a review of Dynamic Intervention Technologies and a method to choose beween them

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outline

- The need for intervention
- A Comparison of Solutions
- Architecture
- Conclusions

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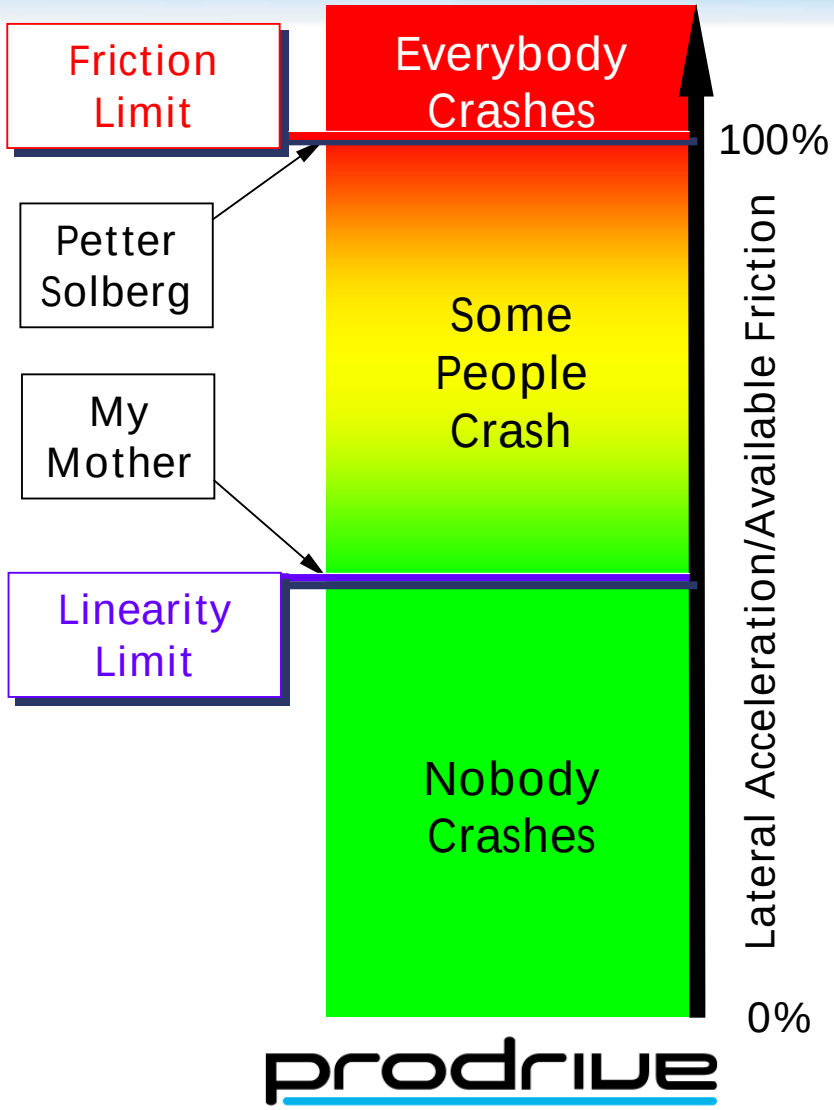
the need for intervention

- Most drivers' "in-head" model of the car is predicated on linearity and zero phase lag
- Most drivers have no experience of significant loss of linearity
- Most drivers have no experience of phase lag in yaw/sideslip resonance

