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Tampere University

SpliTech

Performance of Large Language Models Across Edge and Cloud Platforms in Smart Spaces

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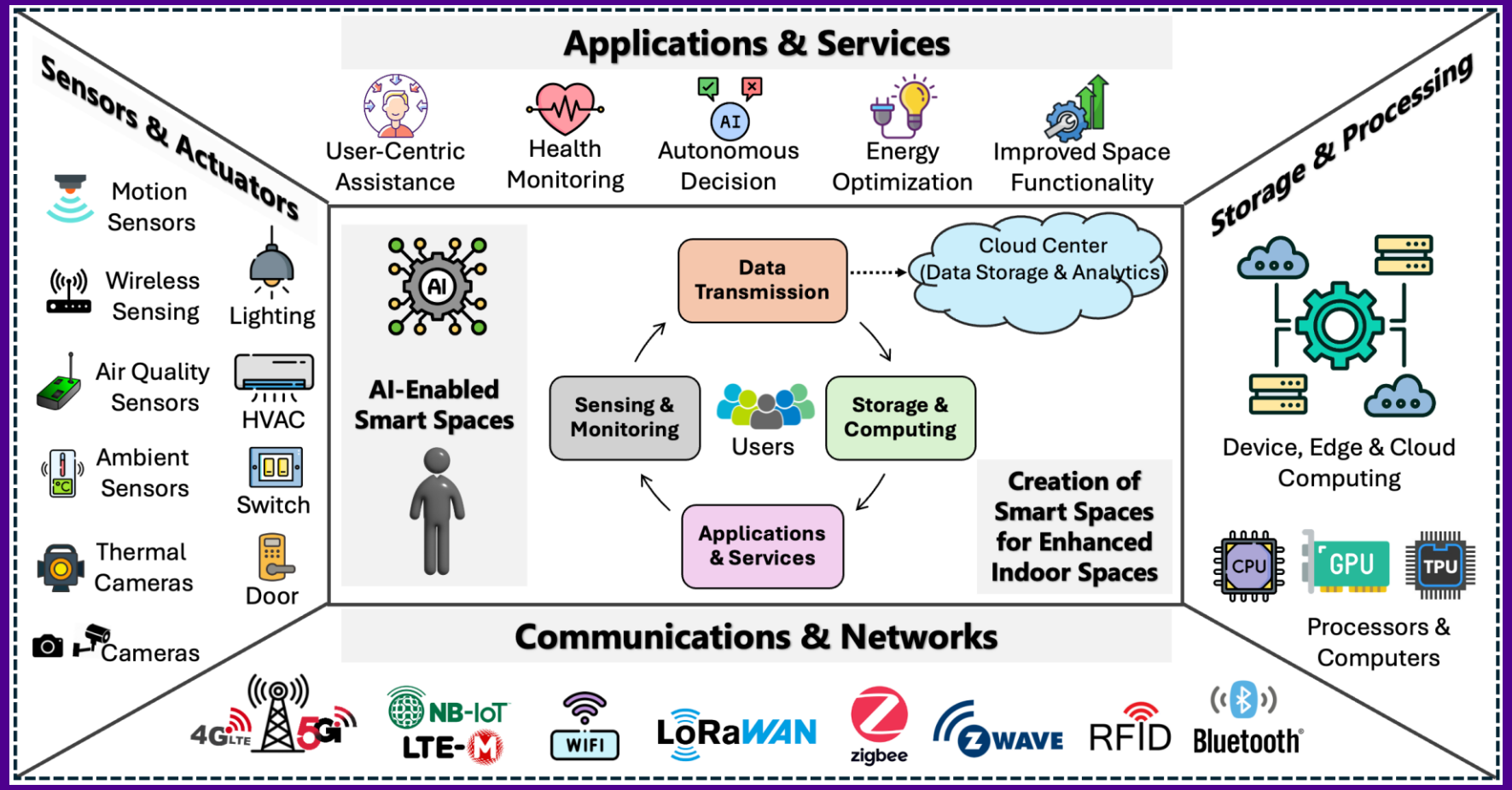
Outline

- ❑ Smart Space
- ❑ AI Applications in Smart Spaces
- ❑ Motivation
- ❑ Hybrid LLM Frameworks in Smart Spaces
- ❑ Experimentation
- ❑ Results
- ❑ Conclusion

1. Smart Space



Varol, A., Motlagh, N. H., Leino, M., Tarkoma, S., & Virkki, J. (2024). Creation of AI-driven Smart Spaces for Enhanced Indoor Environments--A Survey. *arXiv preprint arXiv:2412.14708*.

