Radars for automotive applications

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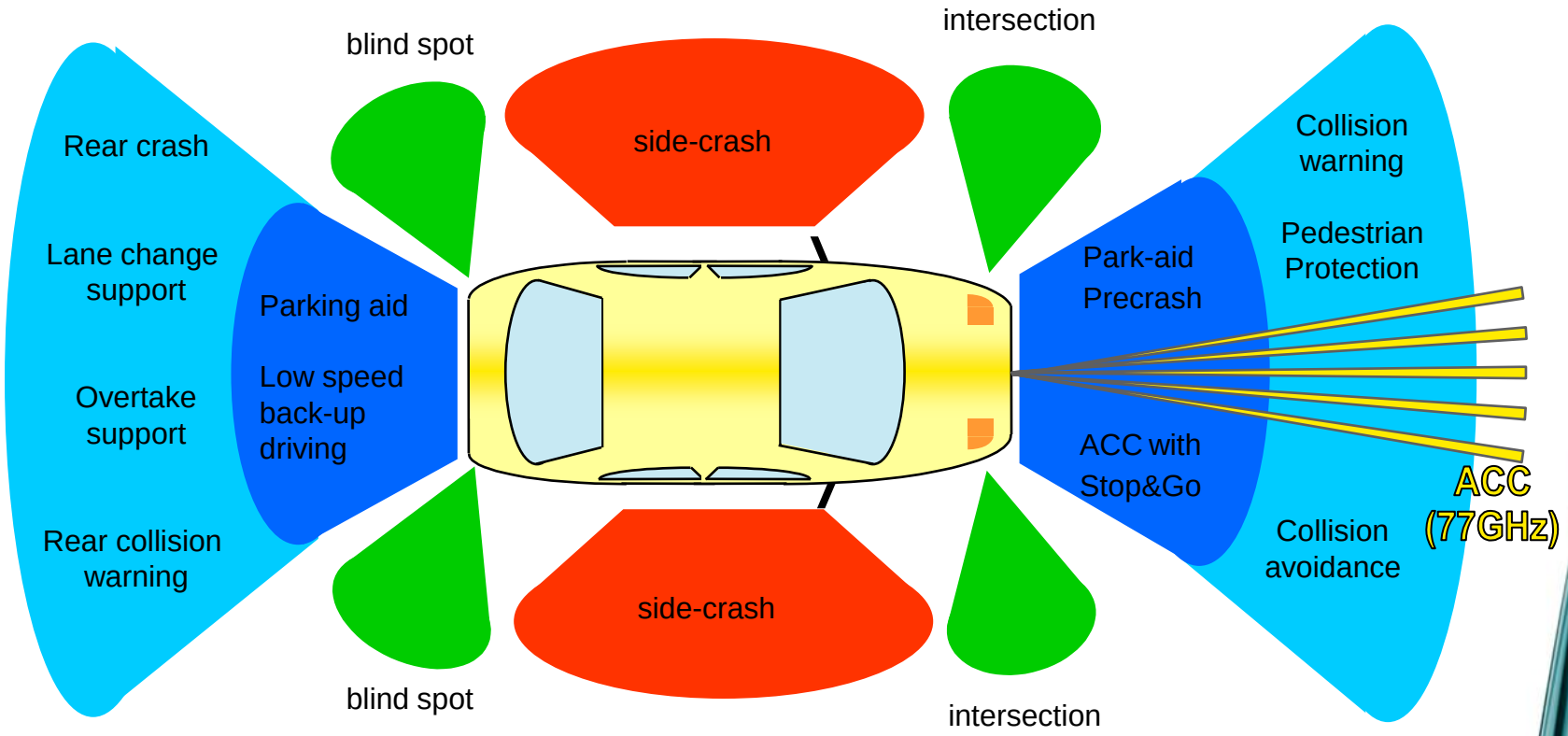
Why use radars in cars/trucks?

- The dream promised to us: **self driving cars**
- Early 70's: First tentative for mm-wave automotive showed the potential for collision avoidance, however integration-unfriendly technologies lead to large size, high cost
- Robust to bad weather conditions
- High accuracy for range measurements

The automotive market

- Consumers are changing
  - The rise of the middle class
- Safety regulations
  - Pedestrian protection needed to get 5 stars
- Market players are changing
  - A similar scenario to the communication industry?
- Technology is rapidly improving and expanding
  - Cost of DSP chips, radars, CMOS, etc. constantly decreasing
    - Market expanding at 40%/year and is expected increasing with all premium/middle cars having a radar in next years (7% of all vehicles sold world-wide, mainly in Europe, Japan and US, will have radar)

Current applications



Challenges – Analog

- 24 GHz → 79 GHz
  - 24GHz a temporary solution
    - Benefits of 77-79 GHz band
  - Better models
    - Accurate and cost effective testing?
  - What technologies to use?
    - SiGe, GaAs today, but CMOS with better integration and reduced power consumption
  - Phased array/MIMO radars
    - Phased array maybe, MIMO needs more work to be realizable

Challenges - Digital

- **Advanced detection and estimation algorithms**
  - Space Time Adaptive Processing (STAP) relying on GLRT detector frameworks, e.g., Kelly, ACE, AMF detectors
  - DOA Estimation using high resolution methods with low computational demands
- **Preprocssing/Classification algorithms**
  - Gaussian mixture models
- **Extended target tracking algorithms**
  - Targets are at close distance, no longer a point source
    - PHD and Bayesian methods
- **Sensor fusion**
  - Many different sensors, efficient ways of integrating the data
  - Suitable common coordinate system
  - How to model?
- **Situational awareness**
  - Including maps of the environment
- **Seamless integration of hardware for user**

Looking forward – what I would like to see

- **In the box**
  - Better warning systems
  - CMOS integrated radars with good performance
  - Extended target tracking algorithms for better accuracy
  - V2V communication
- **Out of the box**
  - Using radars/cameras/sensors to help users become better drivers
  - Not only warn drivers, but warn other vehicles/pedestrians as well
  - Standardized OS on cars, so radars can be treated as upgradable modules
  - Sensor fusion, but with other peoples cars as well
    - Standardized global coordinate system used for all cars
  - Integration of reflectors in the road (with coding on top) for traffic information (stop signs, warnings, turns)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