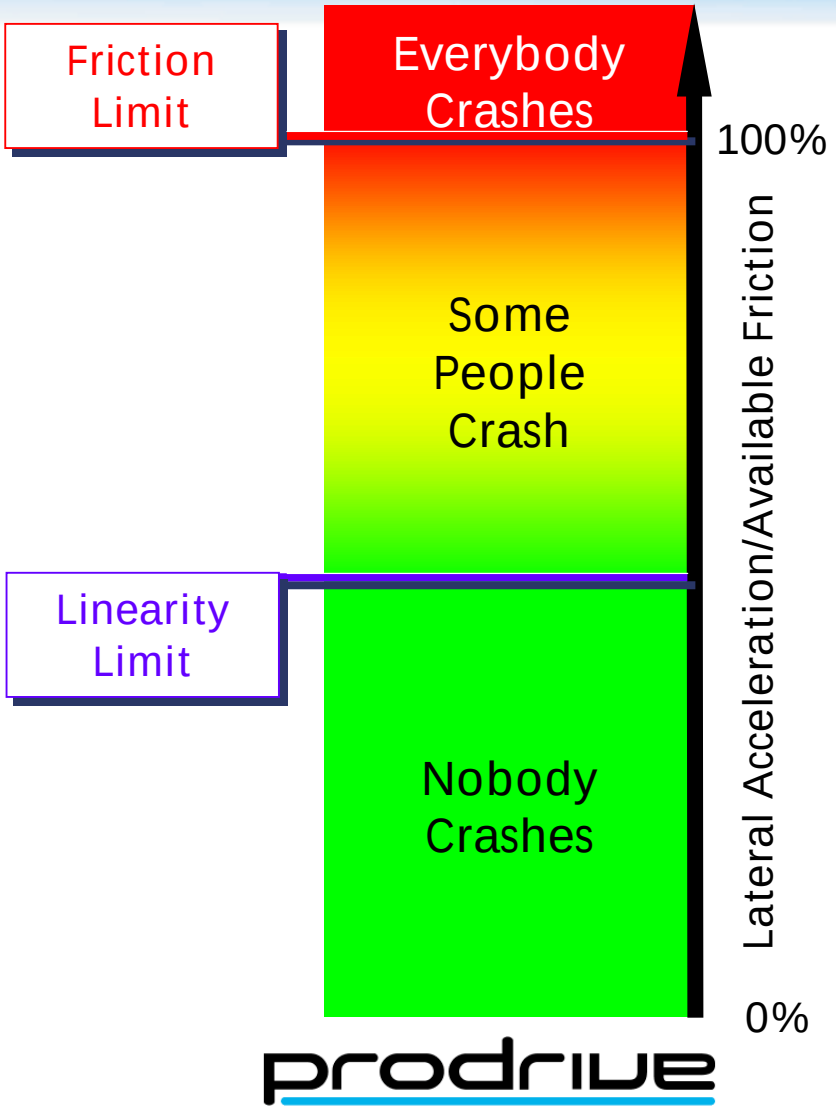
the need for intervention

- When the vehicle departs from linearity, the population is very variable in its ability to retain control of the car
- There are a group of events where crashes occur even though the vehicle was inside the friction limit due to the driver's lack of control skill
- For road cars we need to match the car to the skill of the population
- For Motorsport we can calibrate the car to the individual driver skill level
- There are a group of events where crashes occur because the vehicle is outside the friction limit