2. AI Applications in Smart Spaces

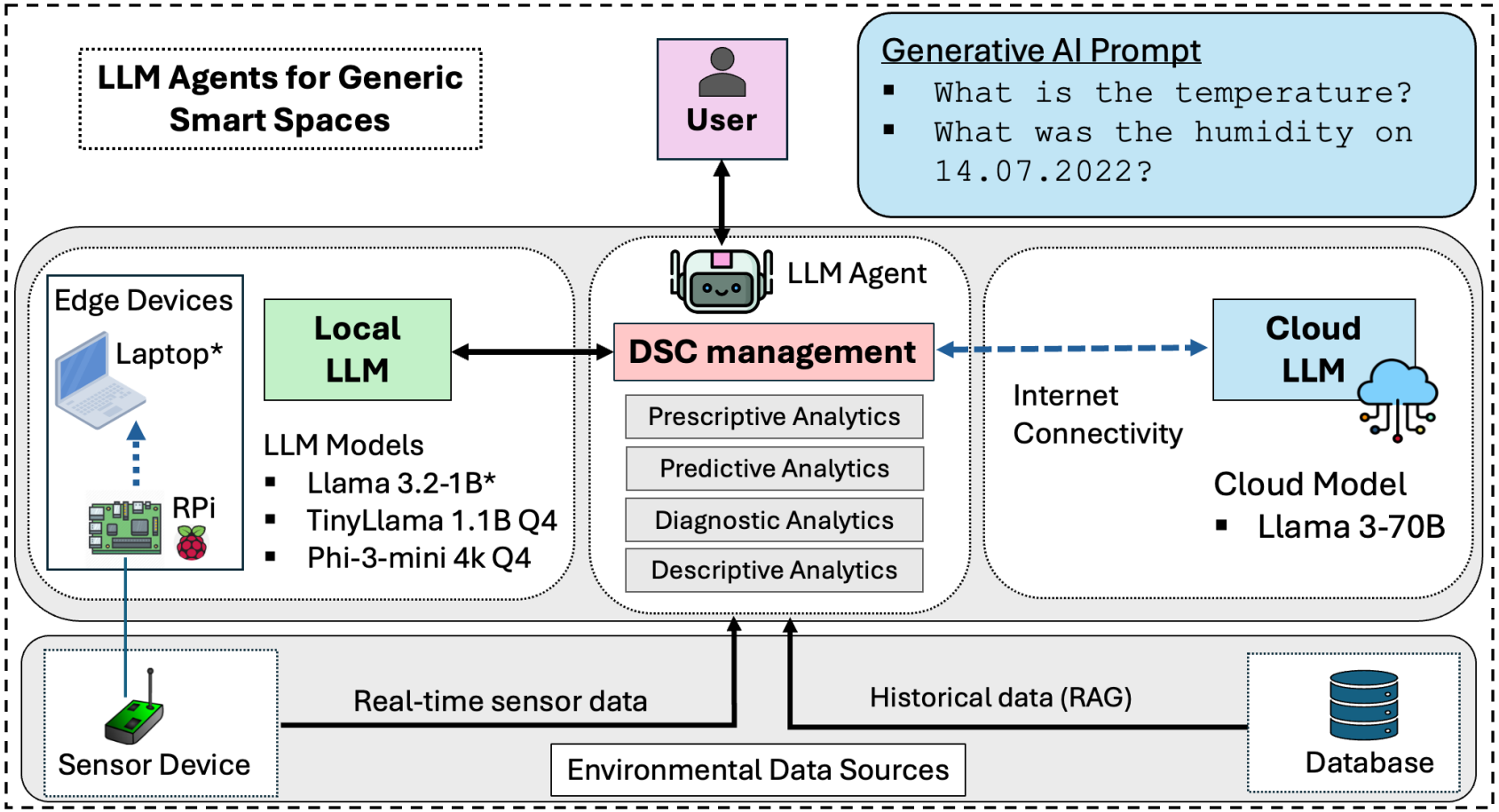
- Activity classification
- People counting with IR sensors
- Action anticipation
- Fall detection
- Converting natural language commands into actions
- HVAC control for energy management
- Detecting behavioral changes

