Zero up nearly 300 percent. The culprit isn't edge AI on small boards, but wafer capacity in fabs run by Samsung, SK hynix, and Micron. As memory makers exit legacy DDR4 to build high-bandwidth memory for AI data centres, single-board computers are splitting into cheap 1-gigabyte survivors and overpriced high-memory models.

TRANSCRIPT



Corn

Daniel's latest finds him short one single-board computer. He runs a little fleet at home, Raspberry Pis and the cheaper Orange Pi cousins, gave one away over the summer, went to replace it so something can watch the home IP camera, and the listings on AliExpress read like a prank. Seventy dollars, eighty, a hundred, a hundred and fifty, on boards he remembers at about forty. He wants to know if he's imagining it, whether the RAMpocalypse has really reached down to the tiny LPDDR4 chip soldered onto a hobby board, and why a crisis driven by AI data centres would bother squeezing the smallest fish in the pond.



Herman

He's not imagining it.



Corn

That was going to be my dramatic pause.



Herman

The numbers are worse than he thinks. Raspberry Pi itself has put its official prices up four times in under a year, and the third-party Chinese boards have moved much further. The cleanest single example is the Banana Pi BPI-M4 Zero, the two-gigabyte version. Twenty-eight dollars ninety at launch in December twenty twenty-three. A hundred and fifteen dollars on AliExpress by this April. That's just under three hundred percent.



Corn

A board that went from impulse buy to "let me think about this for a week." Which, for context, is a category of purchase that never used to involve a week of anything. You saw it, you clicked it, it arrived in a padded envelope, you forgot you'd bought it before it cleared customs.



Herman

And it's not alone. The Orange Pi 5 Ultra, sixteen gig, went from a hundred and twenty-five to three hundred and nine. The Radxa X4, eight gig, from about eighty dollars to two sixty-six. The ODROID-M2 eight-gig kit from a hundred and fifteen to a hundred



Herman (continued)

ninety-five. Meanwhile the one-gigabyte NanoPi Zero2 is still eighteen dollars. Same shops, same supply chain, unchanged.



Corn

So the price of a board now tracks its memory almost one to one, and the boards with almost none are fine. Hold that thought, because it's the whole story.



Herman

On the Raspberry Pi side, the official record is nicely dated. December of last year, first rise. The four-gig Pi 4 went from fifty-five to sixty, the sixteen-gig Pi 5 from a hundred twenty to a hundred forty-five, and they launched a new one-gig Pi 5 at forty-five specifically so people had somewhere cheap to land. Then April first of this year, a second round, and I promise it wasn't an April Fool, Eben Upton put out the actual figure. A seven-fold increase over the previous year in the price of the LPDDR4 used on Pi 4 and Pi 5. Seven-fold.



Corn

I'd want that date double-checked too if the stakes weren't printed on every shopping page on earth. But walk me through what a seven-fold increase actually means for the bill of materials. When you say the memory went up seven times, is that seven times a small number or seven times a number that already mattered?



Herman

It was already one of the bigger line items on a high-memory board, and it went to seven times that. So on a high-memory board, the memory went from being a significant cost to being most of the bill. On a low-memory board, the absolute numbers were small enough that even seven-fold arithmetic left room for a sane price. Which is why the one-gig Pi 5 exists at forty-five dollars and the sixteen-gig one costs like a used laptop.



Corn

Then October, another twelve-fifty on the two-gig models, and just a couple of weeks ago the sixteen-gig Pi 5 went up another eighty dollars, to three hundred eighty-five. It launched at a hundred and twenty. They're citing a lack of alternative supply for that density specifically.



Herman

A Pi 5 at three eighty-five. That's not a hobby board anymore, that's a monthly payment plan with a GPIO header.



Herman

The mechanism, though, this is where I think it gets interesting, because it's not "RAM got expensive" in some vague sense. It's a story about allocation. The scarce resource in this whole mess is not chips of any particular size. It's wafer capacity in the fabs. And the memory makers have looked at their wafer allocation and made a very rational, very brutal decision.



Corn

Which is?



