Debate: Microservices and Microkernels

Based on the exchanges between Linus Torvalds and Andrew Tanenbaum (Open Sources, 1999) regarding Linux and Minix, each man's passion for their design choices matches the degree of defence for either microkernels or monolithic architectures. Torvalds' argument is agreeable that monolithic architectures permit better hardware integration. For example, he states, "The very idea of an operating system is to use the hardware features and hide them behind a later of high-level calls". Since the MINIX operating system utilises a microkernel architecture, Torvalds notes, "Minix now cannot easily be extended to have things like paging, even for machines that would support it". Tanenbaum's argument for microkernels is that an operating system should be portable to new hardware platforms.

Contrasting their views, on the one hand, Torvalds is correct that portable systems ultimately reduce in usefulness, as the design accommodates for the least common denominator. On the other hand, Tanenbaum is correct that breaking monolithic systems down to their constituent components results in better portability and (by association) maintainability. Biggs et al. (2018) looked at the benefits of microkernel architecture. They observed that while monolithic systems have high performance and low context switches, in contrast, microkernel architectures may suffer slight performance costs due to an increased number of context switches. Microkernel architecture is favoured because it **isolates** kernels from the core kernel, enables the **design of least privilege** and supports f**ault containment** if services are compromised. They conclude, "We find that 29% of all critical Linux vulnerabilities would be completely prevented in a microkernel-based system ... and roughly 96% of critical Linux exploits would not reach critical severity in a microkernel approach" (Biggs et al., 2018).

My position on the debate is to agree with Tanenbaum's view concerning microkernel architecture because such an architecture is evident in modern system design with concepts such as "microservices", "containers", "hypervisor" (Shropshire, 2014), or "web servers". As with microservices, microkernels are recommended to be as small as possible with minimal functionality. Büttner & Richter (2004) note that microkernel architectures can be applied to many application domains, not just operating systems and have multiple benefits such as a well-structured system design, increased availability, fault tolerance or inter-process communication transparency. However, their biggest downside for implementation is the increased overhead and diminishing performance as the number of microkernels increases.

Tanenbaum, therefore, was a man of vision, a vision of portability and componentisation ("processes").

References

Biggs, S., Lee, D. & Heiser, G. (2018). The jury is in: Monolithic os design is flawed: Microkernel-based designs improve security. *Proceedings of the 9th Asia-Pacific Workshop on Systems*:1-7.

Büttner, E. & Richter, S. (2004). Microkernel–An Architecture Pattern. Technische Berichte:18.

Open Sources, (1999): Voices from the Open Source Revolution: Appendix A: The Tanenbaum-Torvalds Debate. Available from https://www.oreilly.com/openbook/opensources/book/appa.html [Accessed 27 Oct. 2021]

Shropshire, J. (2014). Analysis of monolithic and microkernel architectures: Towards secure hypervisor design. *2014 47th Hawaii International Conference on System Sciences*:5008-5017.