- Machine Learning
- Deep Learning
- Transformer Networks
- Large Language Models

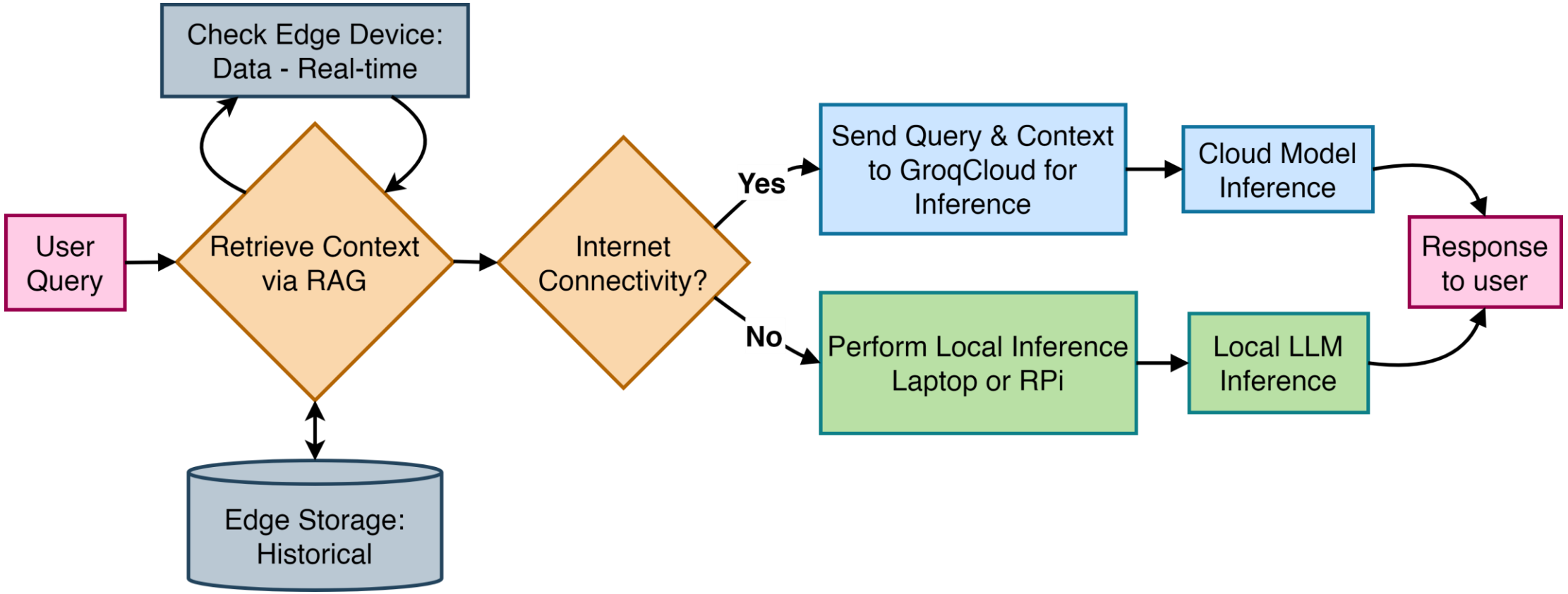
3. Motivation

- AI agents are everywhere in smart environments
- Benefits are huge, so are the risks
- Privacy is one of the main challenge/risk
- We present hybrid LLM framework
- Our solution is keeping data on local devices

4. Hybrid LLM Frameworks in Smart Environments



4. Hybrid LLM Frameworks in Smart Environments



5. Experimentation

Descriptive Analytics

Q: What is the Temperature on 21.11.2020?
A: 29.1

Diagnostic Analytics

Q: From 26.11.2020 to 27.11.2020, list previous and current readings for each sensor parameter and specify if these changes likely impacted the $PM_{2.5}$ level.
A: NH3: 0.82 – 0.69 NO2: 0.12 – 0.14 (No) CO: 4.92 – 4.39 (Yes) PM25: 0.0 – 0.0 (No) Temp: 29.58 – 30.04 (No) Pressure: 943.59 – 945.51 (No) Humidity: 41.06 – 40.78 (No) O3: 7.69 – 5.12 (Yes)