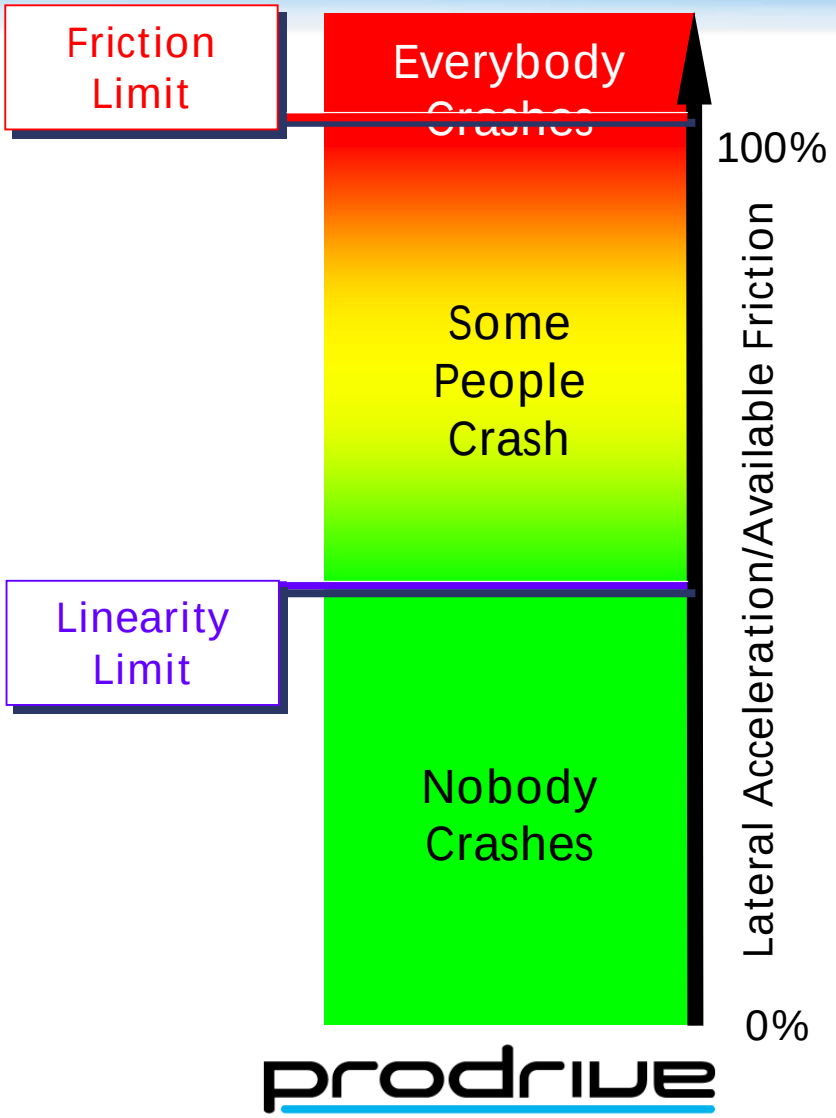
the need for intervention

- Our task has two components



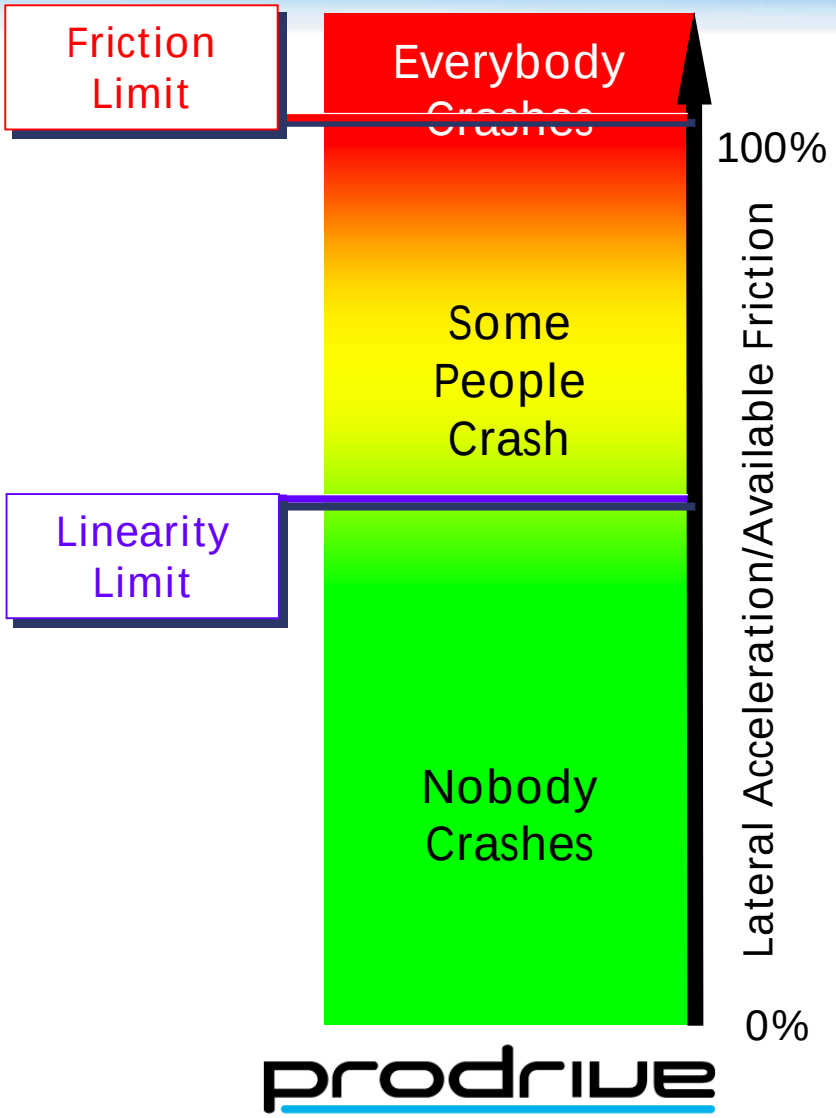
the need for intervention

- Our task has two components
  - to raise the absolute limit



the need for intervention

- Our task has two components
  - to raise the absolute limit
  - to raise the linearity limit
- These simplistic statements ignore some problems:
  - is the distance between the friction limit and the “some people crash” boundary a function of the population only and not the car?
  - are we allowing some people to have faster crashes than they could previously have had?



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dynamic qualities

- “Linearity limit” is something of a shorthand for linearity of both scale and phase for yaw response and lateral acceleration response to handwheel input
- Improvement of the linearity of yaw response of the base car requires the ability to bring to bear yaw moments independent of driver input
- Simplistically there are two possibilities with which to compare dynamic intervention systems:
  - Understeer Correction Yaw Moment
  - Oversteer Correction Yaw Moment
- There is an implicit presumption that the yaw correction is equally influential on the lateral acceleration behaviour; this is not true if the friction limit is exceeded

