

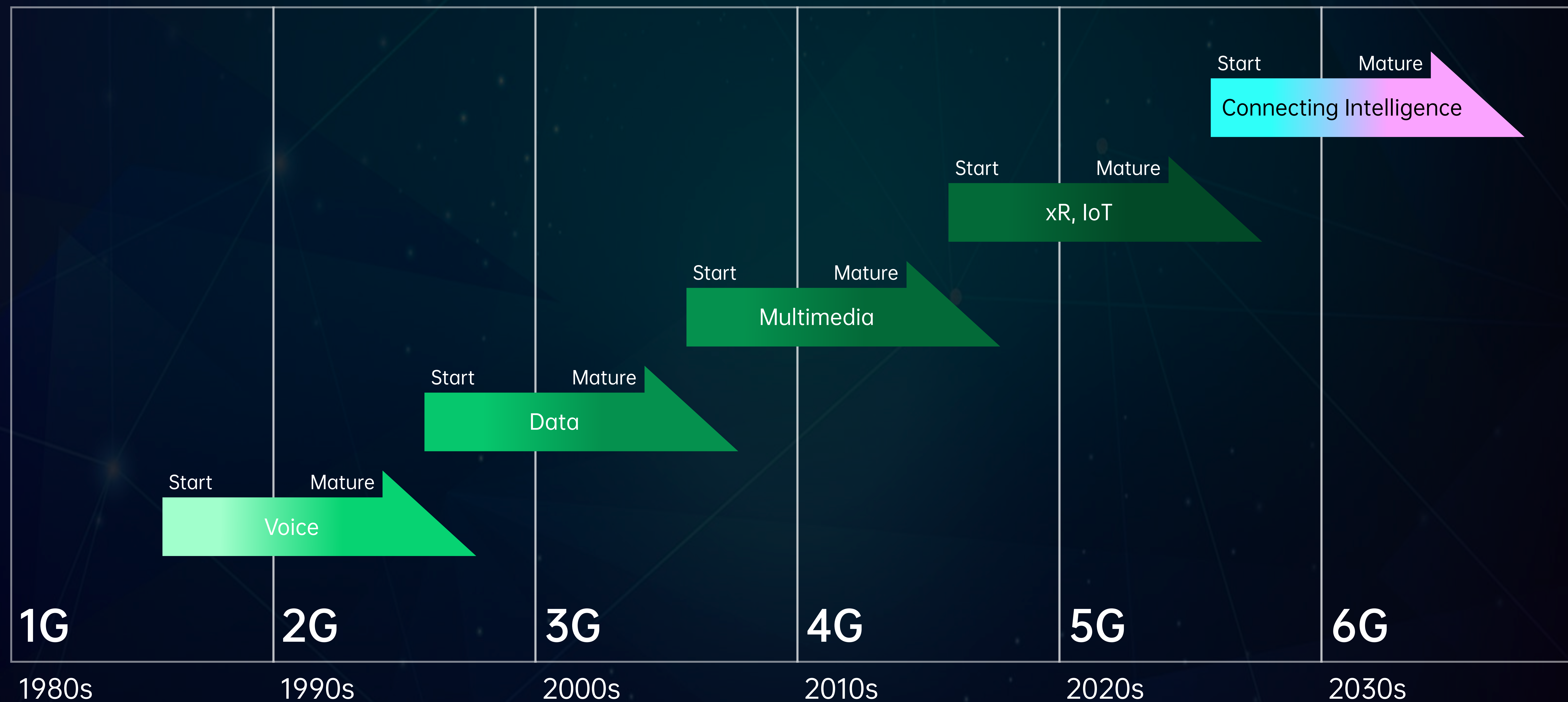
oppo

# B5G & 6G - Connecting Intelligence

2019.05.22



## ► A new service matures over 2 Gs



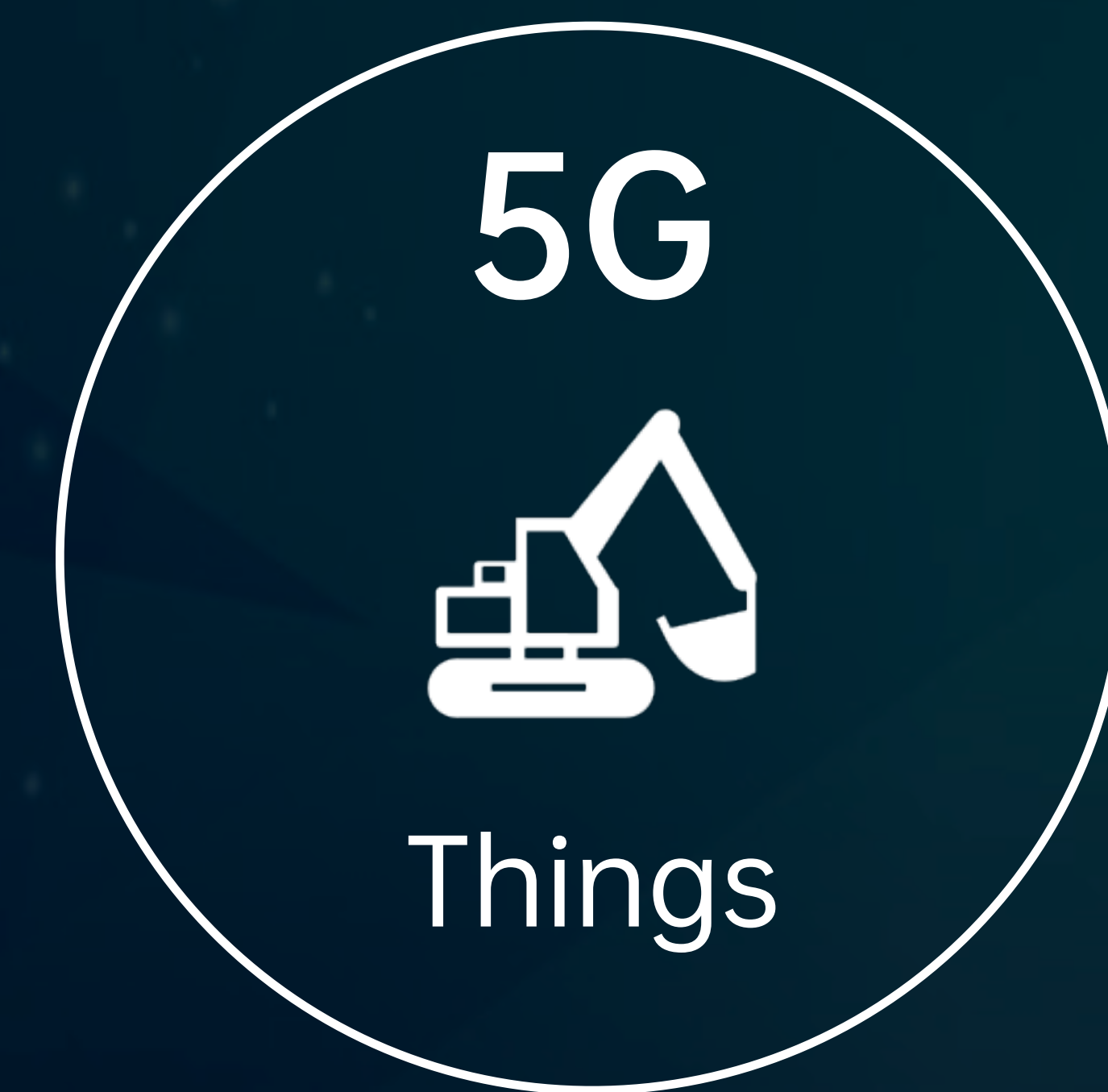


# Three steps for connecting intelligence





# 1st step: Use 5G for AI applications



Media transfer, Sensing, Controlling

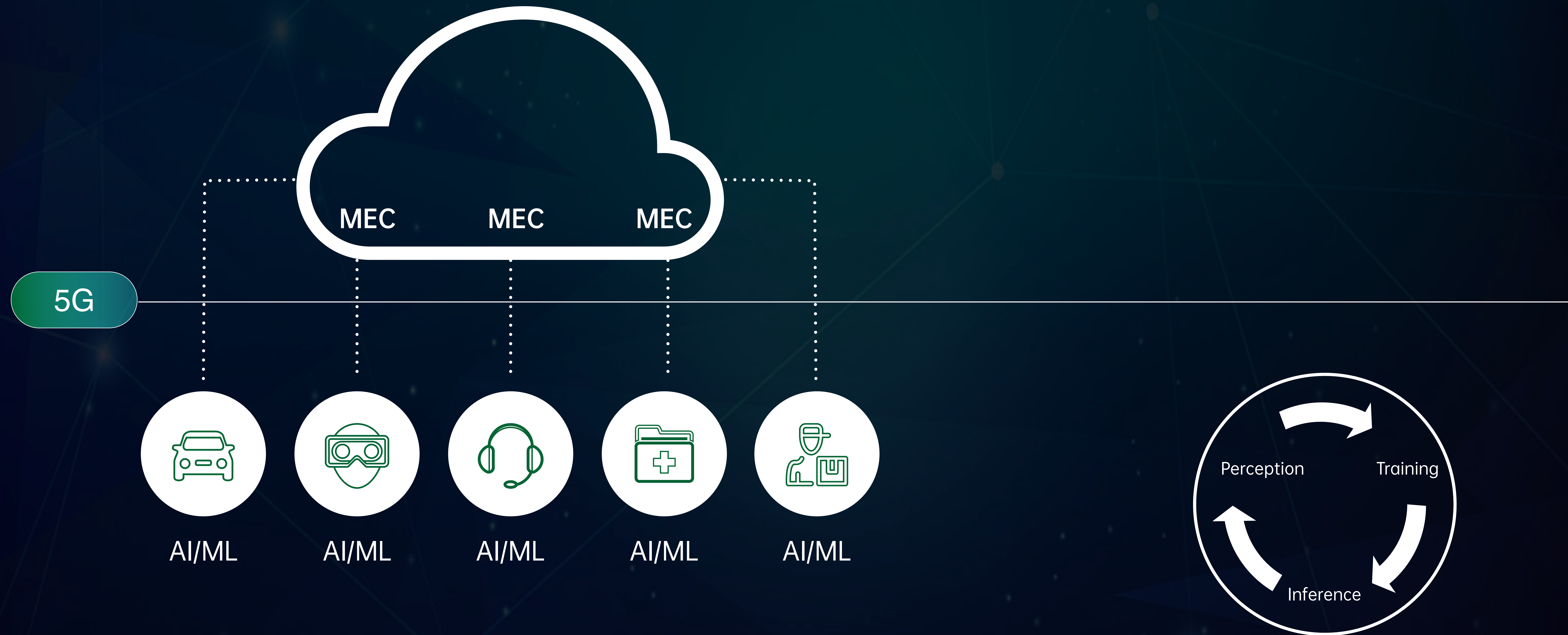


Cloud AI