Predictive Analytics

Q: Based on data from 28.11.2020 to 29.11.2020, predict the value of Humidity for the next day.
A: 41.06

Prescriptive Analytics

Q: Between 04.12.2020 and 05.12.2020 analyze the CO value. Based on this value, recommend action to optimize both air quality and thermal comfort.
A: Increase ventilation and consider using air purifiers to optimize air quality, and maintain a comfortable temperature between 22–25°C to balance thermal comfort.

Gartner's Analytics of Processing Data*

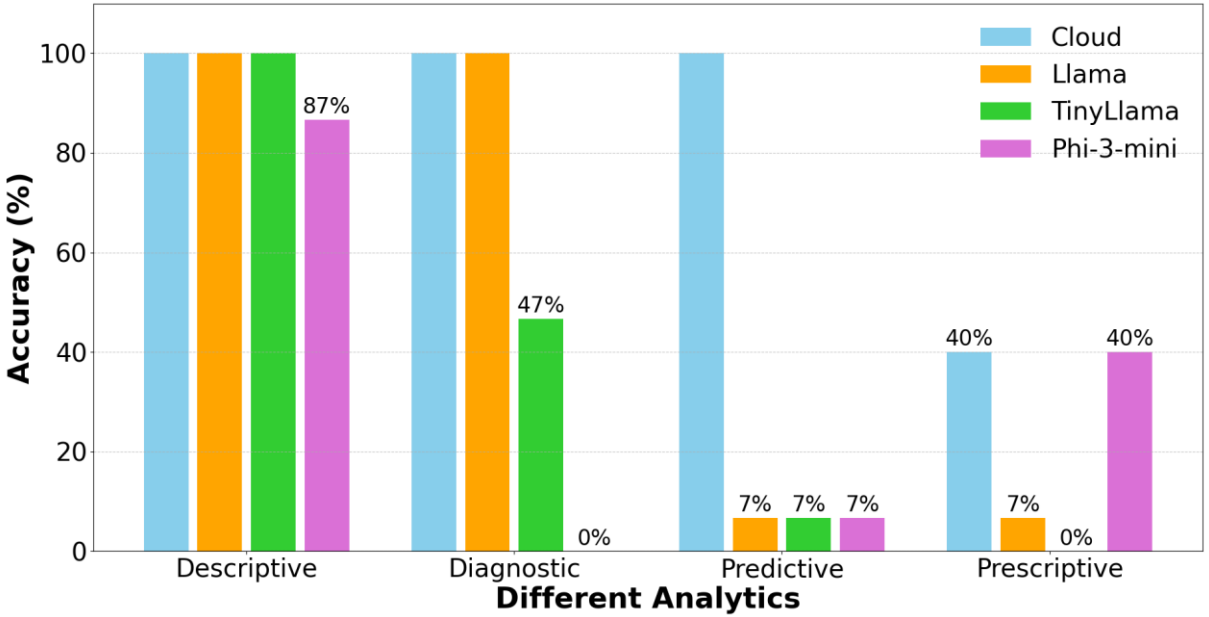
1. What happened?
2. Why did it happen?
3. What will happen?
4. How can we make it happen?

