



Transport Innovation...
The Next Frontier



PBS WITH CONNECTED AND AUTOMATED VEHICLES

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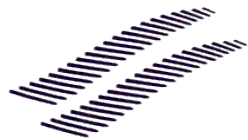


Performance Based Standards

- PBS is a tool that we use to assess whether a vehicle can perform its required transport tasks safely
- Its main application has been to facilitate the use of larger and heavier vehicles

Why do we want bigger vehicles?

- Driver productivity
- Vehicle productivity
- Fuel efficiency and emissions reduction
- Reduced congestion
- Greater safety



Connected and Automated Vehicles Current Technology



Platooning

- European Truck Platooning Challenge 2016
- Vehicle-to-vehicle communications
- Automated speed and headway control
- Driver steering control
- Conventional vehicles (16.5m semi-trailers)
- Headways from 0.5s up (11m at 80 km/h)



Benefits of Current Platoons

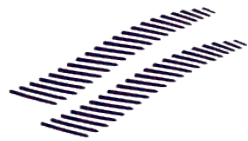
Driver productivity	N
Vehicle productivity	N
Fuel efficiency and emissions reduction	Y
Reduced congestion	Y
Greater safety	Y

Not suitable for use in New Zealand because of our two-lane road network but...

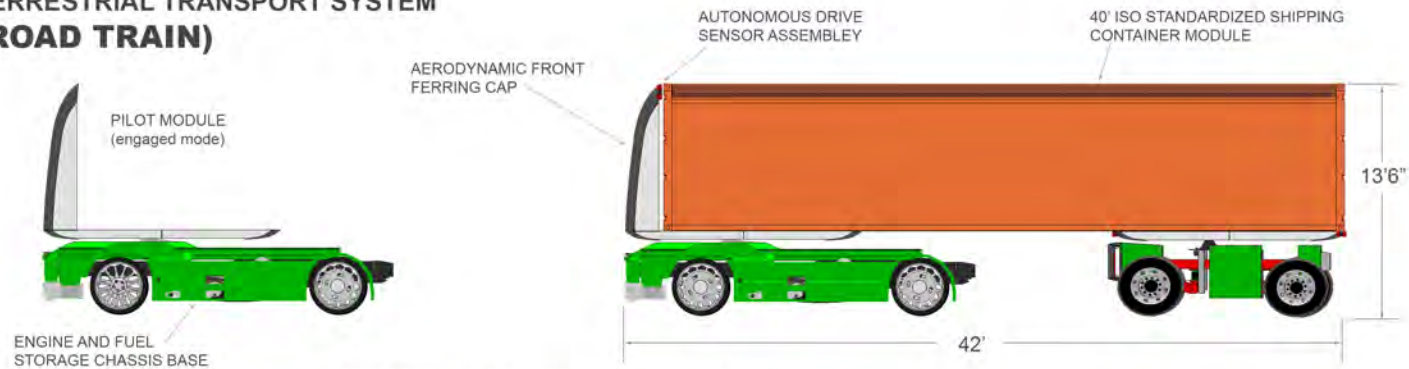
What is there to prevent them being used?
(Road User Rule 2004?)