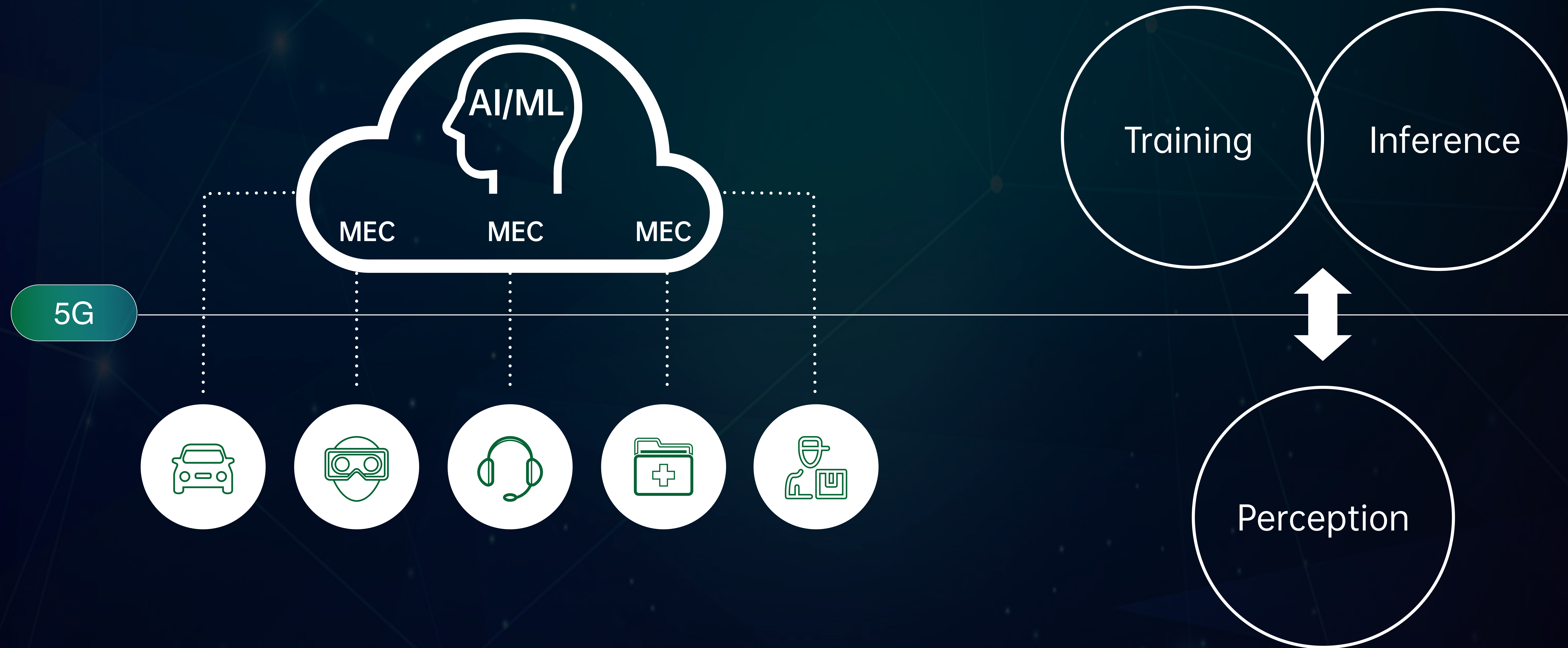
## ► 5G cloud-based AI/ML





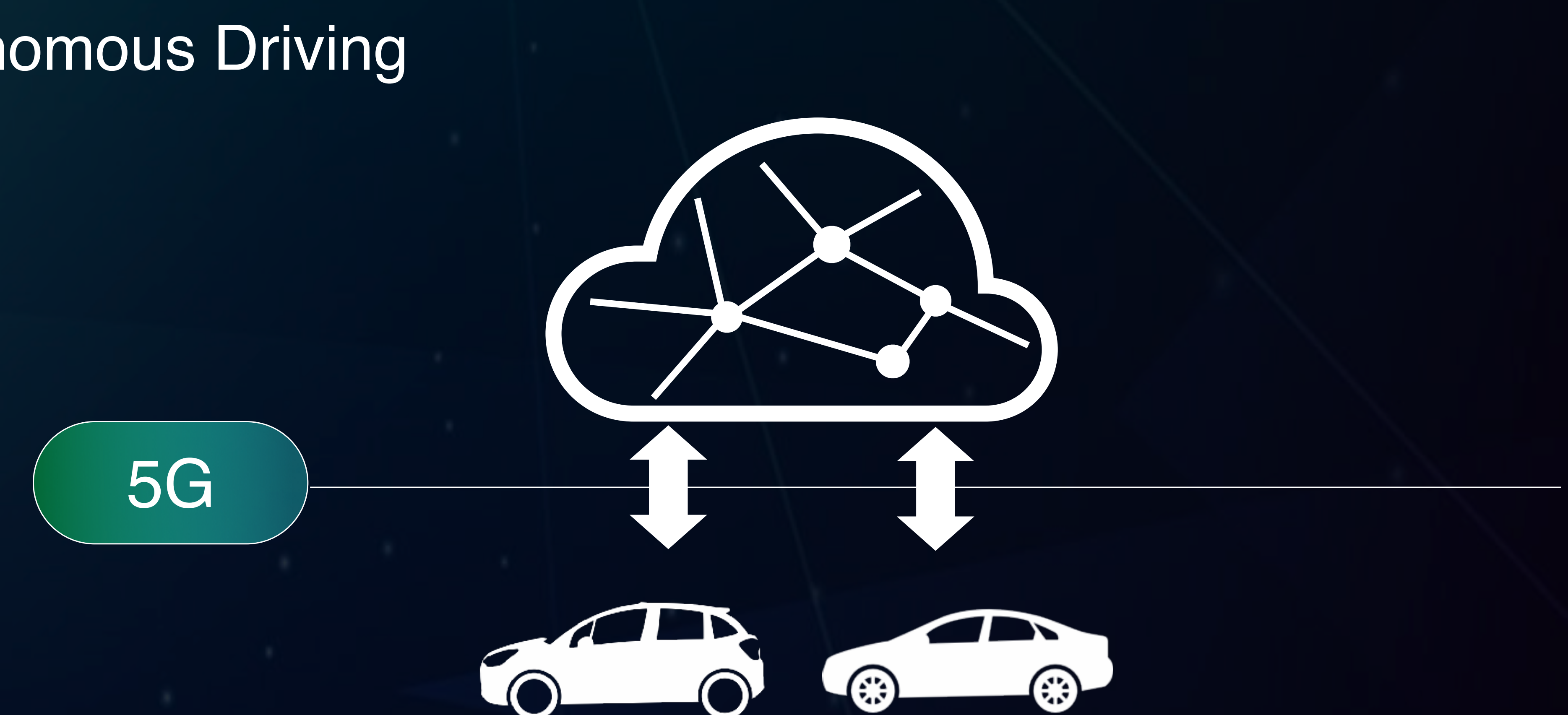
## ► 5G cloud-based AI/ML

- Both high data rate and low-latency required



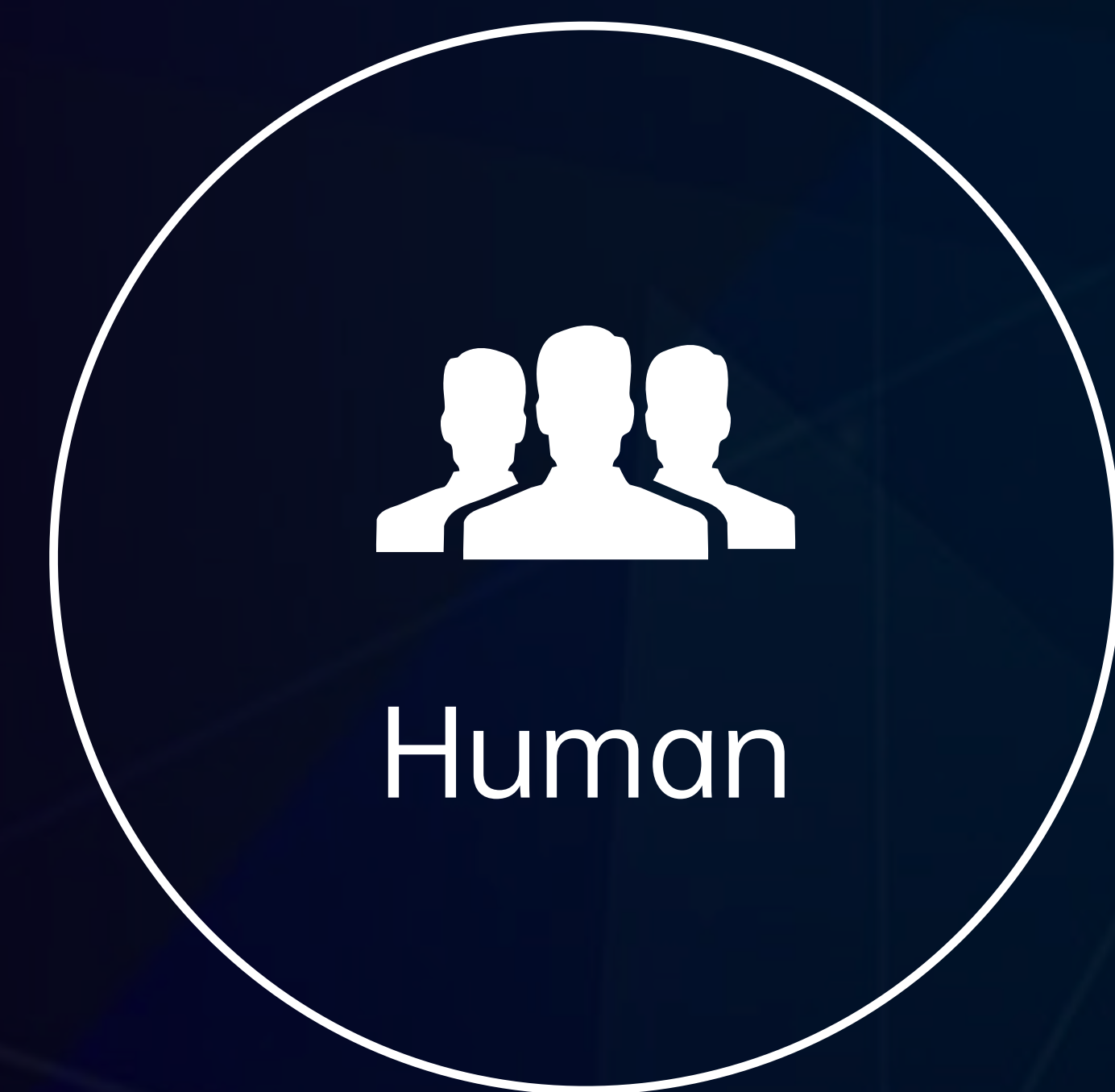


## ▶ 5G-cloud/MEC based AI applications

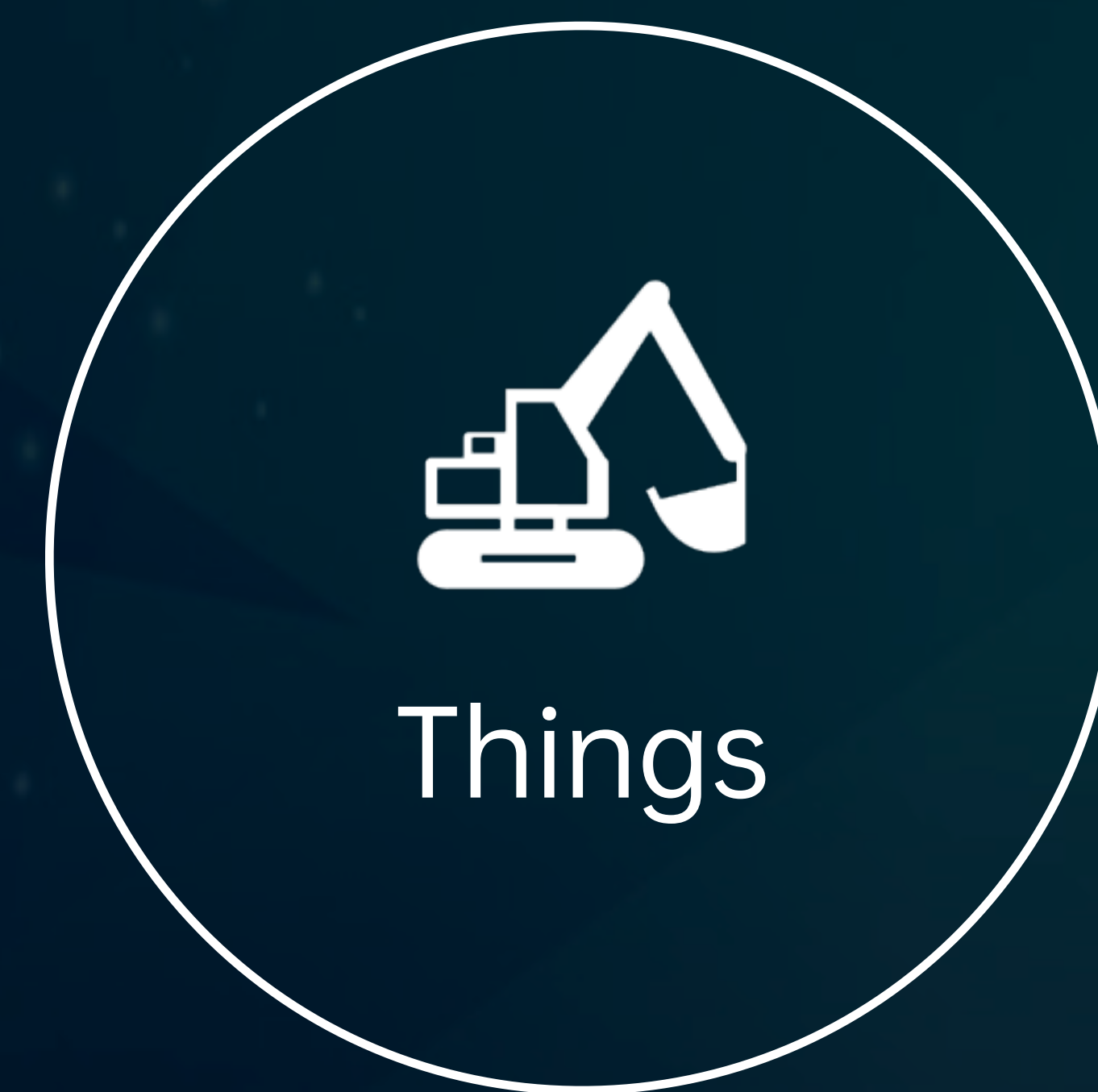




## 2nd step: Enhanced 5G by AI



Human



Things



Media transfer, Sensing, Controlling