Difficulty

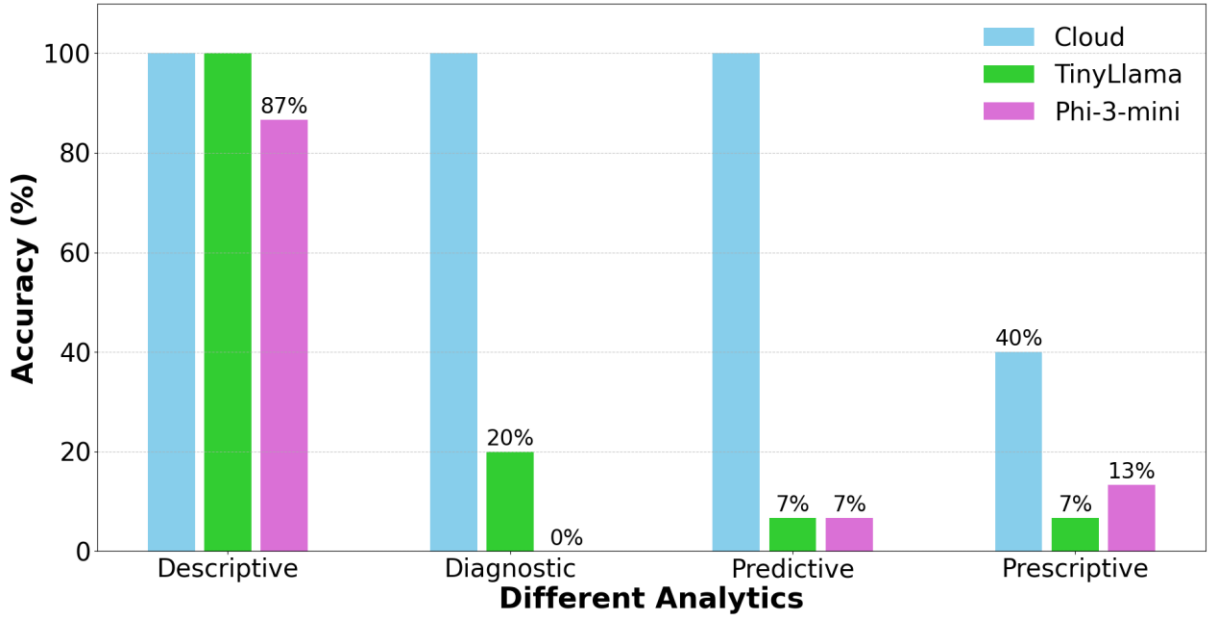
*M. Maoz, "How it should deepen big data analysis to support customer-centricity," Gartner G00248980, 2013.

