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Microprocessors: How did the ARM architecture dominate the mobile chipset market?

It started off as a small player and its competitors were much larger. How did ARM beat the much larger competitors and dominate the mobile chipset market?

3 Answers



Roger Shepherd, Founder and Managing Director at Chipless Ltd

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We need to sort out what the question “How did ARM dominate the mobile chipset market” is getting at. The first thing is to note that ARM do not sell mobile chipsets - indeed they don't sell chipsets. So the question to address is why the ARM architecture is the dominant processor architecture in mobile chipsets.

The pivotal event was the selection by Nokia of a TI chip containing an ARM7TDMI (Thumb capable) processor for its 6110 GSM phone introduced in 1997*. GSM was massively successful throughout most of the world and Nokia went on to dominate the mobile phone market.

However, this doesn't really answer the question. To that we have to address why the 6110 established the ARM standard and how ARM ended up in the 6110 in the first place.

For a phone manufacturer such as Nokia there is an incentive not to change processor architecture - software. This goes beyond simple binary compatibility and includes issues such as engineering familiarity and software tool familiarity. As a result, anyone selling mobile chips to Nokia would likely have to supply ARM architecture processors.

But Nokia were not the only phone manufacturer. Other manufacturers wouldn't have had the same architecture compatibility issues. However the 6110 design-win gave TI the ability to push its chips into other manufacturers, and gave ARM market backing for its

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There are a couple of developments which had happened by the early 90s - one technical, one business. The technical development was the simple 32-bit processor ("RISC"). These were small enough to be implemented as part of a chip and well-enough architected that they were easy to program (in contrast to many 8- and 16-bit processors). ARM was just one of many (MIPS, SPARC, ST20, ...). The business development was "processor as IP" - the idea that a company's business could be selling a processor design to another company that would build a chip incorporating it; this was ARM's business.

TI were well known as a supplier of DSPs and when looking to produce a chip integrating DSP and a general purpose processor it would have had a choice of using an internally developed processor or licensing one. It is likely that Nokia would prefer a licensed core - firstly, it would keep Nokia's choice of chip supplier open in the future (other companies could produce architecture compatible chips), and secondly, they might feel the software story was stronger - tools, operating systems etc. So, TI proposing an ARM core would have been a sound approach.

However, many of the RISC cores suffered from an important problem - the code density was poor. This means that for a given amount of memory, the function that can be implemented is limited; or, that for a given function more memory is needed - and hence more cost. Apparently Nokia weren't happy with the code density of the ARM7 processor and so ARM developed "Thumb" an alternative instruction set which addressed the code density issue.

* I've now (2016/5/18) found a reference to this on the ARM website ([A Brief History of ARM: Part 1](#)) which dates ARM's deal with TI as 1993 and gives 1994 as that date when "ARM's big break came" which "led to ARM creating a custom 16 bit per instruction set that lowered the memory demands" (Thumb).

[2016/5/18 Added final 's' to "... 8- and 16-bit processors"]

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Igor Markov, researcher of computing and semi technologies

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Steve Furber  was designing processors for very long time without getting as nearly as much commercial traction as Intel. So (to simplify), he did several clever things --- find a niche for which Intel CPUs were really bad (small low-power devices), mercilessly optimize his designs for that niche, come up with a business model where Intel could not compete. The last one includes a much smaller price than what Intel would need to charge to ensure profit, and also the ability to embed ARM CPUs into larger designs (soft IP). I don't know what safeguards ARM uses against the theft of soft IP, but the business model itself does not make theft very lucrative -- since the cost of an ARM CPU is only a small fraction of the total cost of an electronic device, a company that manages to sell a very large number of such devices would be better served by paying the small royalty to ARM than run the risk of a legal challenge and an injunction.

For many years, Intel was emphasizing how important it was for a CPU to be Intel-compatible, and this worked in the desktop world. However, as chip technology advanced, the mobile sector overtook desktop computing. I would not say that Intel overlooked this trend, but somehow they were unable to compete (XScale, StrongArm, etc). It also helped that Microsoft was very slow to support mobile, while Apple was effective --- this decreased the need for Intel-compatible CPUs. Yet another competitive advantage that ARM developed over the years is that they were *not* following the "build and they will come" mantra that was popular among US hardware companies (starting with IBM's PC effort where software was outsourced to the small company called Microsoft). ARM developed a complete and effective tool-chain (including compilers, debuggers, etc) for customers to handle their CPUs --- the MIPS toolchain has been significantly weaker most of the time.

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Dan Zhang, Computer Engineering PhD student at UT Austin; interned at Microsoft and Apple

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ARM became popular for PDAs, which were the precursors to smartphones. ARM aggressively targeted the PDA market unlike MIPS. Many companies such as Intel built ARM processors (e.g. Intel had XScale) for use in such devices. Of course, Intel later sold the XScale business in order to focus on x86.

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