eMBB

Massive IoT

Critical IoT

8K



Cloud AI



Cloud-controlled  
Robots

Ubiquitous  
Reality

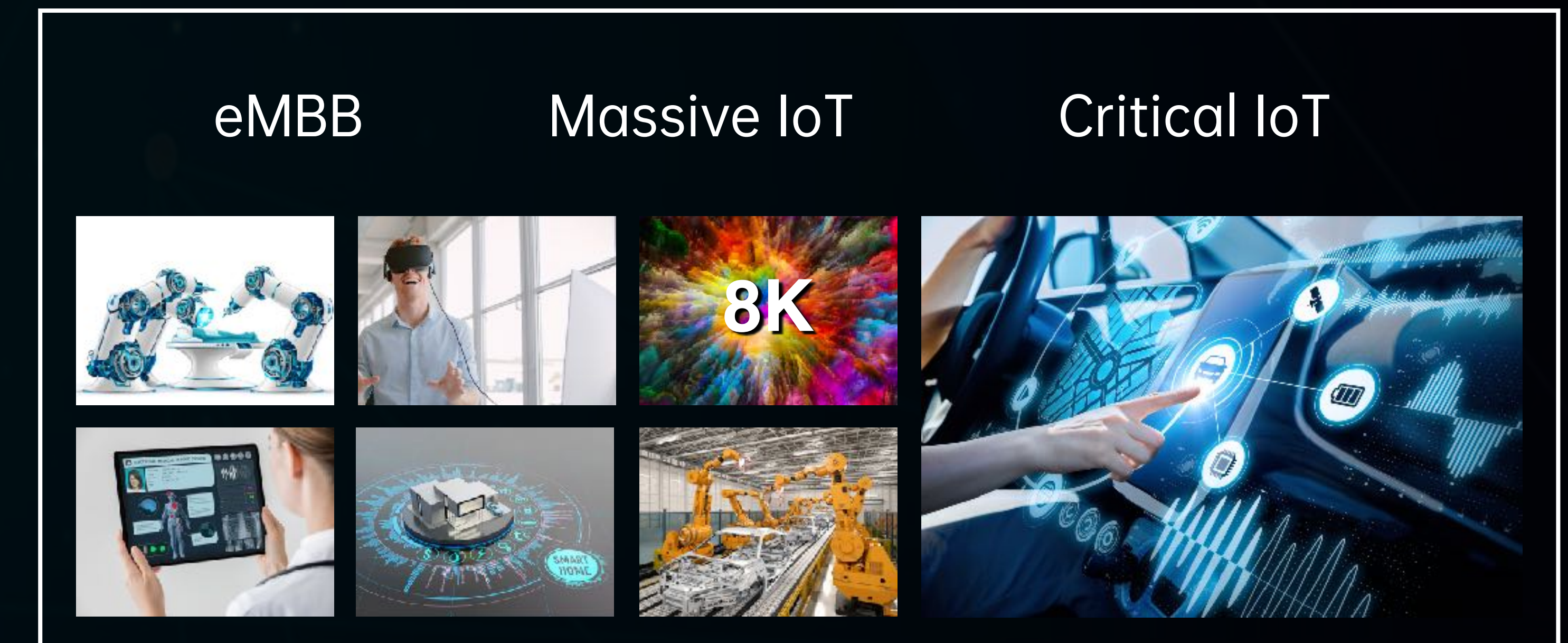
Autonomous  
driving



## 2nd step: Enhanced 5G by AI



### Media transfer, Sensing, Controlling



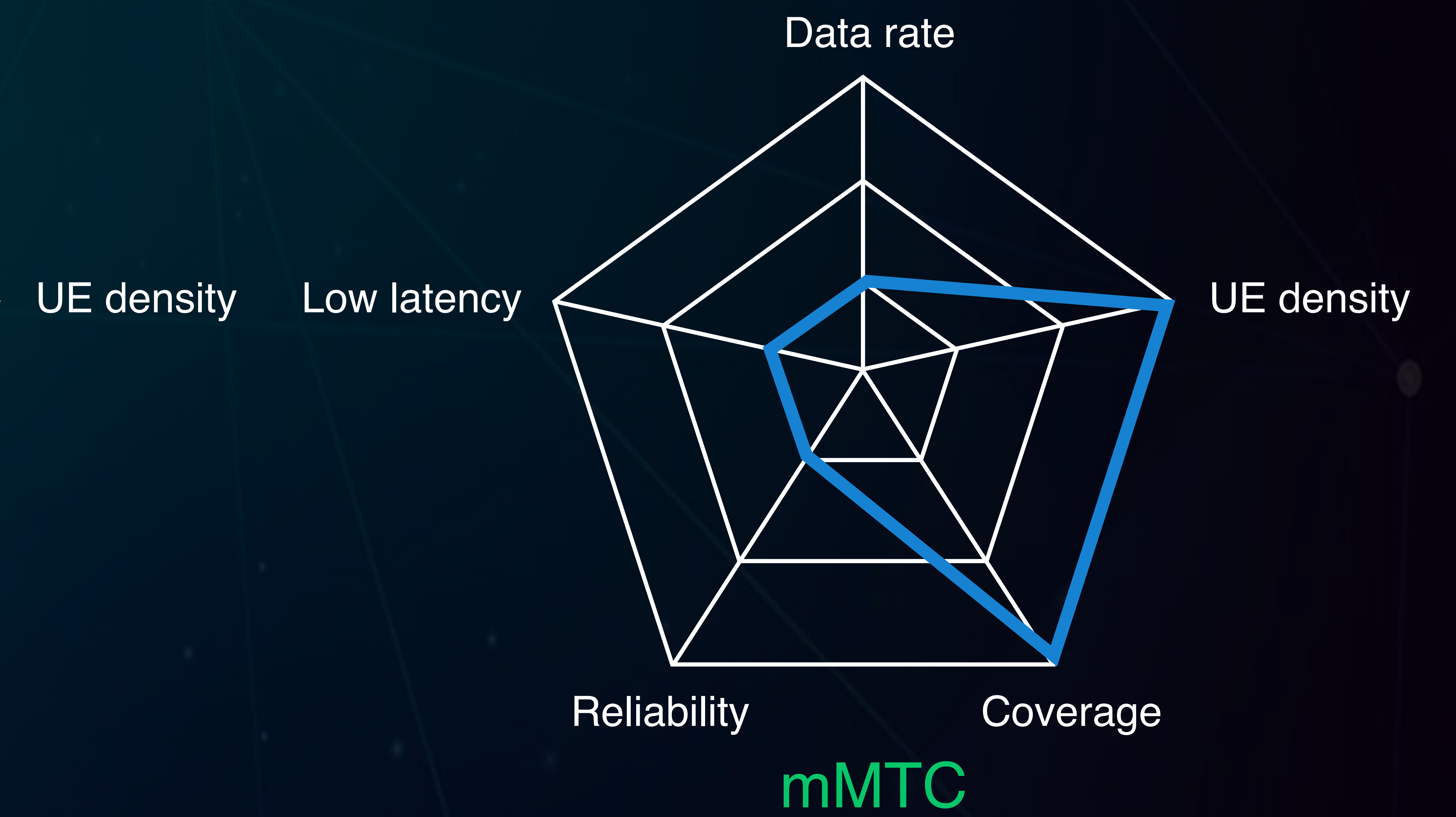
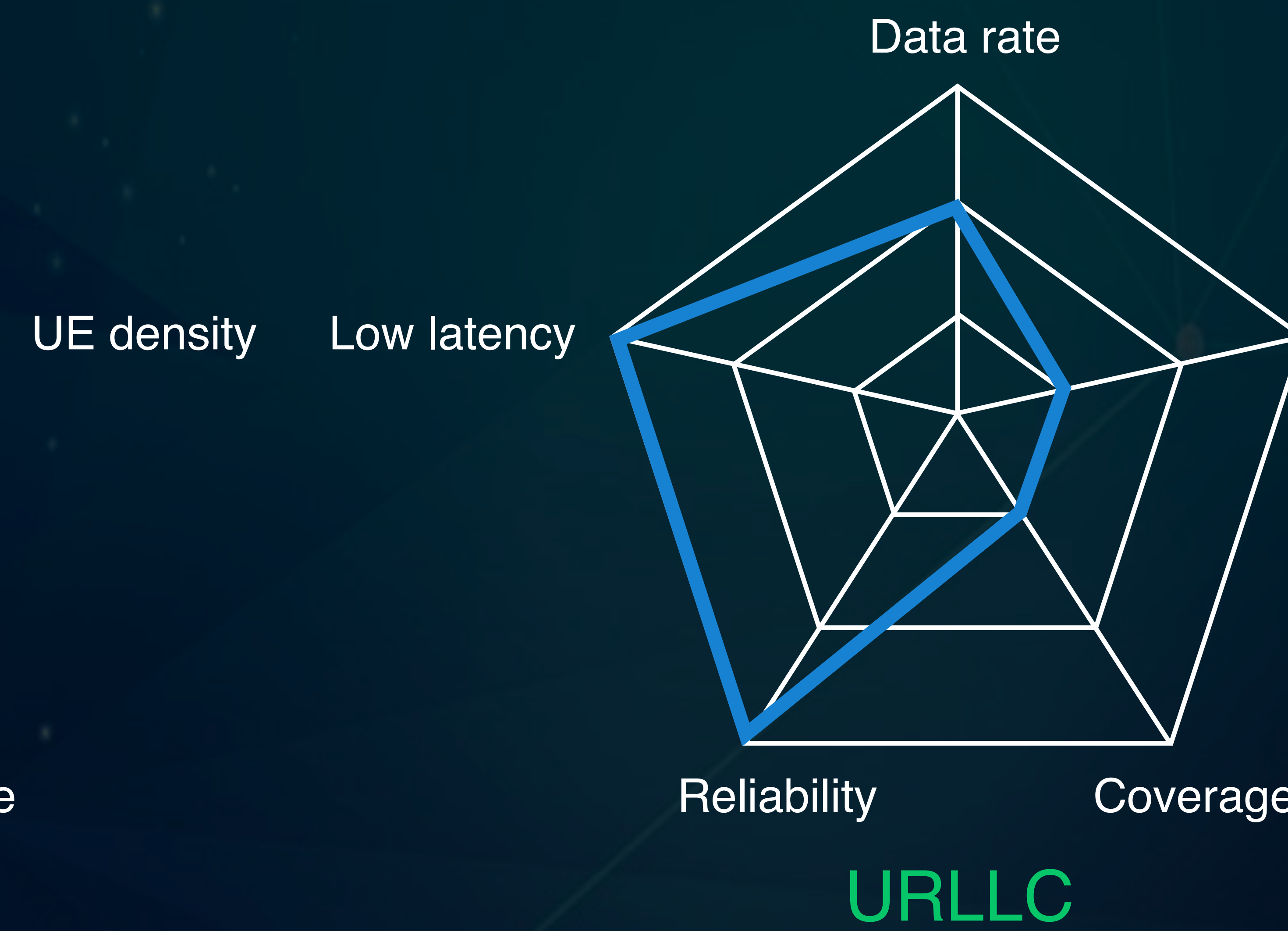
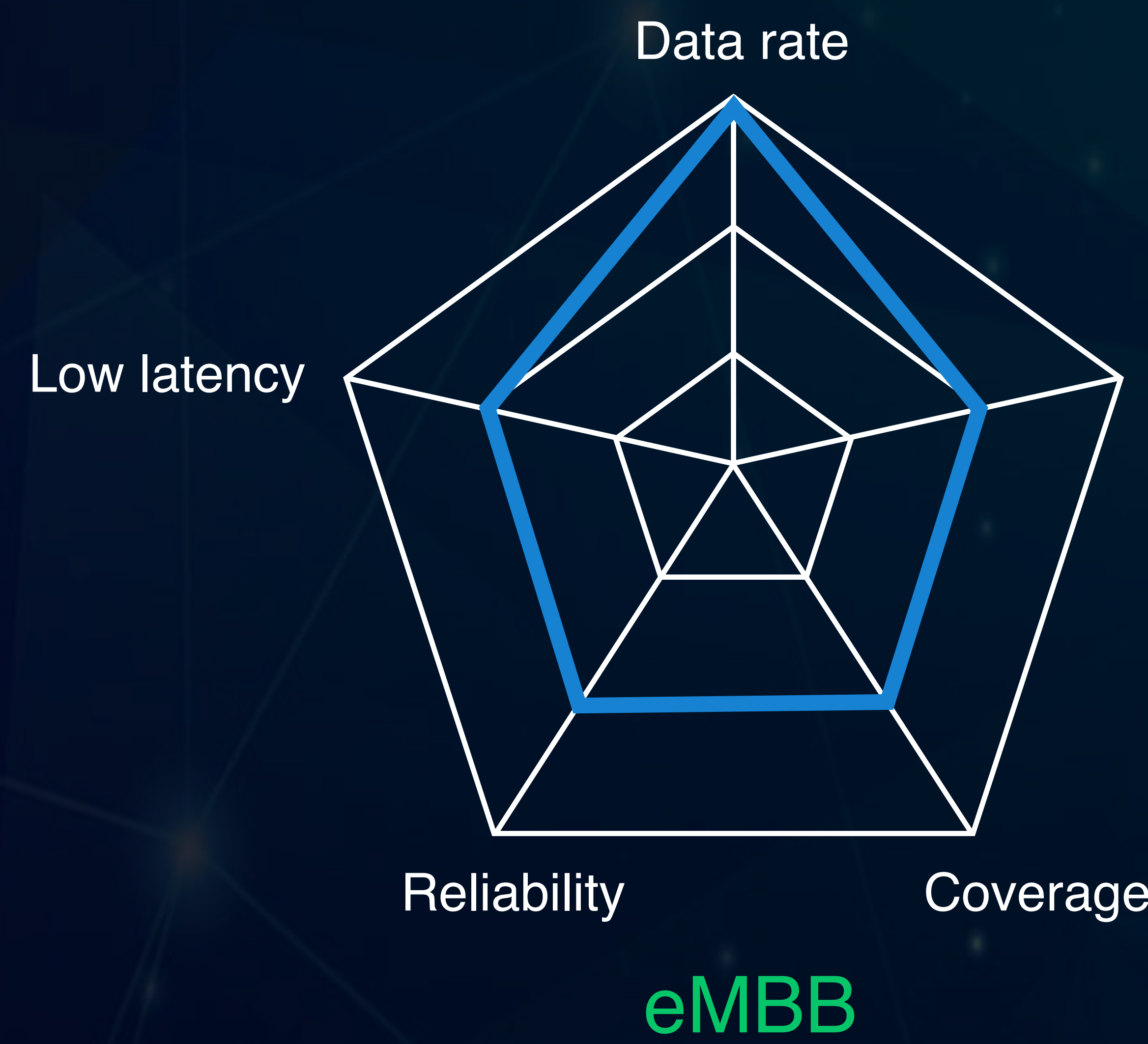
### Cloud AI