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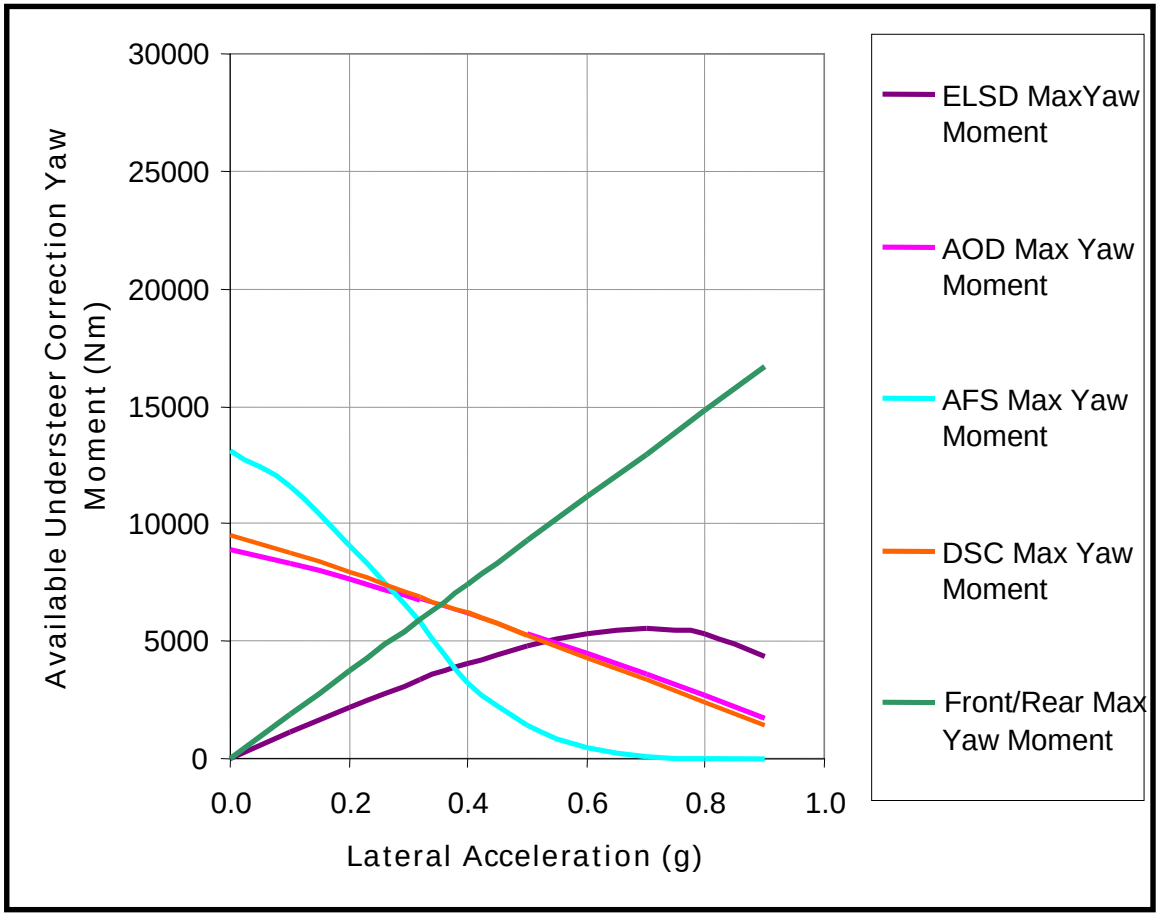
comparison of understeer solutions

- For understeer suppression, Active Front Steer (AFS) is particularly effective on-centre but very poor at the friction limit
- Rear wheel steering is similarly effective on-centre but poor at the friction limit – the actual moment available depends on the amount of steer possible
- DSC (brake-based stability control) is quite good on-centre but falls away on the limit
- Asymmetric driveline hardware is similar in nature



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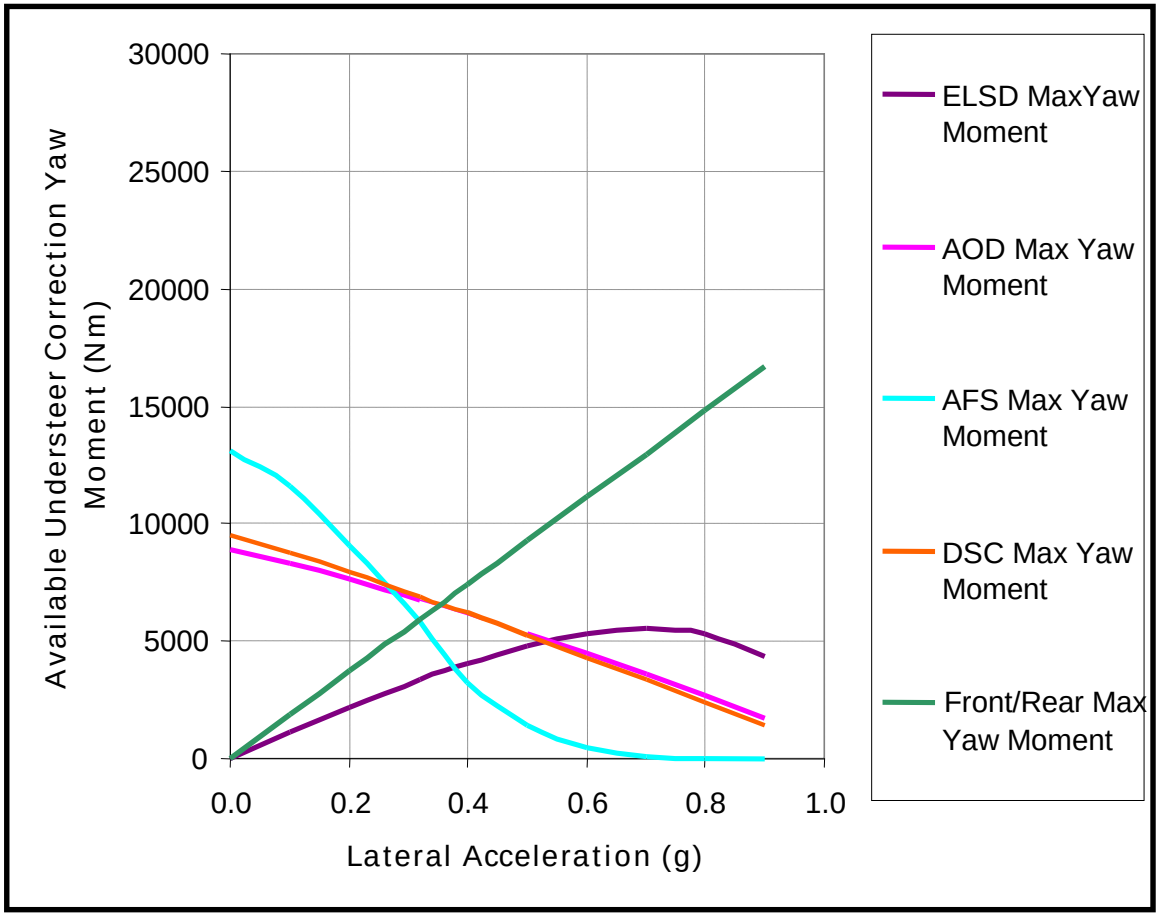
comparison of understeer solutions