6. Results - Accuracy

Generic Laptop

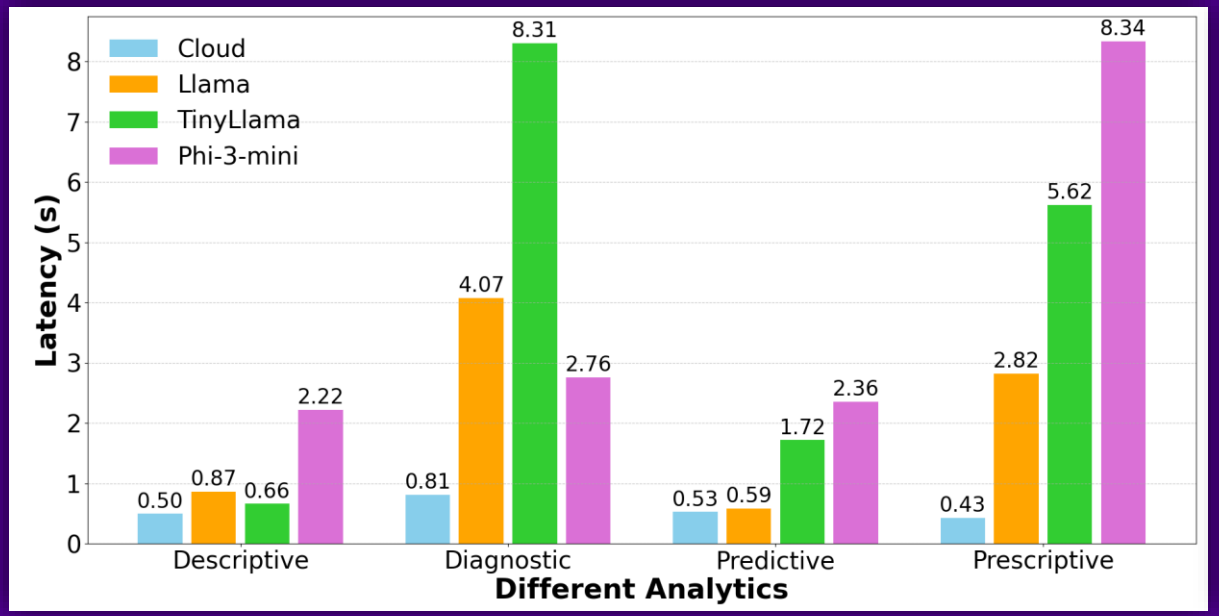


Raspberry Pi 4

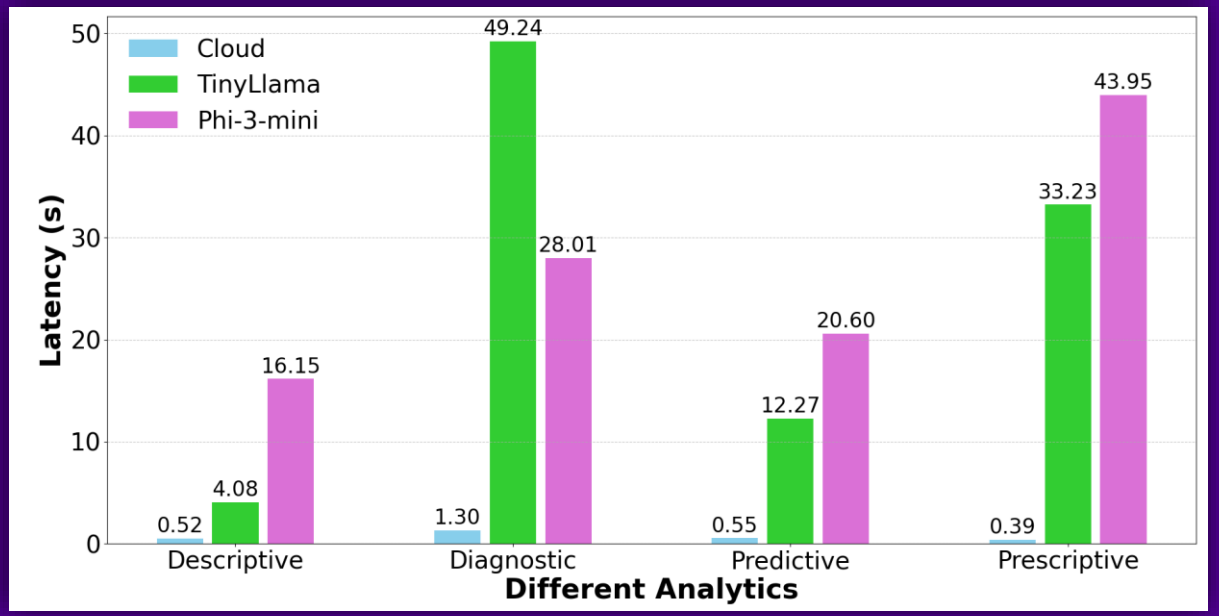


6. Results - Latency

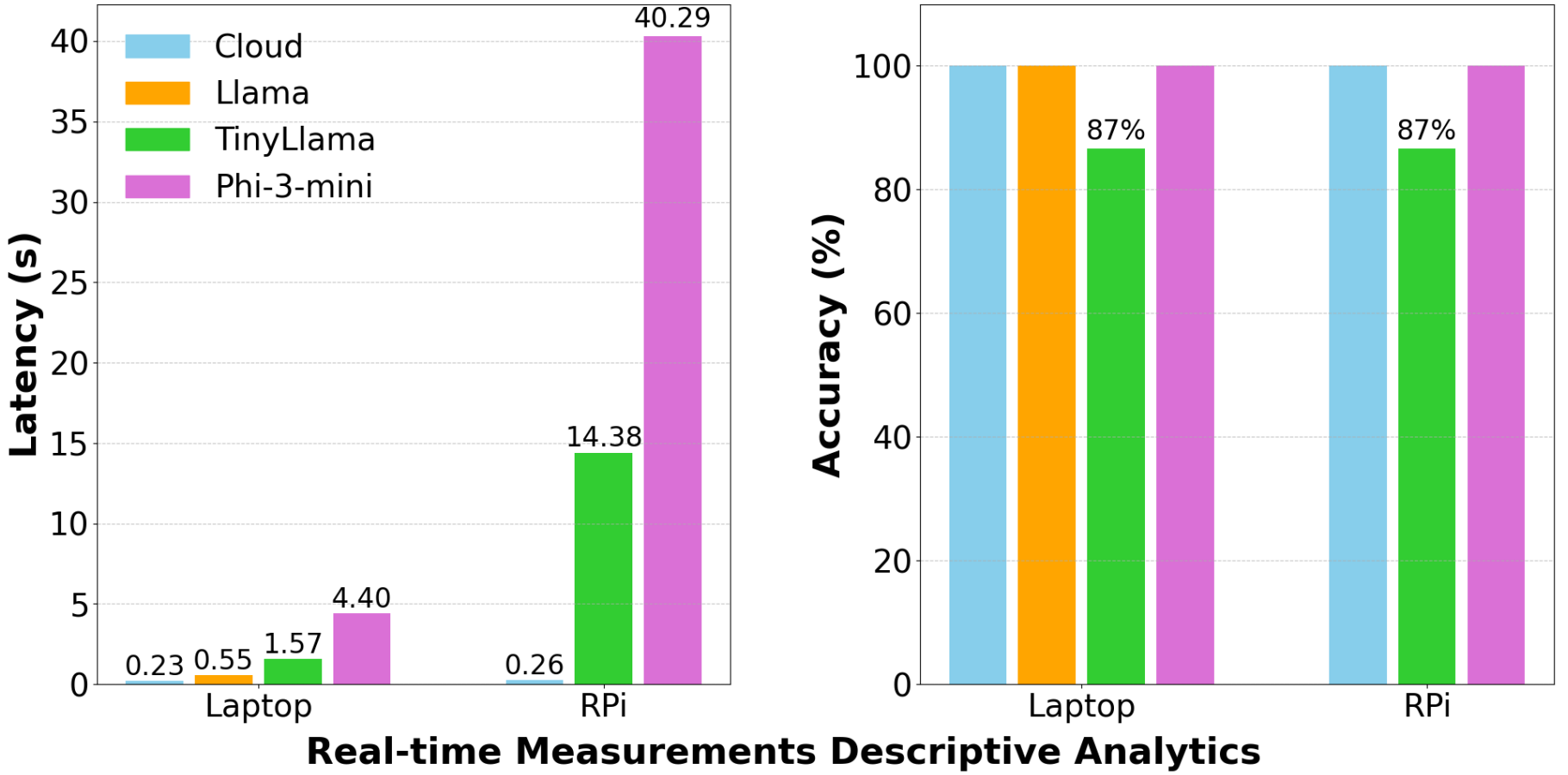
Generic Laptop



Raspberry Pi 4



6. Results – Real-time



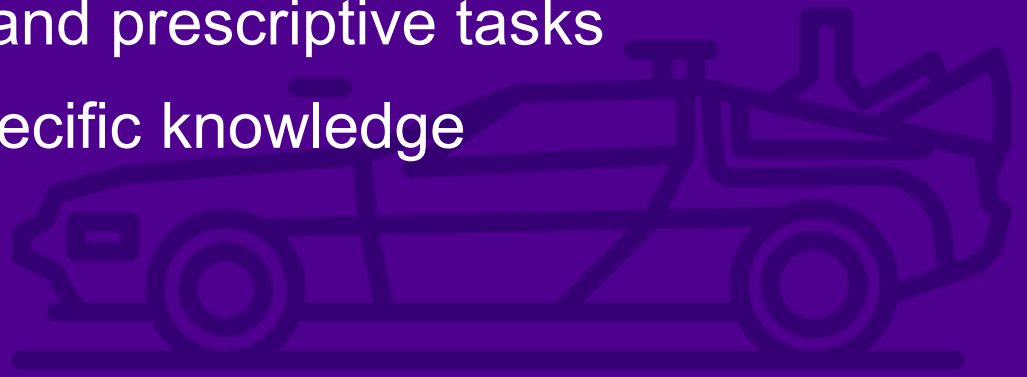
7. Conclusion

- Edge is resilient
  - Simple analytics can be achieved on the edge device
- Hybrid framework keeps data local

- Cloud excels at depth
  - Complex Analytics require cloud capability

Future work

- Fine-tuning local LLMs for predictive and prescriptive tasks
- Equipping local LLMs with domain-specific knowledge



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Thank you!

Questions?

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