Herman

Every square millimetre of wafer can make high-bandwidth memory for an AI accelerator, or it can make LPDDR5 for a flagship phone, or it can make LPDDR4 for a forty-dollar hobby board. HBM takes roughly three times the wafer area per gigabyte compared with ordinary DDR5, so every gigabyte of HBM you make eats the space of a lot of other memory. The makers look at that and they exit the legacy types. Samsung, SK hynix, Micron all set DDR4 end-of-life dates between late twenty-five and early twenty-six. Micron notified customers in June of last year. TrendForce reported the Korean and American makers cutting or ending LPDDR4X production across twenty-five and twenty-six, with LPDDR4X output forecast to fall by double digits this year.



Corn

So it's not that the little chip got scarce because anyone wanted it. It got scarce because the factory it lives in got reassigned.



Herman

And the moment supply retreats while a long tail of embedded products still needs it, the remaining stock gets bid up. Third-quarter last year, LPDDR4X contract prices were forecast up thirty-eight to forty-three percent in a single quarter, and TrendForce's phrasing was "panic buying and competitive bidding." Consumer DDR4 went up eighty-five to ninety percent in the same quarter. And here's the detail I love, in a grim



Herman (continued)

way. An eight-gigabyte DDR4 module was costing more than DDR5. The old standard, dearer than its replacement.



Corn

That's the market saying nobody's making this anymore, so it's not a price, it's a farewell.



Herman

And DDR4 was ranked lowest in suppliers' allocation, because cloud server orders crowded out consumer supply. So the little guy ordering LPDDR4 by the reel for a hobby board is last in every queue there is.



Corn

Which answers Daniel's "why the smallest fish" question directly. The hobby board is the least profitable use of that wafer capacity that exists. The moment capacity gets tight, it's the first thing squeezed out, because nobody at the memory company loses sleep over a board that watches an IP camera.



Herman

Eben Upton's own framing, from the December post, was that the pressure is driven by competition from the AI infrastructure roll-out, painful but, in his words, ultimately temporary. And Jeff Geerling, who's been tracking the hobby board market for a decade, wrote in April that from the vendors he'd checked with, the LPDDR chips now account for the majority of the board's cost. Not a big chunk. The majority.



Corn

So the chip that used to be one component among several is now the board, wearing a small computer as a hat. It's like buying a car where the engine used to be a third of the price and is now the whole invoice, and the wheels and seats come free with the engine.



Herman

We covered the general AI-eats-memory story back in February, so I won't re-tread it, but the bit we didn't have then is this. The damage has now travelled the entire length of the supply chain, top to bottom, and the bottom is where the arithmetic stops working. A data centre can absorb a doubling of memory cost, painful as it is, because the machine it's building earns money. A forty-dollar board can't absorb a seven-fold increase in anything. There isn't forty dollars of margin in a forty-dollar product.



Corn

Seven times the memory cost. The board maker's choices are raise the price until the memory fits inside it, or stop making the board. There's no third door.



Herman

And some of them have quietly taken the second door. Not announced, just... the listing says sold out and it stays sold out.



Corn

Before we get to what the market's doing about it, can I test Daniel's guesses? Because he offered three theories and I want to know if any of them survive contact with the numbers.



Herman

Go on.



Corn

His first one is that the RAM has tripled in cost and it's simply being passed through on the pre-assembled board.



Herman

That one's mostly right, with two caveats worth the airtime. The pass-through is not uniform. Look at Raspberry Pi's own table and the rises are concentrated on the high-memory boards. The one-gig and two-gig Pi 4 and Pi 5 sat between thirty-five and sixty-five dollars even after the April rises. The sixteen-gig models took the hundred-dollar hits. So it's not a tide lifting every boat equally, it's a memory tax scaled by memory. The second caveat is that AliExpress listings carry something extra on top of the genuine cost increase, which is scarcity markup. CNX Software put it well in April. Vendors, quote, don't rush to replenish stock for products they may not be able to sell at a profit.



Corn

So the sold-out board and the overpriced board are the same board, photographed from two angles.



Herman

The ones you can still buy carry the markup, and the ones priced honestly are gone. So when Daniel sees a hundred and fifty dollars on AliExpress for something with an official list price of ninety, some of that gap is a reseller who's the only shop with stock left.



Hilbert

Hilbert's Mid-Show Haiku.



Hilbert

The cheap board I wanted. It costs more than my first car. I am told this is progress.



Corn

His second theory was that small chips are somehow being combined into bigger ones. Some packaging trick, little memory dies getting stacked or fused so the small ones get eaten by the big ones.