- Front / rear torque distribution is very effective at the friction limit but only if there is driveline torque available
- A brake-based system could conceivably work in a “handbrake” type mode to deliver the same authority
- ELSD calculations are also based on driveline torque and presume the rear axle has not broken away
- ELSD characteristics are comparable whichever end of the vehicle it is fitted
- ELSD increases understeer in the absence of throttle



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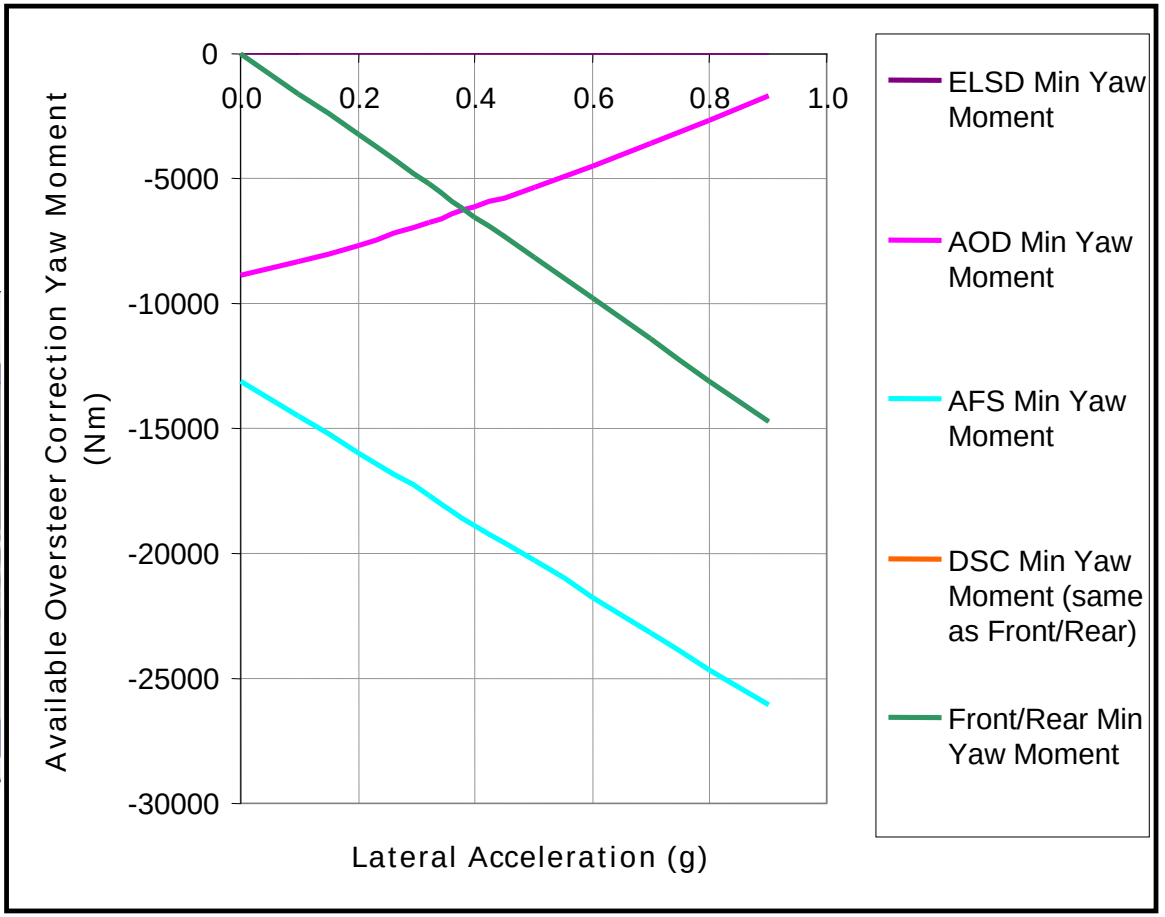
comparison of oversteer solutions

