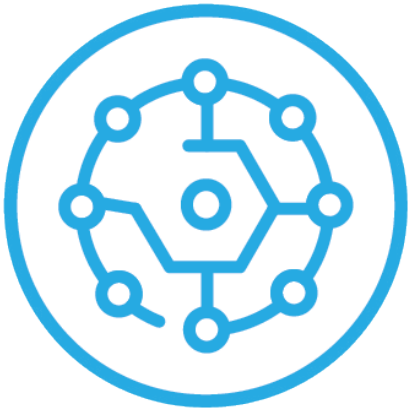
EPoSS.
European Association on
Smart Systems Integration



Joint workshop by EPoSS and
INSIDE Industry Associations

# The Future of Innovation in Edge AI

Online, April 04, 2025

***Notes from the Workshop***

*Part VI: Chiplets for Automotive AI: Enabling Scalable Intelligence at the Edge*

*Presented by Hans-Jörg Vögel, BMW*

## 1. The Rise of AI in Automotive

Artificial intelligence has become a transformative force across industries – and the automotive sector is no exception. Over the last decade, a wave of AI-driven innovation has reshaped everything from autonomous driving systems to personalized user interactions within vehicles.

In recent years, the industry has seen the emergence of **foundation models** – AI models pre-trained on vast datasets and capable of performing tasks they weren't explicitly trained for. These models promise greater flexibility and performance but also introduce a new level of **computational demand**, particularly at the edge – within the vehicle itself.

## 2. Edge AI in Vehicles: Expanding Use Cases and Growing Demands

AI is now deployed across a wide spectrum of automotive applications:

- **Predictive maintenance**
- **Natural user interaction**
- **Driver monitoring**
- **Cabin surveillance**
- **Automated and assisted driving**

Modern automated driving systems increasingly rely on deep neural networks and even **end-to-end transformer-based models**, replacing traditional algorithmic approaches. These models require immense computational resources – especially as we move toward **Level 3 and Level 4 autonomy**.

To put it in perspective: the **compute power** needed has jumped by two orders of magnitude, from gigatops (Giga operations per second) to **teratops** (Trillion operations per second). Just a few years ago, this level of processing was limited to the world's top supercomputers – today, it's expected to run inside a car.

## 3. Power Efficiency: The Core Design Constraint

With rising AI workloads comes an urgent challenge: **energy efficiency**. Every watt consumed by AI computation is one less watt available for electric vehicle (EV) propulsion. Maximizing energy use efficiency directly correlates with increased driving range and sustainability.

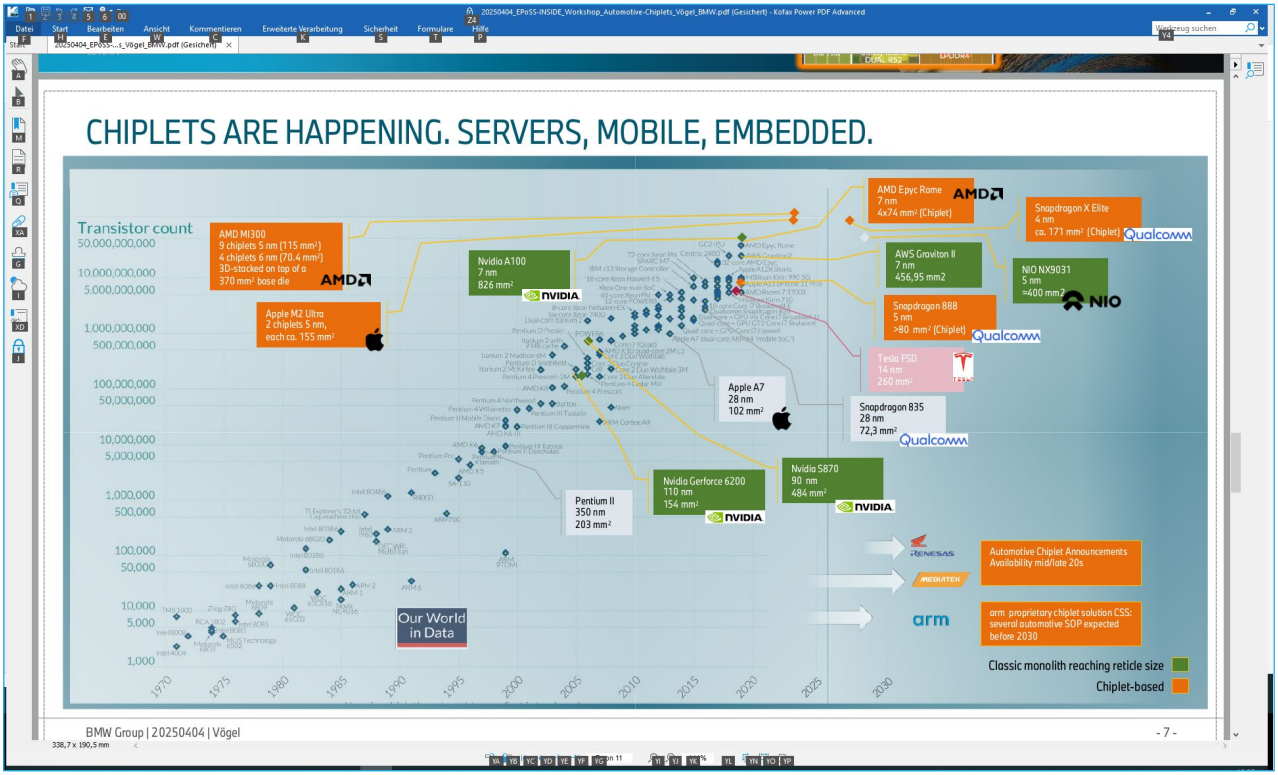
This has made **power-aware AI hardware** a priority. The focus is shifting toward:

