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SCALING AI IN THE CLOUD: THE DISRUPTION OF "CLOUDIFICATION" IN CONNECTED AND AUTONOMOUS VEHICLES

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Introduction: Cloud Infrastructures and the Rise of AI in CAVs

The rise of artificial intelligence (AI) is deeply intertwined with cloud infrastructure, which is largely controlled by Big Tech platforms (Van der Vlist et al., 2024). These companies monopolize computational resources, storage facilities, and data pipelines—critical components for the development, deployment, and scaling of AI-driven systems, products, and services (Narayan, 2022). This paper examines the case of Connected and Autonomous Vehicles (CAVs)—cars integrating "smart" digital components—to explore how "cloudification" has emerged as a key infrastructural transformation in the industrialization of AI.

CAVs and the broader automotive sector serve as a compelling case study for several reasons. The industry involves extensive data collection, often used for profiling users (Caltrider et al., 2023; Hill, 2024), relies on complex global supply chains shaped by geopolitical dynamics, and has historically been a site of significant technological innovation (Hind 2024). Inductively, CAVs illustrate the "industrialization" of AI as it moves beyond specialized applications to acquire infrastructural characteristics across multiple industries.

This paper synthesizes insights from three fields: platform studies, science and technology studies (STS), and innovation studies. First, we draw on research on cloud

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infrastructures (Narayan, 2022), “cloudification” (Kotliar & Gekker, 2024), and AI’s dependence on the cloud (Ferrari, 2023; Van der Vlist et al., 2024) to examine how cloud-based logics govern economic relationships between Big Tech firms and their clients. Second, we engage with scholarship on the platformisation of automobility (Hind & Gekker, 2022; Hind et al., 2022; Hind et al., 2024) to analyze how such logics are further being adopted by CAV firms and the automotive industry, driven by contemporary AI hype. Lastly, we contribute to debates on AI innovation—both within and beyond the CAV sector—by examining the fraught process of transitioning AI from laboratory development to large-scale application and public adoption (Hind, 2024; Illiadis & Acker, 2022; Jaton, 2021; Pfotenhauer et al., 2021).

Method: Investigating CAV Patents and Cloudification

This research is based on a large-scale analysis of patents related to CAVs. While patents do not provide precise descriptions of technological advancements, they serve both as material records of innovation (Parks & Starosielski, 2015) and as speculative imaginaries of future technological shifts (Egliston & Carter, 2022; Jasanoff & Kim, 2015; Shapiro, 2020). Scholars in internet studies and STS have increasingly used patent data to trace emerging technological trends (e.g., Bucher, 2020; Illiadis & Acker, 2022). By analyzing these patents, we map both the *strategies* and *imaginaries* of cloudification in CAV technology and innovation discourse (cf. Richter et al., 2024).

Our methodology consists of two steps. First, we queried Google Patents to collect a dataset of 8,823 patents related to CAVs. This dataset includes metadata such as titles, assignees, timestamps, and issuing offices. Using topic modeling, we identified key themes and word co-occurrences, particularly focusing on terms related to cloud computing (e.g., “server”, “cluster computing”). Second, we selected 50 patents most directly relevant to cloud technologies in the CAV industry, compiling a sizable corpus of patent documents. We then used a large language model (Mistral Small 3), chosen for its open-source, locally-run capabilities, to help systematically analyse these texts (Törnberg, 2023), identifying patterns in how cloudification is conceptualized within CAV innovation. Through iterative, inductive analysis, we bridge these findings with broader scholarly discussions on AI industrialization.

Preliminary Findings: Cloudification, Industry Strategies, and AI Imaginaries in CAVs

Through a mixed-methods analysis of CAV patent documents, we provide evidence of the cloudification of the automotive sector. First, we offer a macro-level perspective by mapping the broader ecosystem of industry players, key innovations, and leading hubs of technological development. Second, we conduct a more granular analysis of the cloud business strategies employed by major CAV firms, examining how they help structure, govern, and shape cloud-based innovation in relation to CAVs. Together, these analyses demonstrate that cloudification is being driven by a tightly interconnected network of automotive, hardware, and Big Tech firms that collectively seek to industrialize, scale, and assert structural dominance over the AI-driven CAV industry.

Our preliminary analysis reveals how the cloud has become an integral component of CAV development, shaping both industry structures and technological trajectories. We map this evolving ecosystem, identifying key connections between industry players, emerging cloud-based innovations, and the research hubs driving these developments. Several notable patterns emerge: the significant role of Big Tech hardware firms (e.g., Intel and Nvidia) in leveraging large-scale cloud infrastructures; the growing involvement of Chinese tech firms (e.g., Baidu, Pony.ai, TuSimple, Nio) amid geopolitical tensions surrounding the automotive sector; the strategic shift of legacy automakers (e.g., Toyota and Nissan), which have redirected their established innovation pipelines toward cloud-based data and AI-driven mobility solutions; and the bubbling undercurrent of AI and CAV start-ups (e.g. SafeAI, Motional, Bedestrian).

At a more granular level, the patents reveal distinct cloud business strategies among leading CAV firms. These strategies shape how specific companies design, manufacture, and operationalize AI-driven mobility technologies at scale. The patents reflect a broader imaginary in which the cloud plays a central role in enabling AI-powered functionalities in CAVs, including: vehicle-to-vehicle and vehicle-to-device communication; object detection and proximity sensing; dashboard integrations for traffic and mobility services; and remote diagnostics. Notably, the cloud is positioned both in contrast to and in support of edge computing, highlighting an ongoing tension between centralized cloud infrastructures and the increasing computational capabilities of local devices. In short, through an analysis of patent documentation relating to CAV innovations, the “cloudification” and subsequent industrialization of AI becomes concrete as both material technological strategies and proposed visions/imaginaries for the future of the field.

Conclusion

The paper underscores the centrality of cloud infrastructure in shaping the future of AI-powered mobility. Cloudification is not merely an industry trend but a structural transformation driven by a coalition of automotive, hardware, and Big Tech firms seeking to expand platform logic beyond individual manufactured units into AI-enabled, globally scalable infrastructures. Across this constellation of actors, cloudification is posited as *the* desired developmental approach for a host of technologies, from data connectivity to machine vision. This shift reinforces the structural dominance of Big Tech platforms, which consolidate their control over AI supply chains by embedding cloud services as indispensable intermediaries - even in “mature” sectors with established players, such as the automotive industry.

As a result, a precarious rentier dynamic (Sadowski, 2021, Nethercote, 2023) is emerging, wherein CAV manufacturers and related firms are becoming increasingly dependent on Big Tech’s cloud infrastructure. As we contend, this dependence has the potential to create bottlenecks, vulnerabilities, and long-term dependencies that shape the future of AI-driven mobility - at a time when new kinds of “technological sovereignty” (Rikap & Lundvall, 2021) are being asserted through trade tariffs, export bans, and “onshoring” techniques. Ultimately, the cloudification of CAVs exemplifies the broader industrialization of AI—an expansion of computational infrastructures that extends beyond traditional technology sectors to transform mobility and global economies.

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