- For oversteer correction, AFS has most authority
- Asymmetric device is severely limited in the oversteer situation

- Front / rear torque distribution is powerful if driveline torque is used
- DSC is powerful if reduced vehicle speed is required (driver's feet off all pedals)



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observations

- Systems with a high on-centre authority are good for reducing phase delays and delivering character
- Systems with a high authority off-centre are good for keeping control of the vehicle near, at or beyond the friction limits
- No one system has high authority in every possible regime
- Required market positioning is therefore likely to determine “best possible” combinations of systems in a fairly straightforward way

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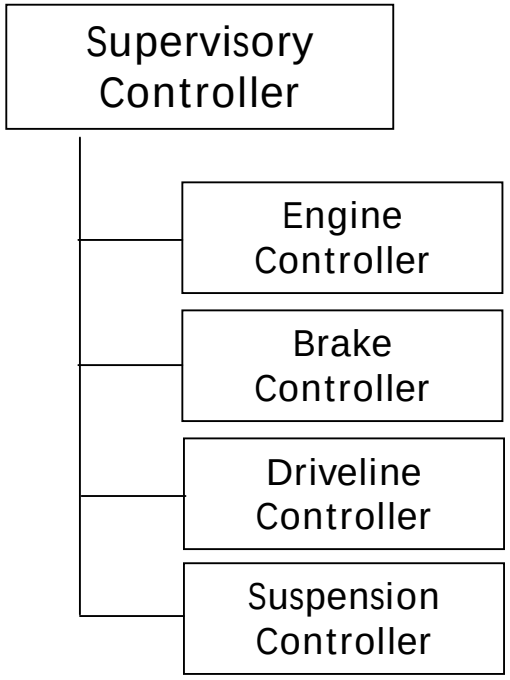
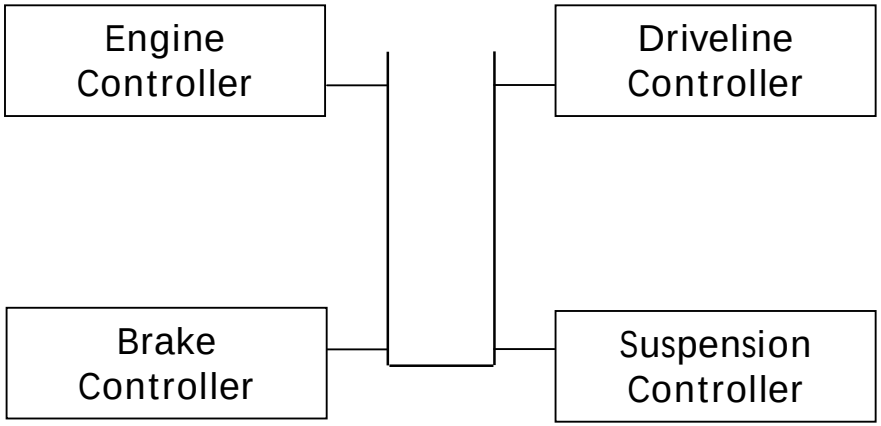
architecture

