End-to-End Data/Storage in Autonomy

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Emerging Autonomous Markets And Storage

• We’ve all heard of the SAE Autonomous Driving Levels
  • Adaptive Cruise Control thru to no driver intervention driving
• But the market is more complex than that
  • Anything less than Level 5 has limitations and those limitations create different markets
  • Different usages/complexities mean different storage requirements
Driver must pay attention at all times
- Hands on the wheel (L2):
  - Most ‘semi-autonomous’ products in market
  - E.g. Tesla Autopilot, OEM ADAS features
- Hands off the wheel (low L3):
  - Very few in market today
  - Highway only
  - E.g. GM SuperCruise, Audi ProDrive

On-vehicle:
- Local processing camera, radar, ultrasonic
  - Today no LIDAR, but may come
- Local HD mapping storage
- Mapping updates/patches
- Storage for accidents/logging

Cloud:
- HD mapping storage
- Analytics data processing/collection
- OTA Updates
Data/Storage: L4 Robotaxis

A Taxi with no human driver (you ride in the back)

- Large push to bring to market quickly
  - Currently in test
  - On-road 2019 onwards
  - Operate only in pre-defined regions

**On-vehicle:**
- Local processing of LIDAR, 8+ cameras, radar, ultrasonic
- Ultra HD LIDAR mapping storage
- Storage of past decisions
- Storage for accidents/logging

**Cloud:**
- AI infrastructure for ML training
- Big data infra for LIDAR mapping
- Long-term storage for accidents/learning
- Compliance support Big Data storage
- Analytics data processing/collection
- Simulation storage and processing
Data/Storage: L4 Consumer

Hands off the wheel vehicles
- MY2021 plans from traditional OEMs
- Typically highway or suburban regions

Two approaches:
1. Either larger version of L4 Robotaxi
   - More mapping, etc. —> $$$
2. Increasing Machine vision over LIDAR
   - Less reliance on LIDAR and UHD maps

On-vehicle:
- Camera-centric local processing with LIDAR, radar, ultrasonic
- Much increased in performance/thruput
- HD Mapping storage for localization
- Storage of past decisions storage
- Storage for accidents

Cloud:
- Very large AI infrastructure for training
- Big data infra for HD mapping or purchase from HD mapping vendor
- Long-term storage for accidents/learning
- Compliance Big Data storage
- Analytics data processing/collection
Open Challenges?

• The mass market for vehicles will be slow to arrive
  • Vehicle processes take ~3+ years, but thankfully AVs are usually modified vehicles

• Limited view on end-to-end systems by OEMs
  • So many largely focus on the cars and sensing
  • Also Cloud for ML

• AVs often use components from multiple Tier1 vendors
  • Opportunity for the mass market, but higher capability vehicles are largely TBD

• Limited number of high-performance embedded AI systems
  • NVidia, Intel, etc. but embedded SoCs are coming along

• 5G
  • Some of the market ties AVs to 5G
  • All AVs on the road are not-5G and work just fine
Mobility Service Trends and AV

- User volume is key to mobility services
- Funding largely matches market share
- Major cost of each trip is driver cost/retention
5G encompasses so much, that in reality there are 3 different 5Gs
- Low-latency 5G
- Low-power 5G
- High-bandwidth 5G

Physics won’t allow us to do this with one radio
- Unless we place devices very near pico-cell towers ($$$)
- Automotive solutions will need 2-3 different radios in order to fulfill this dream