# Challenges to 5G enhancements

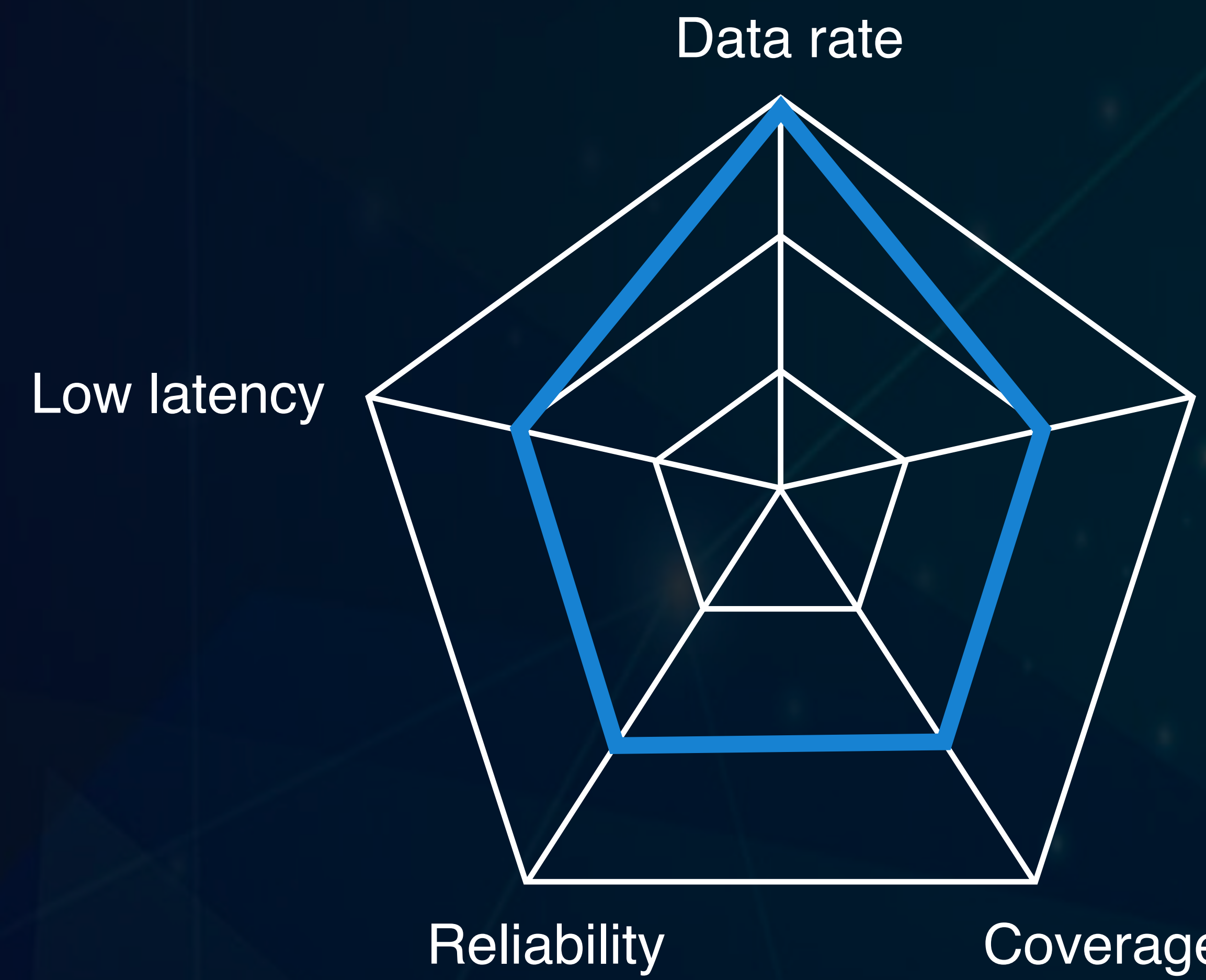
5G



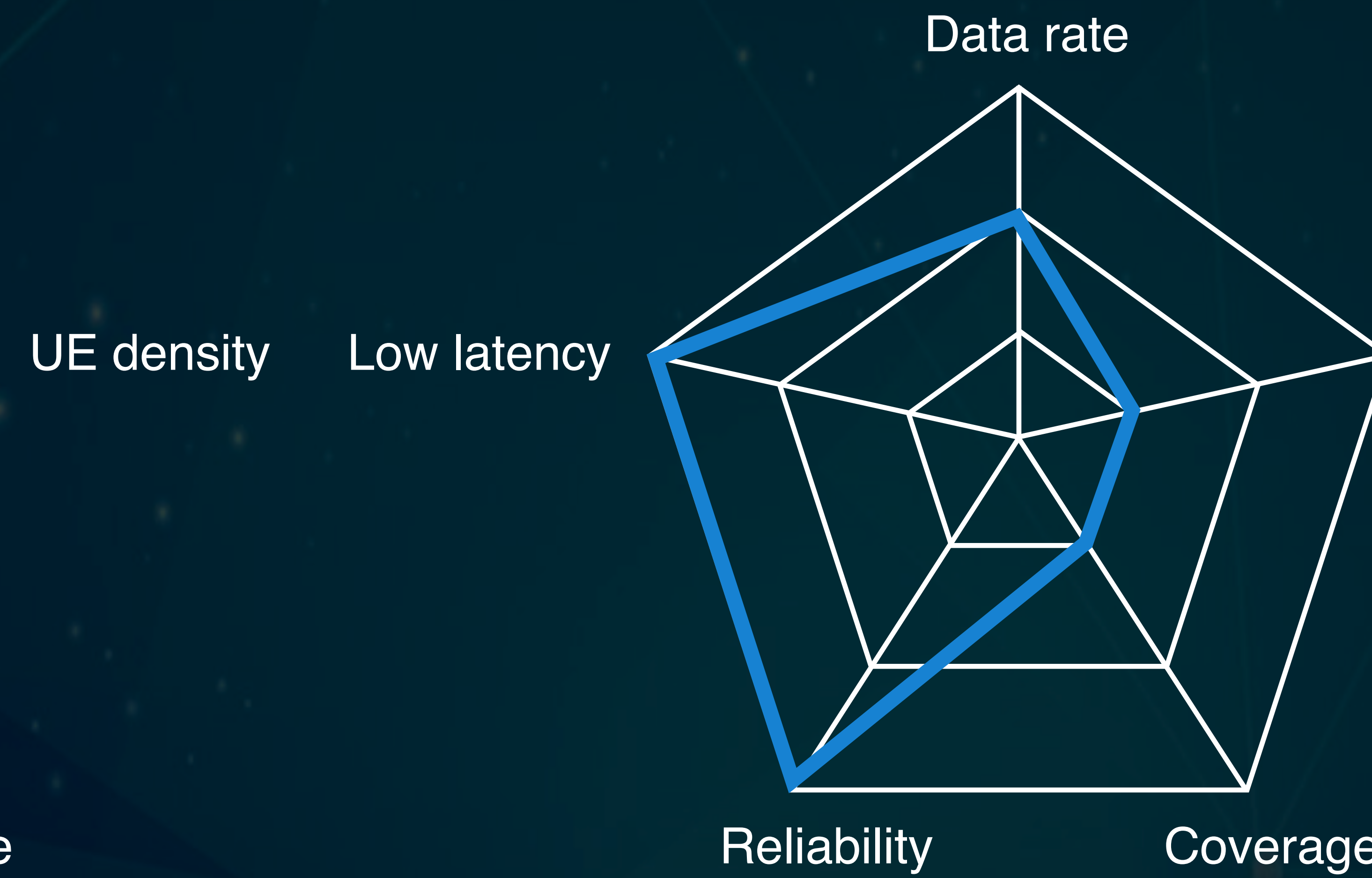


# Challenges to 5G enhancements

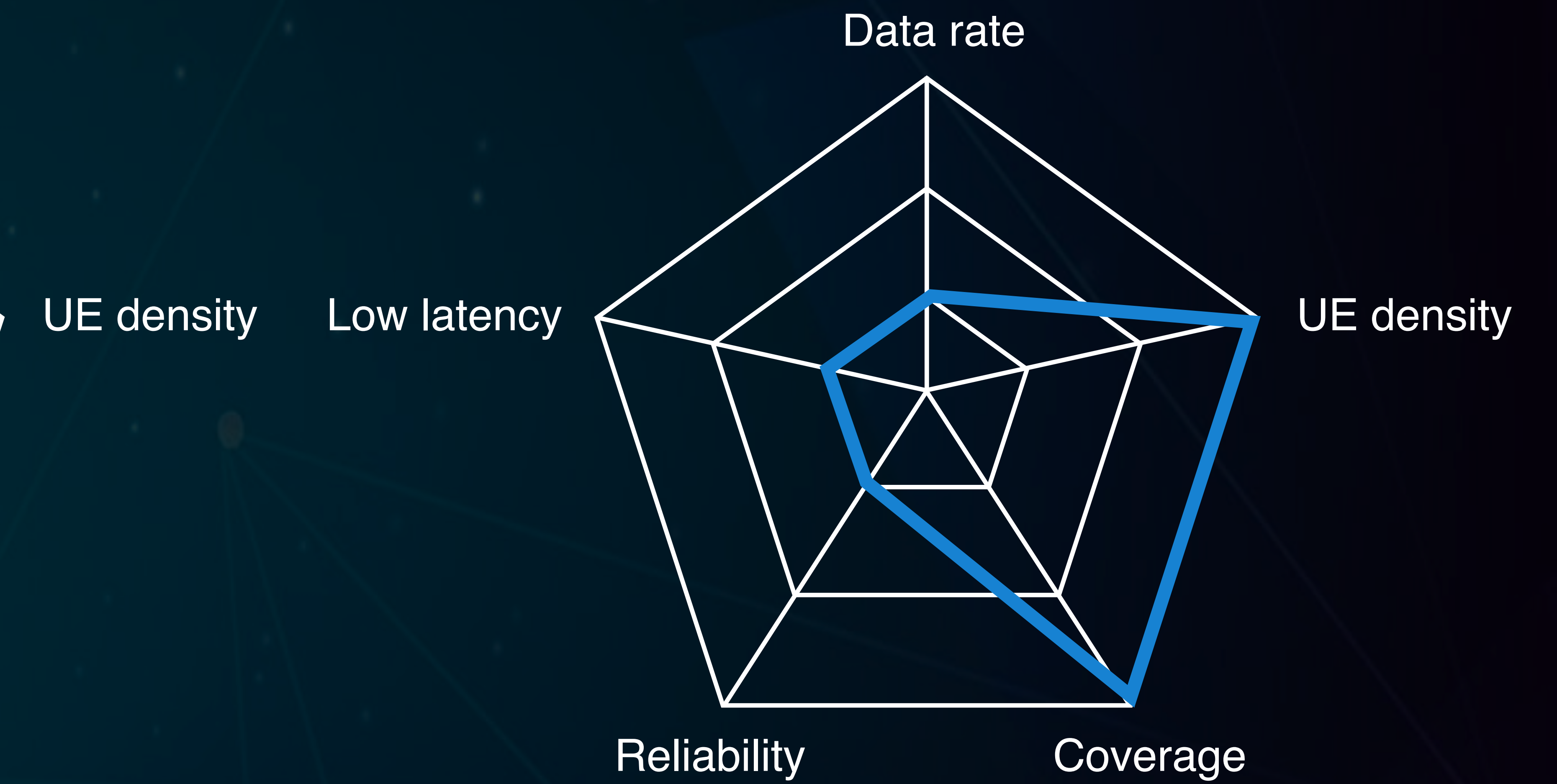
5G



eMBB

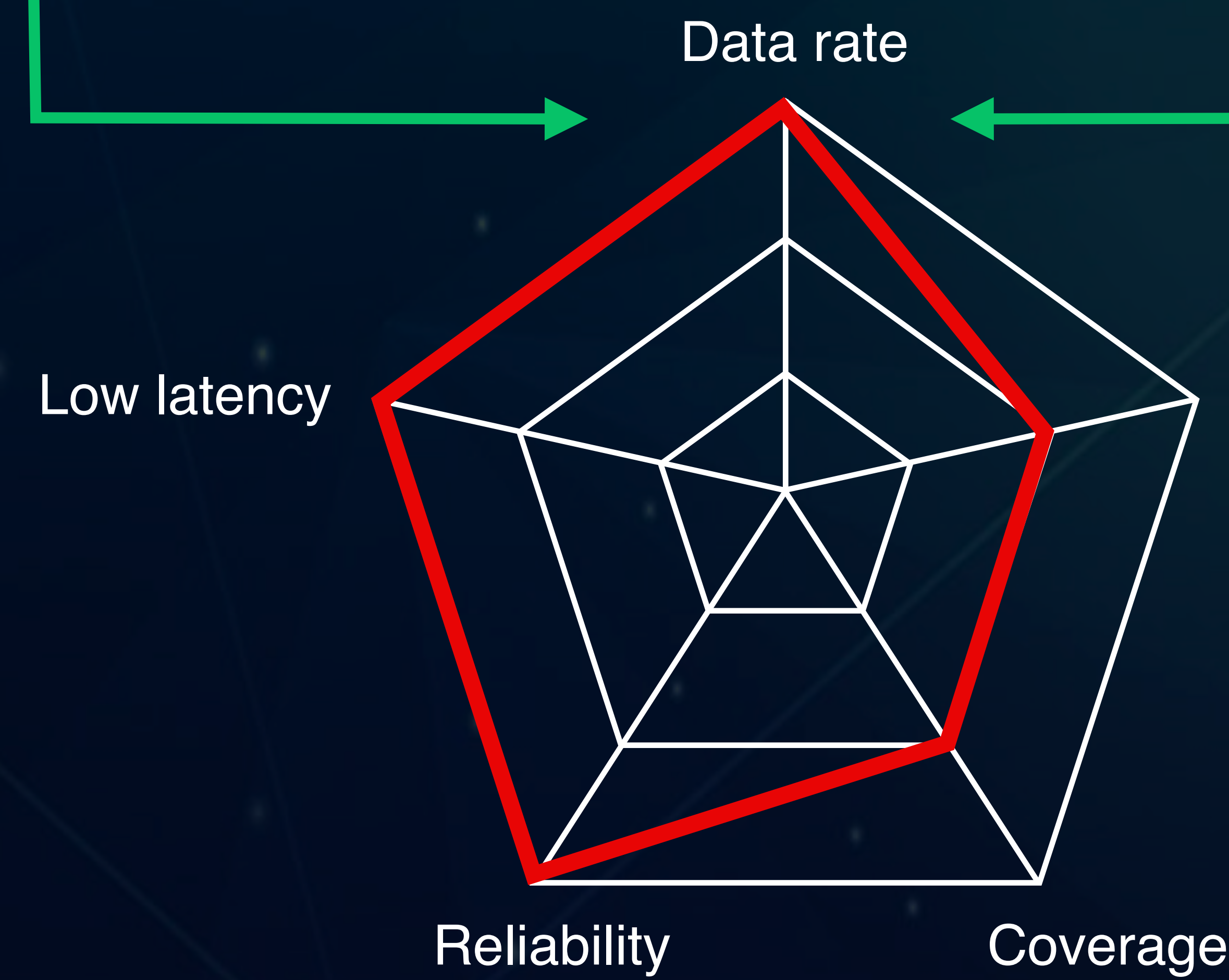


URLLC

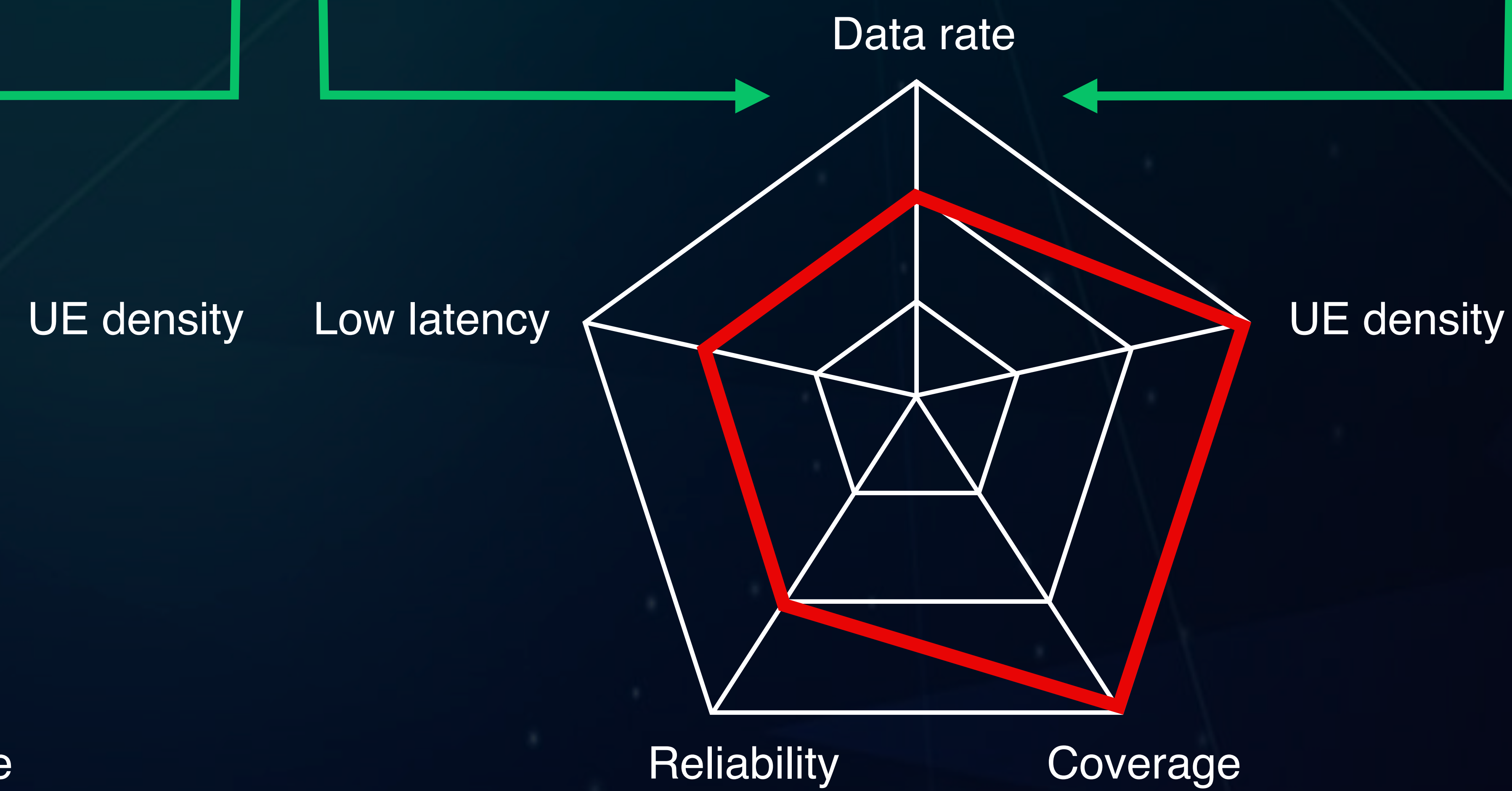


mMTC

5.5G



Broadband URLLC



Enhanced MTC



# Challenges to implementations

Algorithm