- Who really has control?



Single Master Control



Predetermined
co-operation protocol

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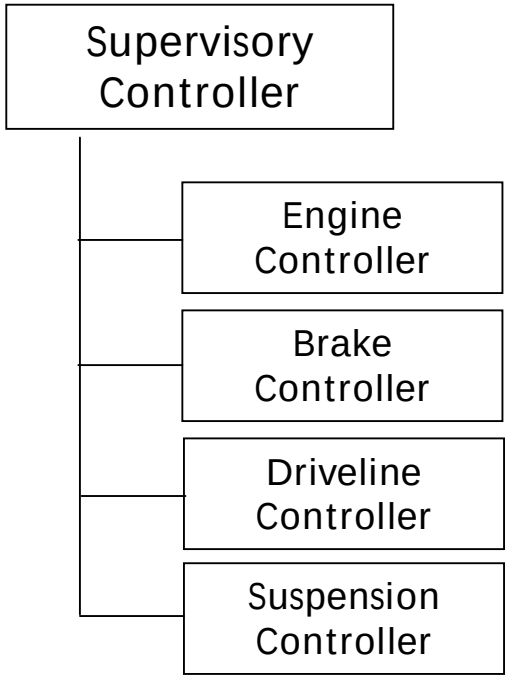
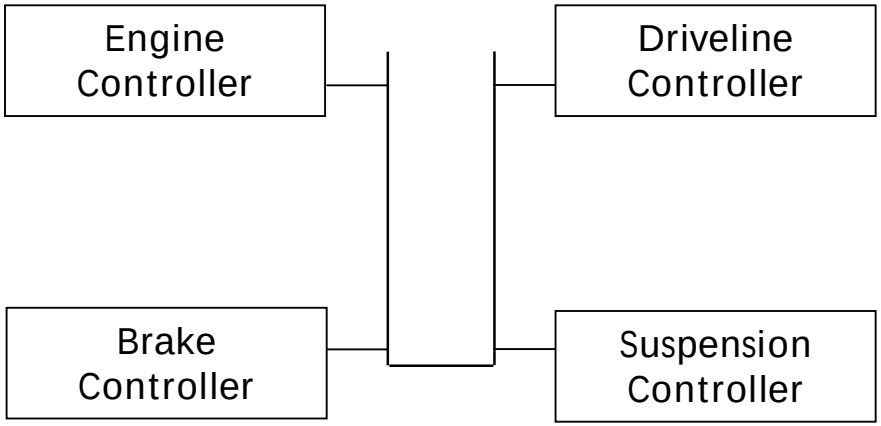
architecture

- Whose car is it anyway?



Supervisory controller clearly and unambiguously defines the vehicle



Co-operation protocol defines the vehicle – who sets it?

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conclusions

- Brake-based systems are here to stay
- Steer-based systems are up-and-coming
- Other systems have a part to play in delivering brand attributes
- Load-based systems are more for ride than handling
- Interaction between systems is more difficult to solve politically than technically!

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