Herman

I looked for that and I can't find anything supporting it. Nobody in the reporting describes chip consolidation as a mechanism here. The story is capacity reallocation and legacy-node exit. There's no great homogenising of chip sizes going on. LPDDR4 dies are what they always were, there are just fewer of them.



Corn

His third one I actually think is the most natural guess, and it's also wrong. Edge AI. Little local models running on hobby boards, every maker and hobbyist suddenly wanting a Pi for inference, demand pulling from below at the same time the data centres pull from above.



Herman

It's the obvious theory and no source I've seen names it as a driver. Nothing in the price reporting points to hobbyist inference demand. The pull is entirely from the data-centre side. Which makes sense when you look at the numbers, because the hobbyist market for these boards is, in the memory makers' world, rounding error. Even if every Pi owner in the world started running a small language model tonight, the wafers wouldn't notice.



Corn

So the little chip isn't expensive because the little board got popular. It's expensive because the big customer in the same factory got very, very popular.



Herman

Right. And what the market's doing in response is, I think, the new part. The segmentation. You can watch the hobby board market splitting in real time into two products. There's "enough memory to do the job" and there's "memory as a luxury good."



Corn

The one-gig NanoPi Zero2 at eighteen dollars, unchanged, sitting next to a two-gig Banana Pi at a hundred and fifteen.



Herman

Same shop. And Raspberry Pi's answer is almost elegant, in the way that reveals the problem. In April they launched a three-gigabyte Pi 4 at eighty-three seventy-five. Not because anyone was clamouring for three gigabytes. Because three was the amount of memory that could still be priced sanely. The whole point of that product is so buyers, in their words, need not pay for more memory than they use. When your product line's defining feature is "we found a hole in the memory price ladder," the ladder is broken.



Corn

And their classic products, the Zero, the Pi 3 and older, they didn't move at all.



Herman

Not a cent, and Upton said no rises are planned, because those boards use LPDDR2, which is so old the AI boom can't be bothered to want it, and Raspberry Pi holds substantial inventory of it. There's something funny about that. The most obsolete memory in your catalogue is now your most stable cost line.



Corn

The chip nobody wanted turned out to be the chip nobody could take away. There's a fun fact buried in this, by the way, that I only learned while we were prepping. Hobby boards like the Pi have always been built on mature, mass-market parts. The original Pi used a chip designed for set-top boxes, paired with cheap mobile memory that phones had already made plentiful. The whole category rides on yesterday's components being cheap. So the one thing that can really hurt it is yesterday's components running out. Which is exactly what's happened.



Herman

The practical takeaway for Daniel, and honestly for anyone in his spot, is to right-size the memory. A board watching one IP camera does not need four gigabytes. It needs a gigabyte and change, and a one-gig board at eighteen dollars will do the job his departed Pi was doing.



Herman

A one-gig Pi 5 at forty-five, or the NanoPi Zero2 at eighteen, or even one of the older LPDDR2 boards, would sit there and watch that camera for a decade. The trap is buying the two-gig or four-gig board you remember, at the price of a much better computer.



Corn

And the trap has a time component. Upton keeps calling this temporary. Painful but ultimately temporary, difficult but ultimately temporary, prices will be rolled back when memory costs fall. Meanwhile Micron says the shortage lasts until at least twenty twenty-eight. Those two statements can both be true, but they're describing very different waits.



Herman

What's interesting to me is that the shape of the recovery is already visible. Overall DRAM contract prices rose about eighty percent quarter on quarter in the second quarter of this year, then about forty in the third, with about twenty forecast for the fourth.



Corn

Still climbing, but the slope is flattening.



Herman

Which tells you the panic phase is over and the expensive phase has begun. Whether expensive flattens into cheap by twenty-eight is Micron's guess against Upton's promise, and I don't know who's right. But I notice something else in that trend, which is that the steepest rises have already happened to the legacy types. The end-of-life dates are set. Nobody's un-retiring DDR4.



Corn

No, once a fab line moves to LPDDR5, it doesn't move back because hobbyists miss the old prices. The fabs don't do nostalgia.



Herman

The Chinese maker CXMT is the one wrinkle. They still make DDR4 and LPDDR4, and they've returned to profit as prices rose. There was some reporting in April that Samsung stopped taking new LPDDR4 orders and moved those lines to LPDDR5, which is consistent with everything else. If CXMT keeps making legacy memory, they inherit every embedded customer in the world. But nothing suggests they'll cap prices out of kindness.