Standards

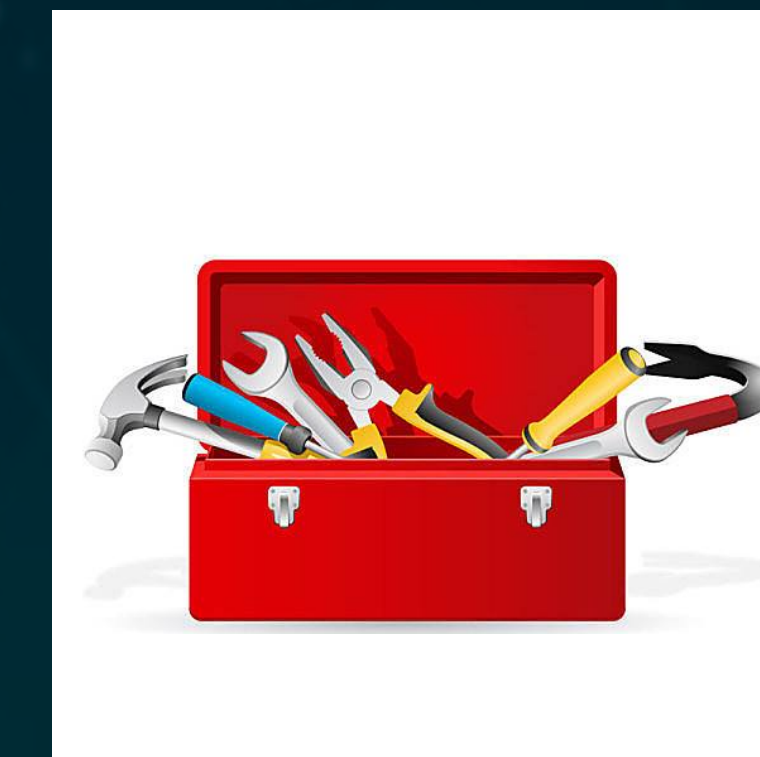


LTE

Algorithm



Standards



5G

Algorithm

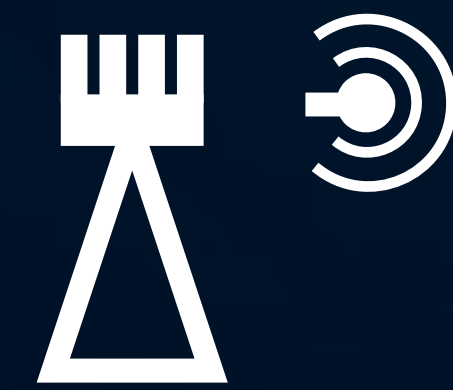


Standards



B5G

Space



Time



Subframe level @ 15kHz

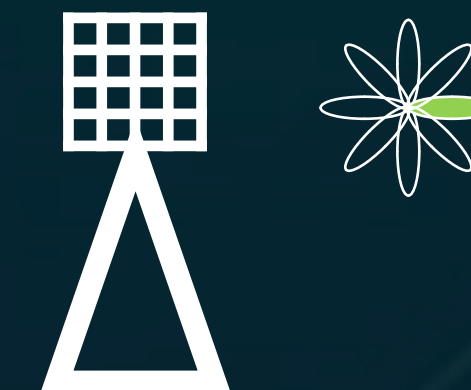
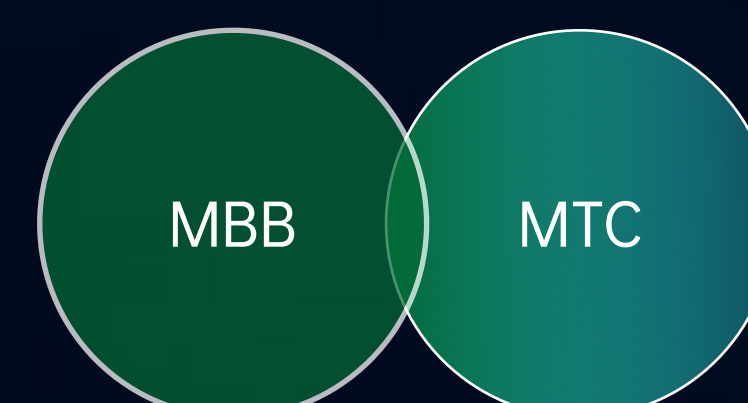
Frequency

~20 MHz

User

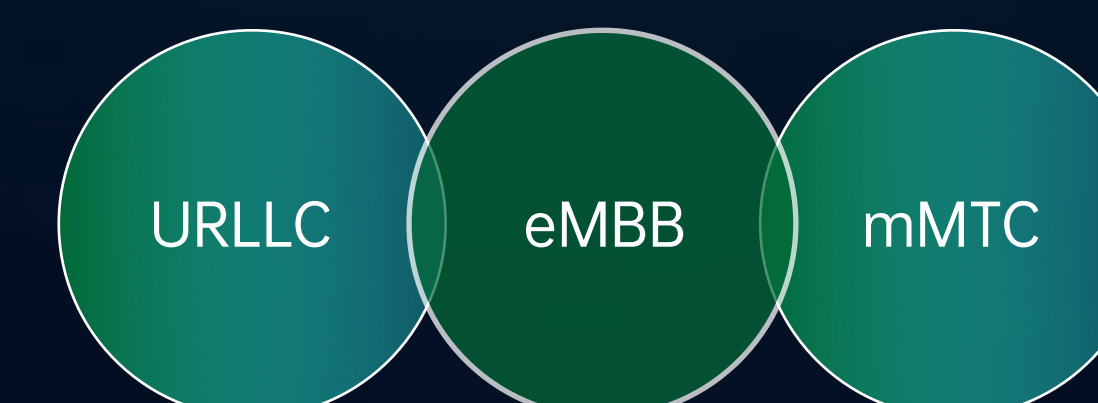
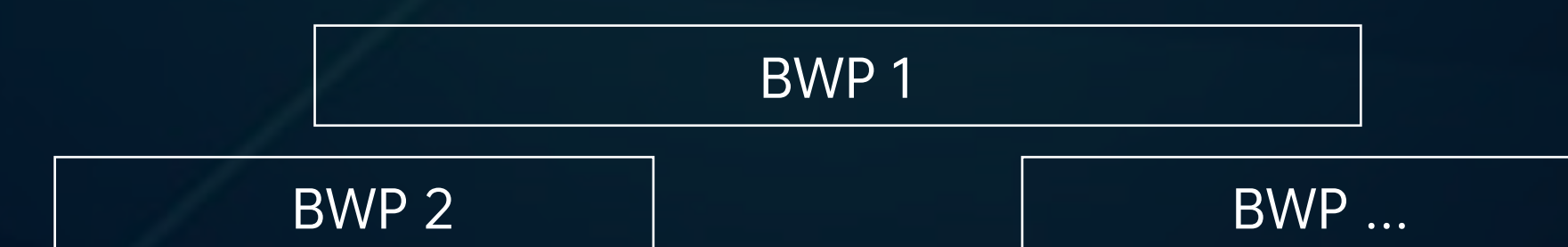


