Unit 12: The Great Tanenbaum-Torvalds Debate Revisited

Required Reading

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 (APSys '18). ACM 16:1–7.

Summary
The document critically evaluates the limitations of monolithic operating system designs, such as Linux, Windows, and MacOS, particularly in terms of security vulnerabilities. It emphasizes that the growing complexity and size of these OS kernels inherently expand their Trusted Computing Base (TCB), leading to an increase in security flaws. In contrast, microkernel-based designs, like those using the formally verified seL4 kernel, prioritize minimal TCBs and internal protection boundaries, significantly enhancing security. Through a detailed analysis of critical Linux vulnerabilities, the study concludes that a microkernel approach could mitigate 96% of these issues, with 40% of them entirely eliminated under verified microkernel systems. The findings advocate for a systemic shift towards microkernel-based OS architectures to meet modern security demands.

Reflection
The analysis highlights an important yet often overlooked challenge in modern OS development: the trade-off between functionality and security. By addressing the fundamental design flaws of monolithic systems, the study encourages a rethinking of foundational structures in operating system architecture. It underscores how the relentless pursuit of features and performance can lead to vulnerabilities that compromise the very integrity of the systems we rely on. The findings reinforce the value of minimalism and modularity in software engineering, exemplified by microkernel designs. This reflection emphasizes the need for a paradigm shift, urging the industry to prioritize secure design principles and invest in formally verified systems, not merely as an option but as a necessity for robust cybersecurity in an increasingly interconnected world.

Bucchiarone, A. Dragoni, N. Dustdar, S. Larsen, S.T. & Mazzara, M. (2018) From Monolithic to Microservices: An Experience Report from the Banking Domain. IEEE Software 35 (3):50-55.

Summary
The report examines the transition of Danske Bank's FX Core system from a monolithic to a microservices architecture, highlighting the challenges and benefits associated with this migration. Monolithic systems often face scalability and adaptability issues due to tightly coupled components and shared resources. The new microservices-based architecture breaks the system into smaller, independently deployable units that enhance modularity and allow for efficient scaling and deployment. Using tools such as Docker for containerization, RabbitMQ for integration, and a continuous integration/continuous deployment (CI/CD)

pipeline, the system now supports automated updates, fault tolerance, and improved monitoring. This modular approach has not only resolved the inflexibility of the old system but also paved the way for more efficient team collaboration and dynamic adjustments in the rapidly evolving foreign exchange market.

Reflection

The study is a significant contribution to software testing and complexity analysis,

The transition from a monolithic to a microservices architecture represents a significant shift in how complex systems are managed and scaled, particularly in domains like banking, where performance and reliability are critical. This case study demonstrates the profound impact of microservices on addressing the limitations of monolithic designs, such as rigid scalability and maintenance hurdles. While the new architecture introduces its own complexities—such as managing distributed components and ensuring effective orchestration—the benefits of agility, fault isolation, and independent deployments outweigh the challenges. This migration underscores the importance of embracing modern DevOps practices and robust infrastructure to support evolving business needs, making it a valuable example for organizations considering similar transformations.

Additional Reading

Schmitz, T., Rhodes, D., Austin, T.H., Knowles, K., Flanagan, C. (2016) Faceted Dynamic Information Flow via Control and Data Monads. In: Piessens F., Viganò L. (eds) Principles of Security and Trust. POST 2016. Lecture Notes in Computer Science, vol 9635. Springer, Berlin, Heidelberg.