Corn

Nobody in the memory business has ever done anything out of kindness. It's not in the die.



Herman

Let me ask you something, though, because you're the one in this flat who keeps old hardware alive out of principle. Would you actually buy a one-gig board? Or would you sit there, four gigabytes short of happiness, waiting for the rollback?



Corn

I'd buy the one-gig board and I'd be smug about it, which is the part you were really asking. The camera job needs a gig. I ran a whole home network on less memory than the browser tab this episode is being researched in.



Herman

That's the thing, right. Daniel's actual job is almost insultingly modest. Watch one camera. The two-gig board he remembers was already more than the job needed. The market has just made the mismatch expensive.



Corn

And his "two- and threefold jumps in a year are almost unheard of in tech pricing," that part of his framing deserves a straight answer too. Is that true?



Herman

It's true and it's the tell. In tech, prices fall. Components get cheaper on a schedule you can nearly set a calendar by. A tripling in a year is so far outside normal that it's not really a price signal anymore, it's a supply signal. And the closest analogue we have is the DDR4-over-DDR5 inversion. Old memory dearer than new memory isn't a market at equilibrium, it's a market closing a product.



Corn

The price isn't telling you it's scarce. It's telling you to stop wanting it.



Hilbert

I've been living this since August with a Samsung four-gigabit LPDDR4 part. I need four of them for a controller board I'm repairing. Four. That's it. Used to be you'd buy a handful for pocket change and not think about it. Now the one supplier who answers the phone wants more per chip than the whole board cost new, and the other two want you to open an account, which I won't do.



Herman

Three suppliers?



Hilbert

I keep a sheet. Price by week, by supplier, and a column at the end for how they sounded. The fellow at the Shenzhen outfit has gone from chipper to flat-out resigned since June. The German one is still optimistic, but he's optimistic about everything, so I discount him.



Corn

You're tracking supplier morale in a spreadsheet.



Hilbert

It's a small sheet. The problem is the shipping. Fifteen dollars flat, no matter the quantity. So buying four is nearly four dollars a chip in postage, which is ridiculous, so you buy the quantity where the shipping stops insulting you. Which is why I'm at several hundred. Of a chip I need four of.



Herman

Several hundred LPDDR4 chips.



Hilbert

Two hundred and forty. So I've started sketching a second controller, because that's the only respectable way out of it. My nephew's in distribution, he says the whole legacy line is being kept alive by industrial buyers who'll pay anything, and he's usually wrong about most things, so I don't rely on him. But the resigned one in Shenzhen says the same, and he's never been wrong when he's sounded tired. Last quote I took was Tuesday. Eleven dollars forty a chip, and free shipping over two hundred units. That's the math I'm in.



Herman

Two-forty... he bought his way out of the shipping charge and into an inventory problem. That's the most rational irrational thing I've heard this month.



Corn

Free shipping over two hundred units. The escape hatch is bigger than the room.



Herman

And notice it's the same inversion we were just talking about. His repair chip is expensive for the same reason the two-gig board is expensive. Not because anyone wants that exact chip, but because the factory that made it has moved on, and the few who still hold stock can name their number. The industrial buyers are the cloud servers of the legacy world. Everyone else is the hobby board.



Corn

Which makes the one-gig advice even simpler than I said it. Buy the memory nobody's fighting you for. The whole pricing system right now is a map of what the fabs still want to make, and the bargains are whatever's too old to matter. LPDDR2, the Pi Zero, eighteen-dollar NanoPis. Obsolescence is the discount.



Herman

And that flips the usual advice on its head. For twenty years the rule has been buy more memory than you need, it's cheap. Now the rule is buy less memory than you want, it's dear, and the cheapest board in the shop is the one with the oldest chip on it.



Corn

The open question, the one I'd leave Daniel with, is what's on the other side of this. If Micron's right and the shortage runs to twenty twenty-eight, the hobby market spends two years learning to live on one gigabyte. Habits like that don't reverse just because the price does. The low-memory board might not be the emergency measure. It might be what the market becomes.



Herman

The irony worth chewing on is that the boards least affected are the ones with the least memory, which is the exact opposite of the desktop world, where more memory is survival. The hobby market may come out of this bifurcated, and stay that way even when the fabs roll back the prices. Thanks as always to Hilbert Flumingtop for producing the show.



Corn

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Herman

See you soon, brother.



Corn

See you soon.