Service



Symbol level @ 15/30/60/120/240 kHz

~100 MHz





# Challenges to implementations

Algorithm



Standards

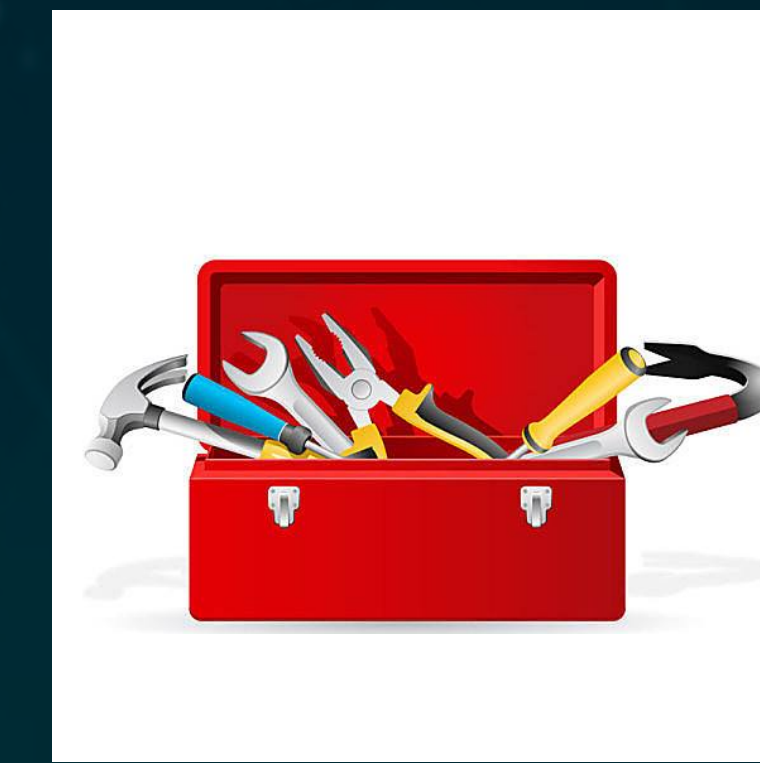


LTE

Algorithm

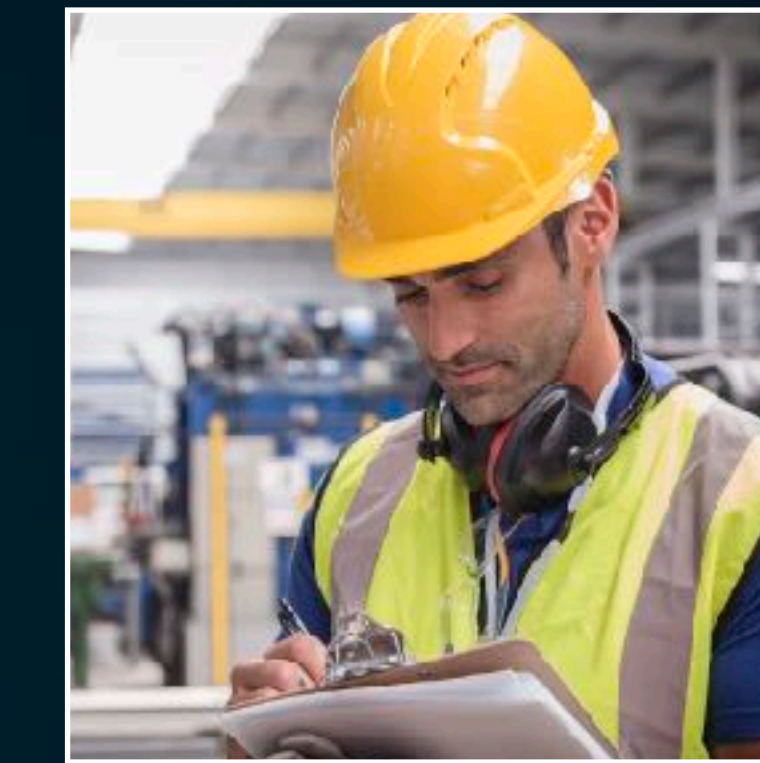


Standards



5G

Algorithm

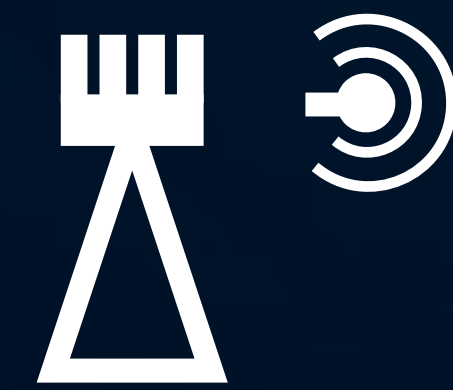


Standards



B5G

Space



Time



Subframe level @ 15kHz

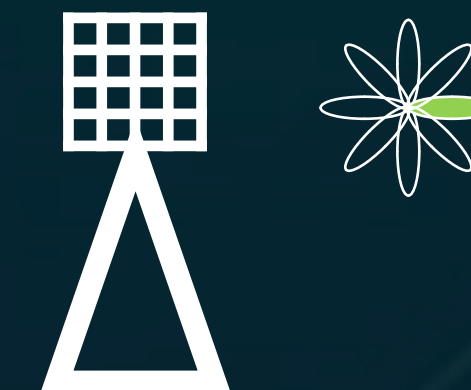
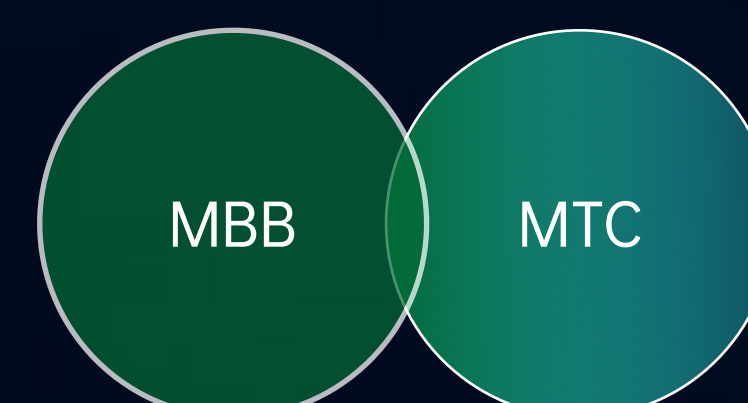
Frequency

~20 MHz

User



Service



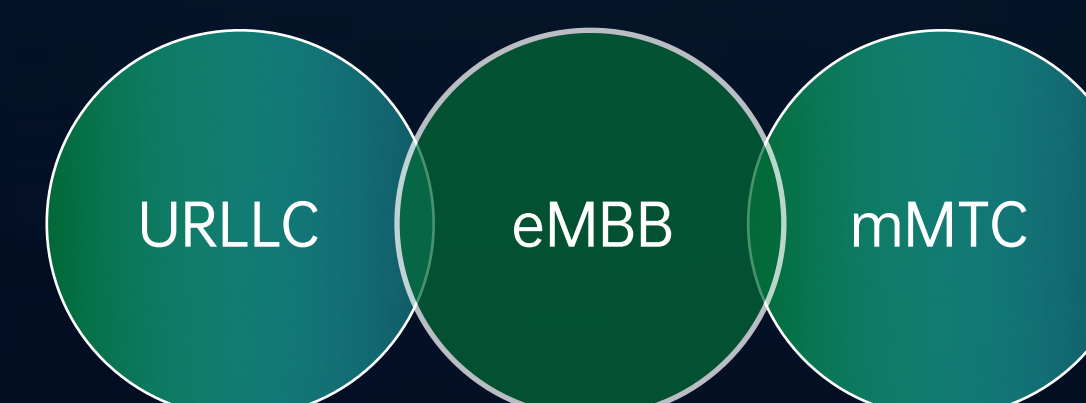
Symbol level @ 15/30/60/120/240 kHz

~100 MHz

BWP 1

BWP 2

BWP ...



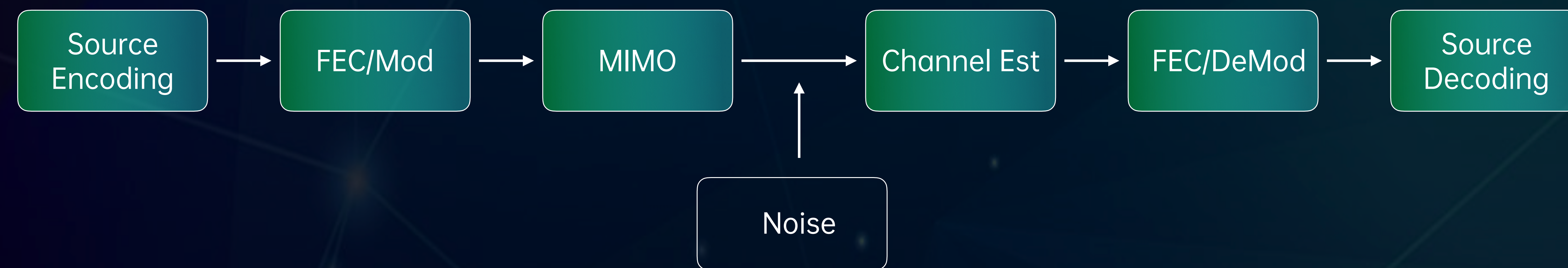
AI may help





## ► Why AI/ML can enhance 5G?

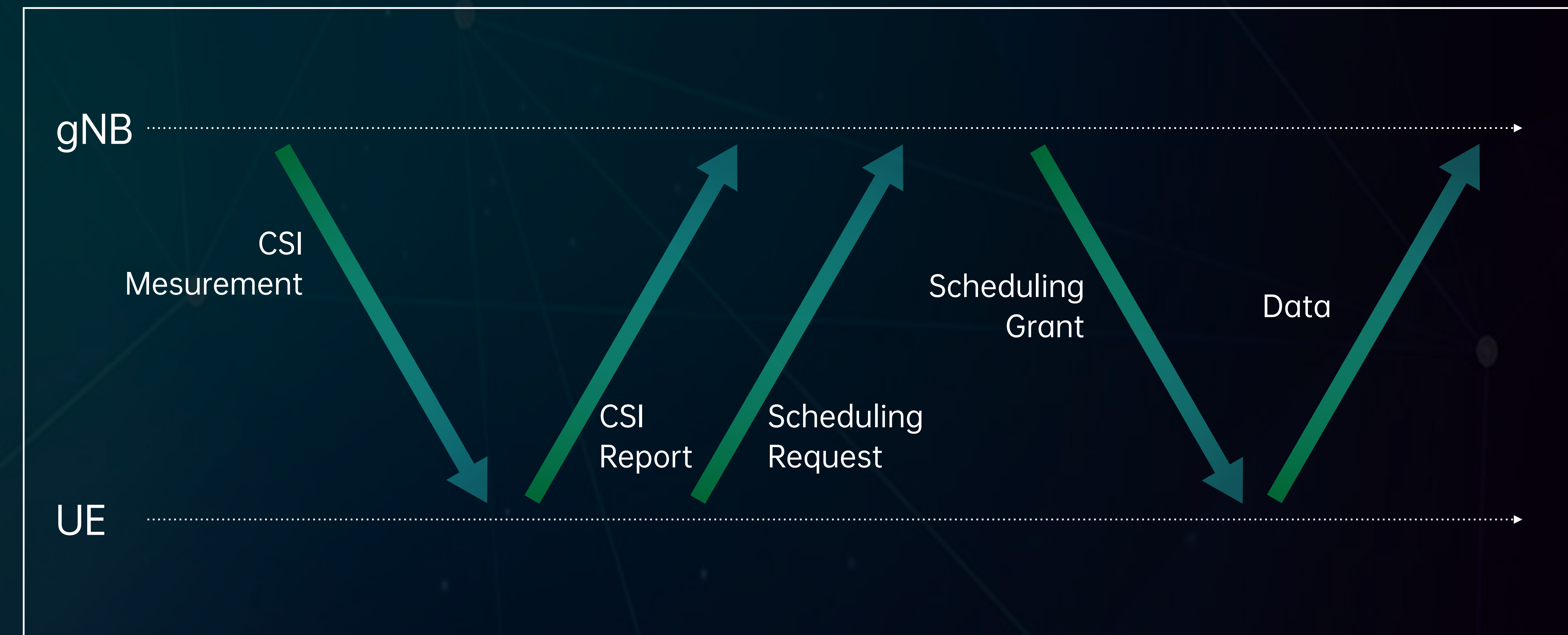
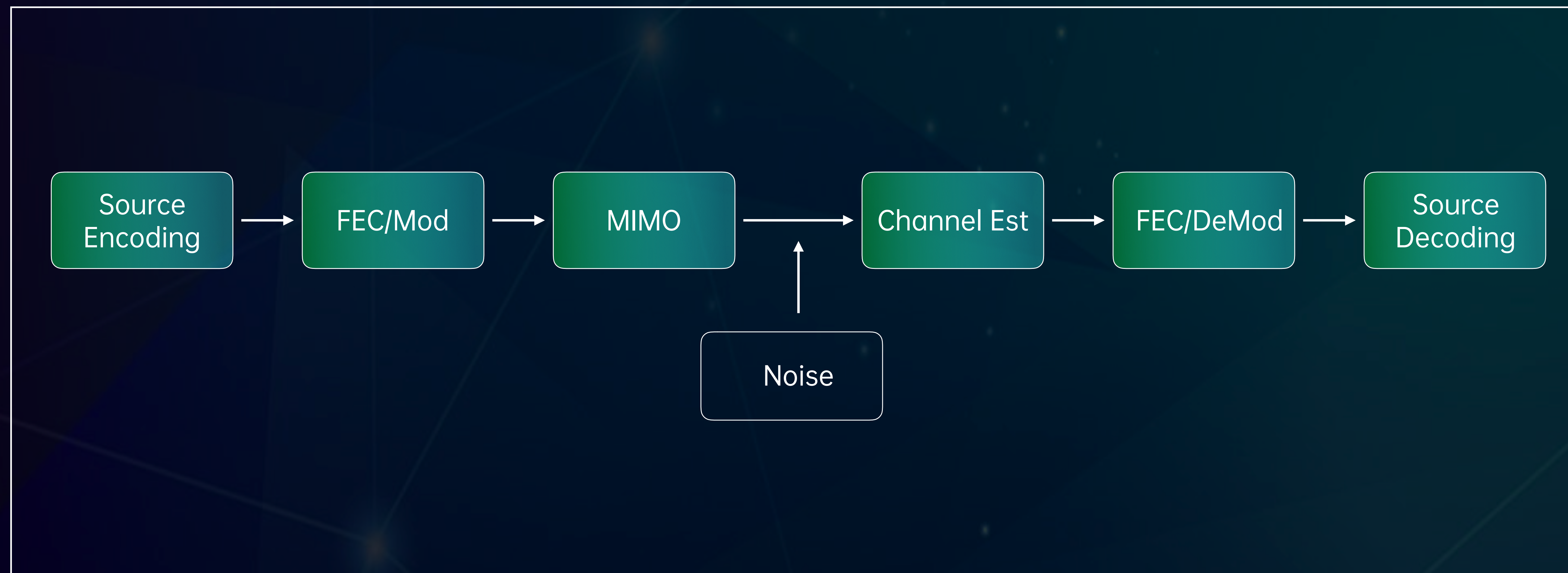
- Traditional "step-wise" procedure: Artificially splitting steps to guarantee per-step "explainability".
- Assumption: Optimal modeling, accurate inputs and in-time processing for each step.