- Developing **low-power AI accelerators**
- **Model optimization techniques** like pruning and quantization
- **Cross-layer co-design**, aligning AI algorithms, network architectures, and hardware capabilities

Rather than simply scaling up hardware, successful deployment demands a holistic design strategy. This includes **neural architecture search** and **hardware-software co-design**, ensuring optimal performance-per-watt across the full system stack.

## 4. From Monolithic Chips to Modular Chiplets

Historically, advances in compute power have been driven by **Moore's Law** – packing more transistors onto ever-larger silicon chips. But modern AI processors have reached sizes of 400–800 mm², nearing the **reticle limits** of chip manufacturing.




Copyright: BMW

This is where the **chiplet paradigm** enters.

Rather than producing massive monolithic system-on-chips (SoCs), designers now **divide chips into smaller chiplets**, which are assembled in a single package. This modular approach offers:

- **Improved yield and lower costs** by using smaller dies
- **Scalability** to increase performance without pushing manufacturing limits
- **Heterogeneous integration**, allowing different chiplets to be built on different process nodes (e.g., mixing advanced 3nm AI accelerators with legacy 28nm safety controllers)

In server and cloud domains, this transition is well underway. AMD's MI300, for instance, already integrates **13 chiplets** in one package. This modularity is now gaining momentum in **automotive and embedded systems** as well.

## 5. Chiplets in Automotive: A New Frontier

Automotive systems have unique requirements – safety, long lifecycles, and operational robustness. Chiplets provide new flexibility to address these challenges while supporting the fast-evolving needs of AI.

Key advantages include:

- **Cost-efficiency:** Spreading advanced compute across multiple chiplets lowers the design burden and reduces silicon waste.
- **Technology diversity**: Not all subsystems need to use the latest (and costliest) nodes; legacy components can coexist with bleeding-edge AI blocks.
- **Faster innovation cycles**: AI accelerators can be updated independently of the rest of the system.

This **heterogeneous compute integration** is especially useful in the automotive sector, where **AI advances rapidly**, but other components (e.g., safety-critical logic) evolve more slowly.

## 6. Global Momentum and Europe's Position

Globally, the **automotive chiplet trend** is accelerating:

- In **Japan**, the Toyota-led **Advanced Semiconductor Technology Research Association (Astra)** is developing reference architectures for chiplet-based automotive systems.
- In **North America**, key industry players are also investing heavily in this space.
- In **China**, similar initiatives are underway, though with a slight delay.

In **Europe**, there is strong research expertise but a lack of industrial ambition. However, this is starting to change. The **IMEC Automotive Chiplet Program** (which includes BMW among its founding members) aims to close this gap and foster European leadership.

Recent announcements, such as IMEC's expansion into Germany with a focus on **automotive chiplet industrialization**, signal renewed momentum.

## 7. Conclusion: Toward a Modular, Efficient AI Future

As vehicles become more intelligent, connected, and autonomous, **edge AI will only grow in importance**. The compute demand of foundation models, transformer networks, and generative AI in cars must be met with **scalable, efficient hardware architectures**.

**Chiplets** offer a practical, powerful solution – enabling high-performance, energy-efficient, and adaptable AI systems for next-generation vehicles. With collaborative efforts across research, industry, and policy, Europe is well-positioned to play a leading role in this emerging frontier.

BMW CEO Oliver Zipse at CES 2023[1]: *"The car is not an iPhone on wheels."* It's a mission-critical system that demands custom-fit technologies – and chiplets may be the key to driving AI at the edge forward.

1 https://www.carsifu.my/news/bmw-boss-not-afraid-of-tech-rivals-cars-arent-iphones-on-wheels