## ► Why AI/ML can enhance 5G?

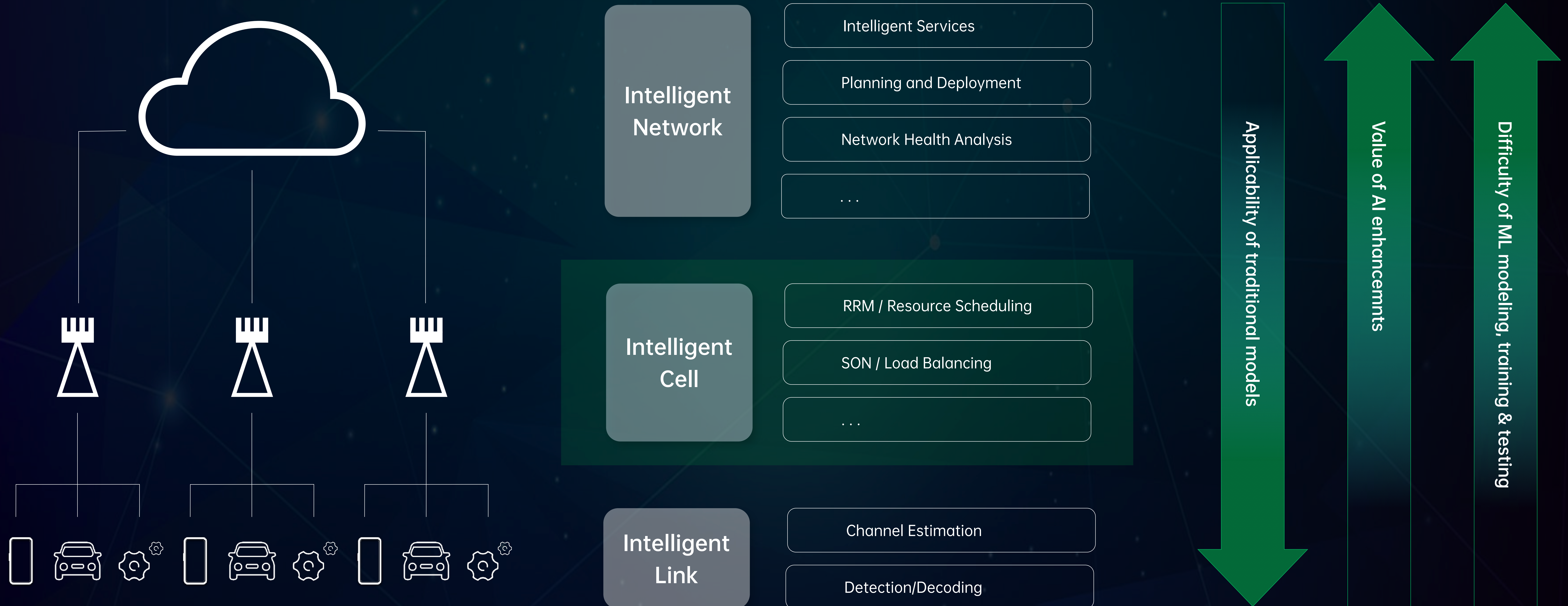
- Traditional "step-wise" procedure: Artificially splitting steps to guarantee per-step "explainability".
- Assumption: Optimal modeling, accurate inputs and in-time processing for each step.



- ❖ **Risk:** The whole procedure may suffer from "sub-optimal, inaccurate and slow" steps.
- ❖ **AI/ML enhancements:**
  - Solution 1: to replace traditional models with neural networks for "problematic" steps
  - Solution 2: to replace the whole procedure with a neural network by sacrificing "explainability"



# Value vs. applicability of AI enhancements





## ► Questions to 5G AI enhancements



Use ML in which part?



Applicability of training set?



ML at UEs?



Security & Privacy?



## ► Questions to 5G AI enhancements



Use ML in which part?



Applicability of training set?



ML at UEs?



Security & Privacy?



## ► Questions to 5G AI enhancements



Use ML in which part?



**Applicability of training set?**



ML at UEs?



Security & Privacy?



## ► Questions to 5G AI enhancements



Use ML in which part?



Applicability of training set?



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Security & Privacy?



## ► Questions to 5G AI enhancements



Use ML in which part?



Applicability of training set?



ML at UEs?



**Security & Privacy?**



# 3rd step: 6G of connecting intelligence



Media transfer, Sensing, Controlling

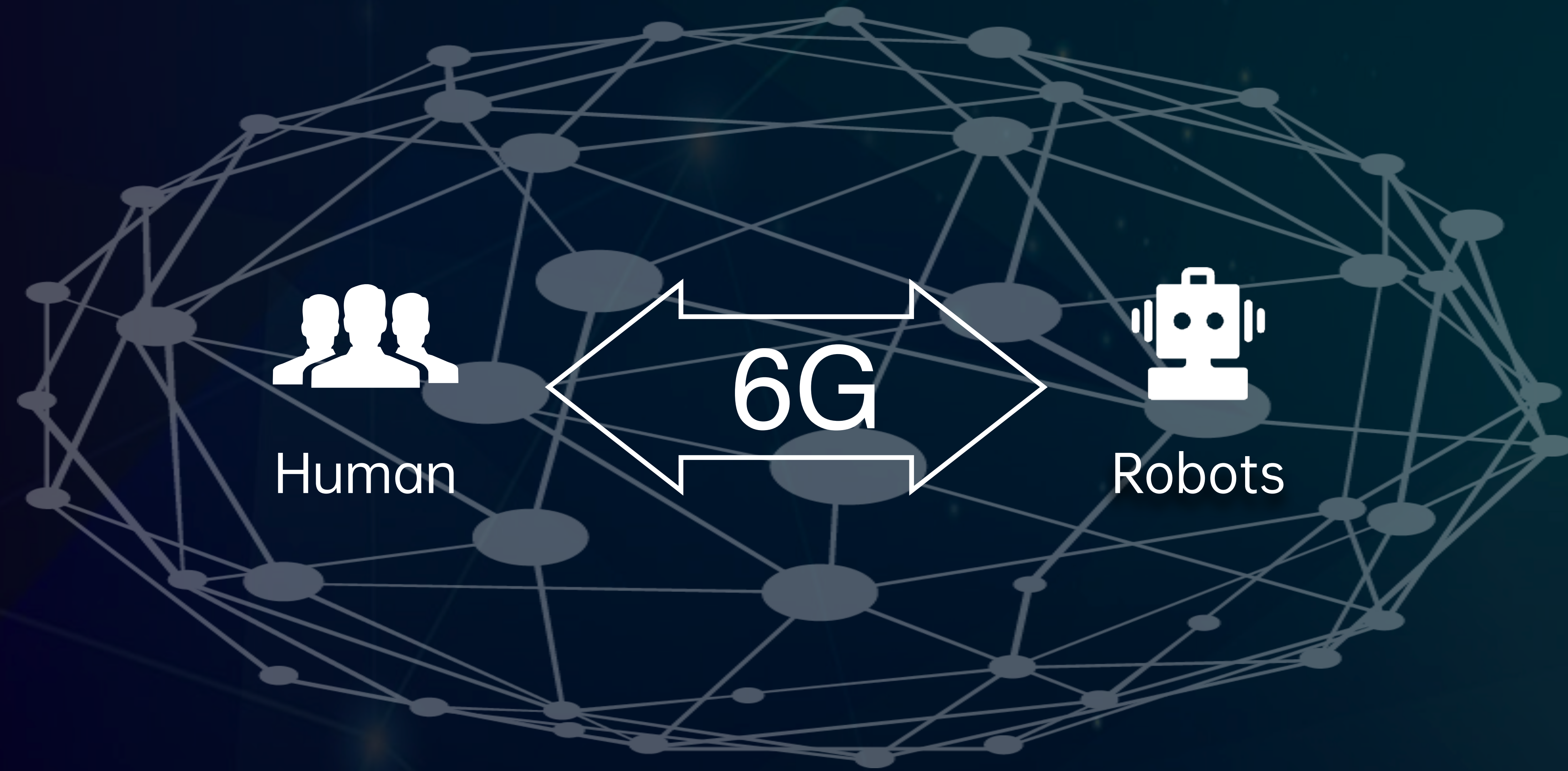


Cloud AI





# 3rd step: 6G of connecting intelligence



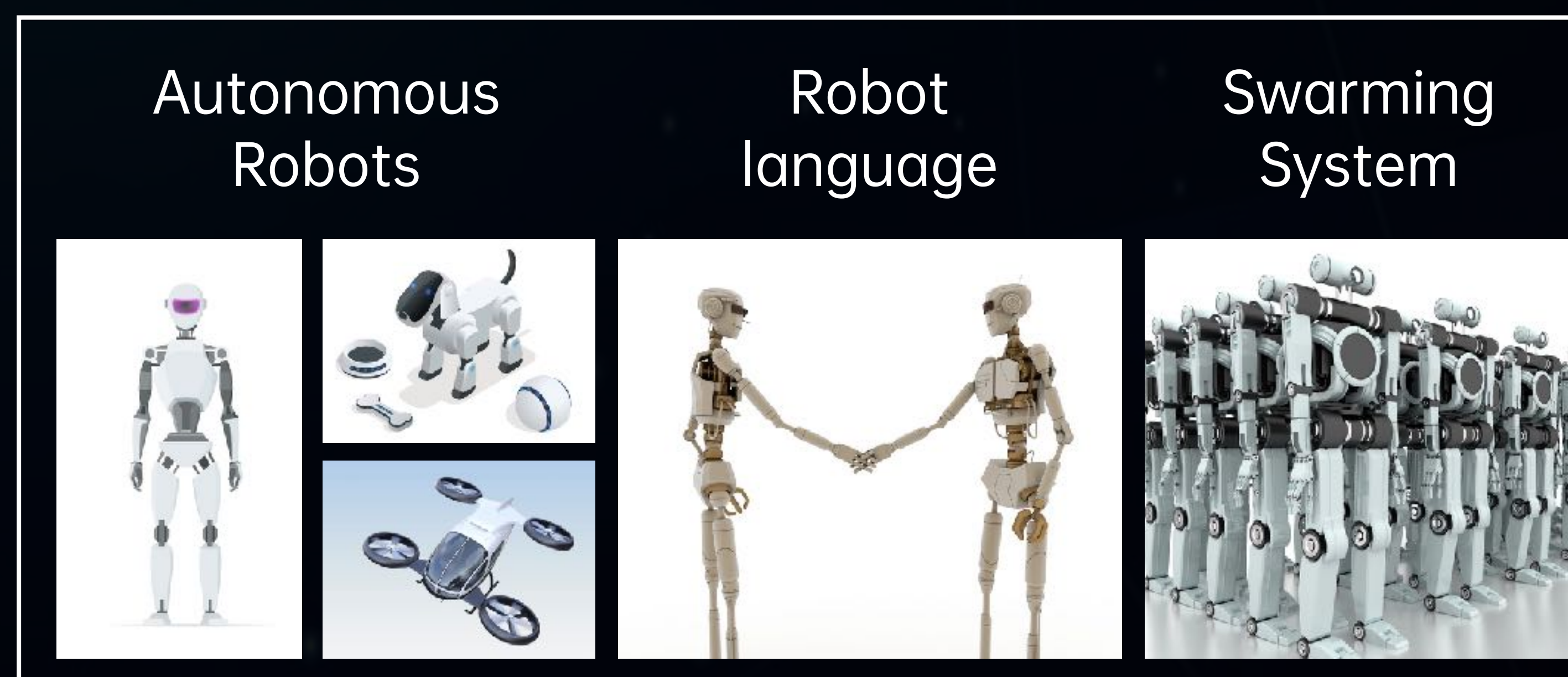
## Media transfer, Sensing, Controlling



## Cloud AI



## Intelligence transfer





► 2030s: Network shared by all intelligent agents





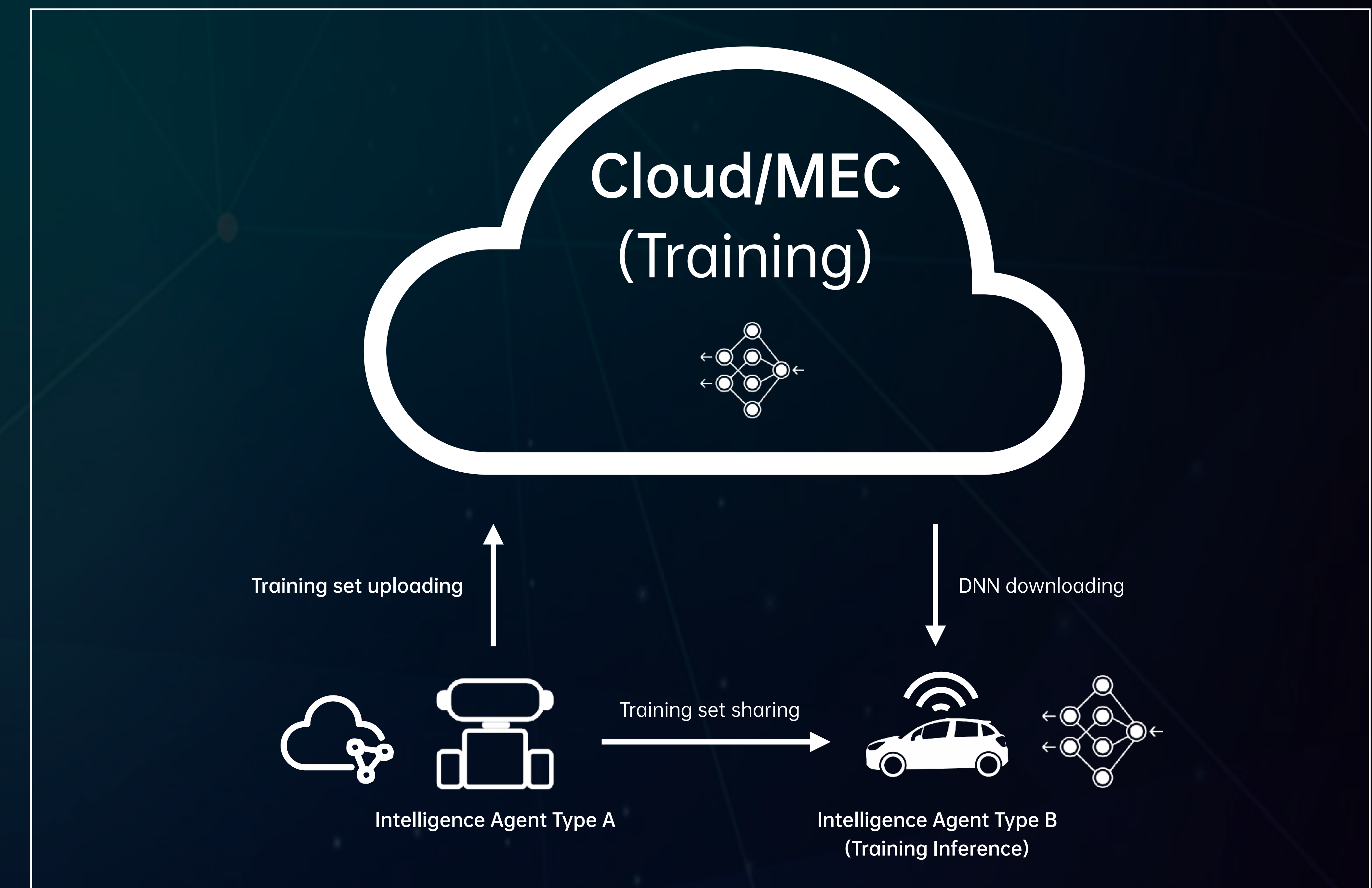
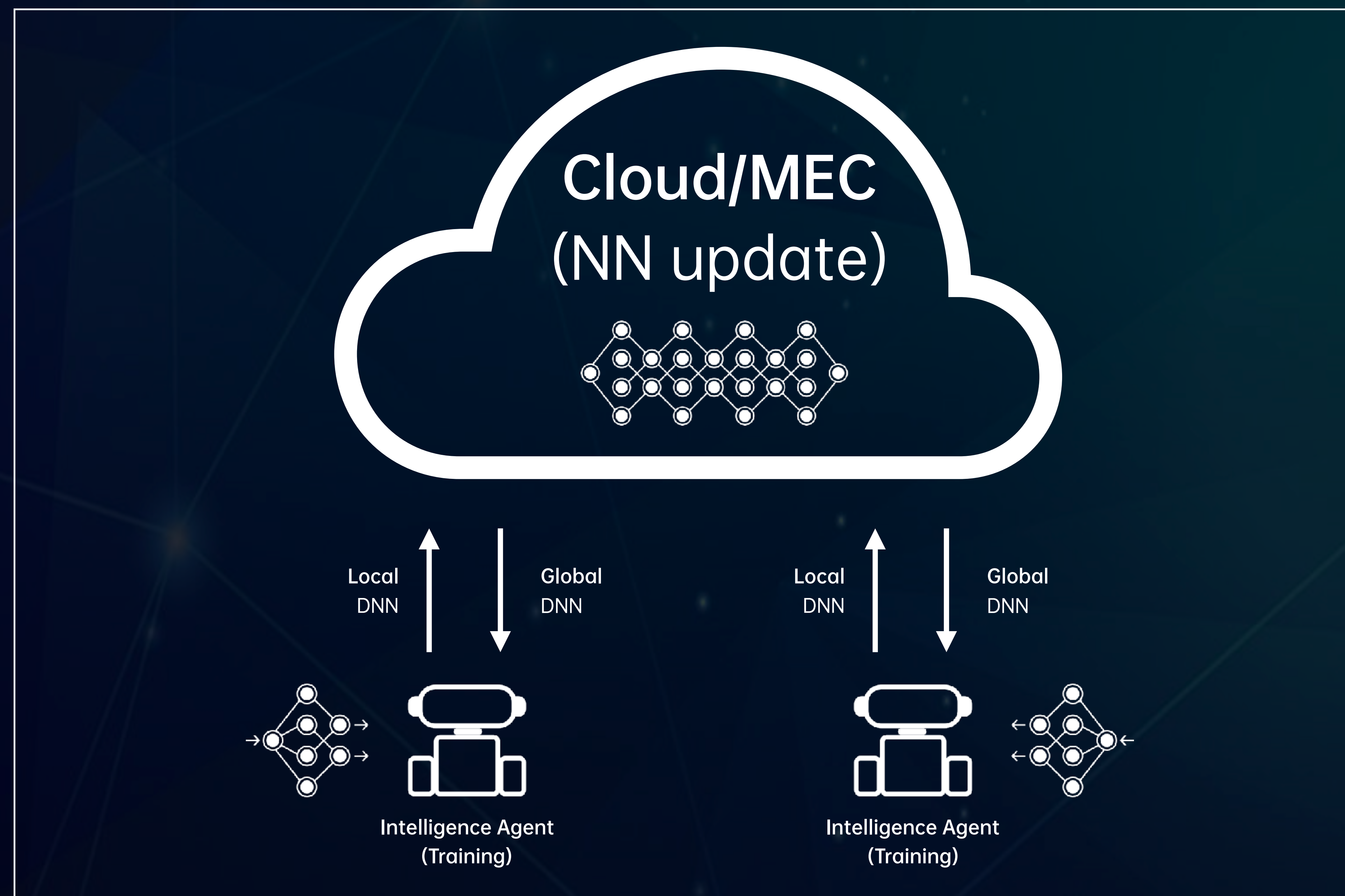
# Intelligence exchange: New traffic type in 6G network

## ❖ Neural network downloading/uploading

- Collaborative/Federated ML between same type of intelligent agents
- Task-dependent, environment-dependent ML models
- Limited on-board storage/processing capabilities

## ❖ Training set/background knowledge sharing

- Between different types of intelligent agents
- General intelligence transfer for open purpose



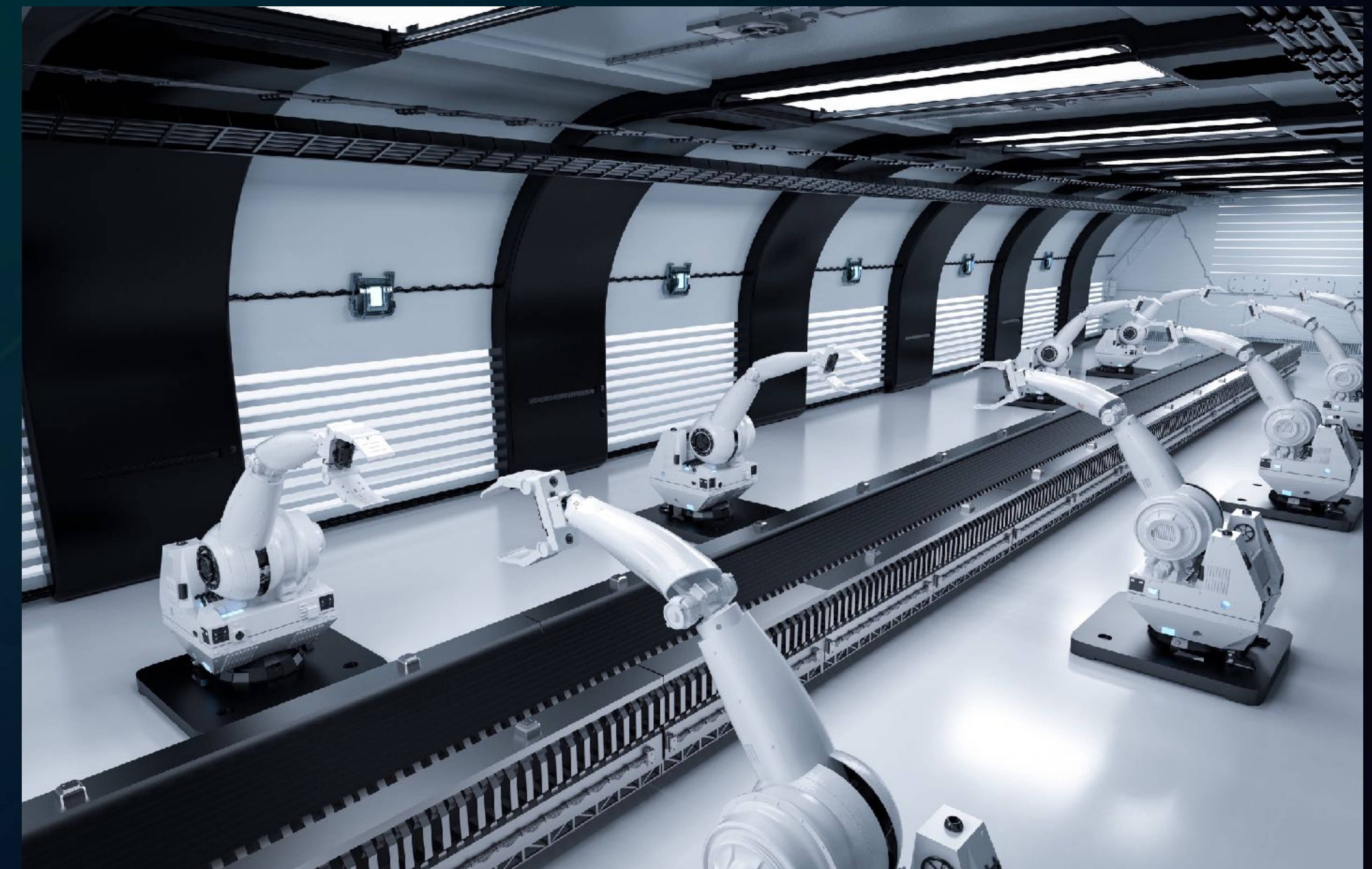
- Super high data rate and capacity are required.
- Extreme requirements on latency and reliability can be relaxed.



# ► Intelligence exchange: New traffic type in 6G network

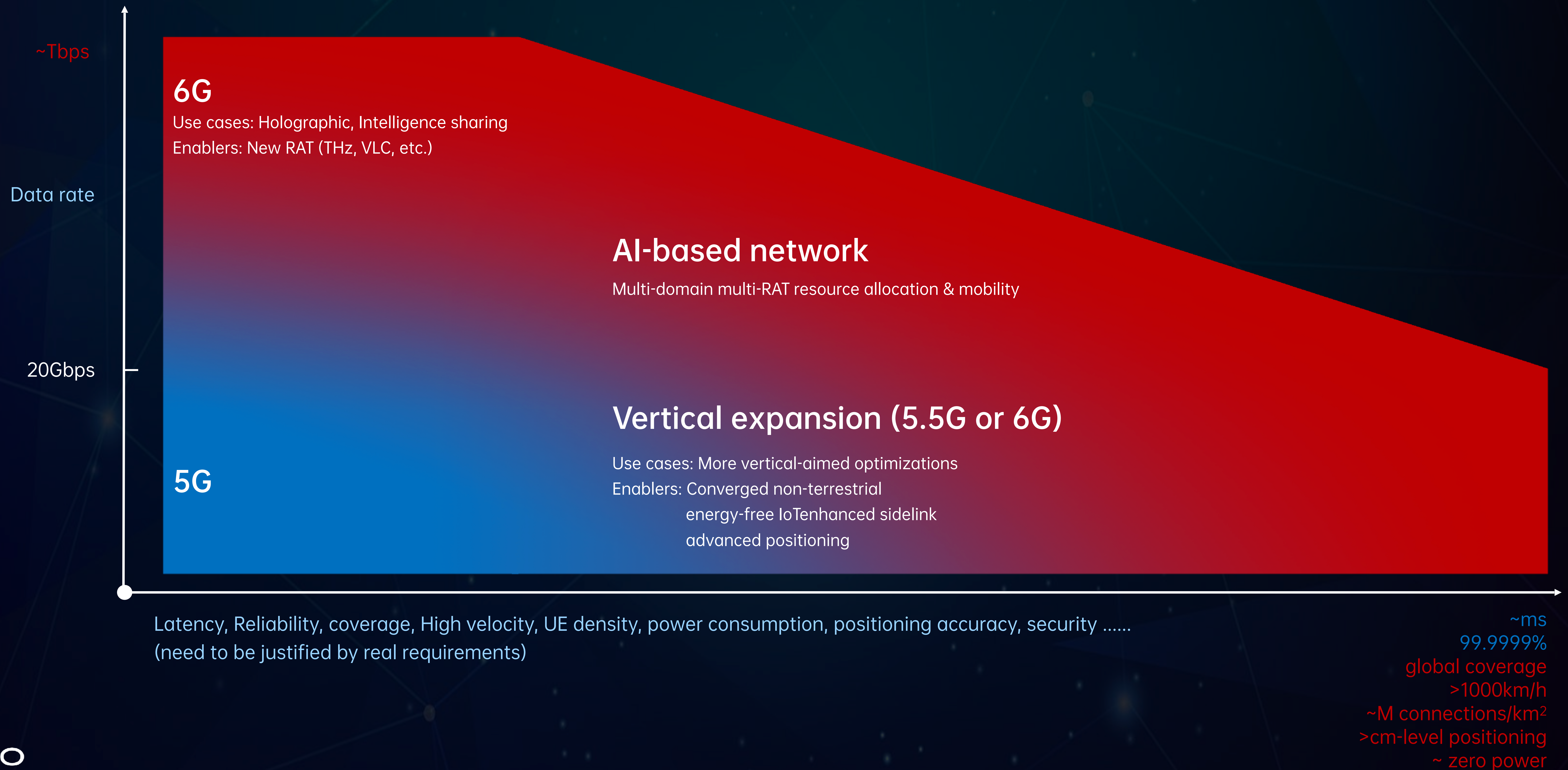
## ❖ Swarming systems

- A large scale of intelligent agents with coordinative operation and cooperative learning
- Swarming intelligence could be achieved by interactions among local agents
- Complex tasks could be accomplished through the swarming intelligence





# ► Potential 6G requirements and technologies





Thank you!