Future Technology Platoons

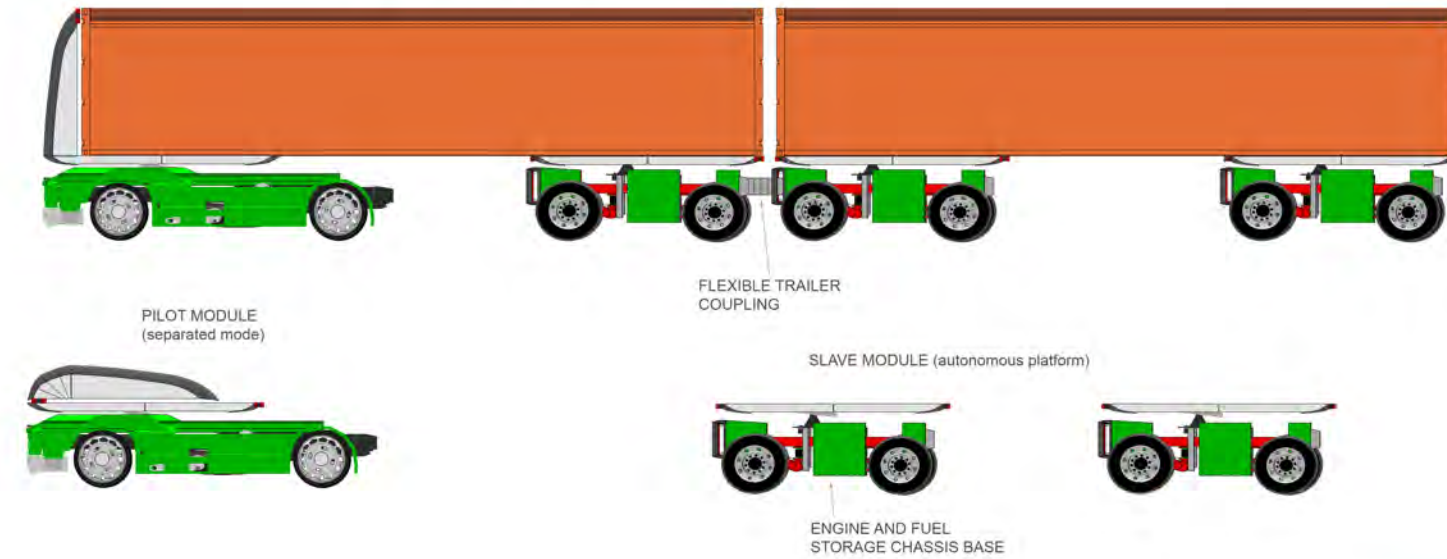
- Automated steering
- Driverless trailing vehicles
- Fully automated driverless platoons, or
- Fully automated combination vehicles




AUTONOMOUS ISO STANDARD TERRESTRIAL TRANSPORT SYSTEM (ROAD TRAIN)



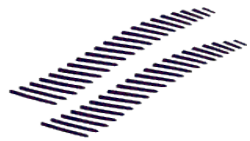
ROAD TRAIN (up to 4 40' containerized trailers stacked in one train)





NICK PUGH STUDIO 

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TRANSPORT RESEARCH



Benefits of Future Tech. Platoons

Driver productivity	Y
Vehicle productivity	Y
Fuel efficiency and emissions reduction	Y
Reduced congestion	Y
Greater safety	Y

Usable in New Zealand?

Interactions with other road users?

Scope for improved inter-modal operations



Performance of Platoons

- Each individual vehicle will have acceptable performance
- Platoon is effectively a combination vehicle
- What is the performance of the platoon?
 - Low speed off-tracking
 - High speed off-tracking
 - High speed dynamic performance

Low Speed Off-tracking

- 18m tridem semi-trailer combination
- Proposed PBS limit for swept width < 6.7m
- Driver-controlled steering
 - Single vehicle swept width – 6.61m
 - Two vehicle platoon swept width – 9.82m
- Automated steering
 - Need V2V comms to make any difference
 - Unless vehicles are identical – trailing vehicle needs to know how both vehicles respond to steering inputs



High Speed Off-tracking

- Outboard off-tracking on large radius turns
- Proposed PBS limit $< 0.46\text{m}$
- Driver-controlled steering
 - Single vehicle off-tracking- 0.31m
 - Two vehicle platoon off-tracking - 0.62m
- Automated steering
 - Need V2V comms to make any difference
 - Unless vehicles are identical - trailing vehicle needs to understand dynamics of both vehicles

High Speed Lane Change

Performance Standard	Acceptability Limit	Single semi-trailer	Two-vehicle platoon
Rearward Amplification	< 2	1.14	1.60
Load Transfer Ratio	< 0.6	0.47	0.64
High Speed Transient Off-tracking	< 0.6m	0.38	0.89

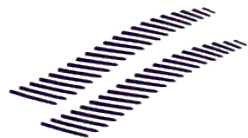
Implications for Real World Operations

- Low speed off-tracking is a geometric effect and is on the inboard side of the turn
- High speed off-tracking is a dynamic effect and is on the outboard side of the turn
- Real world off-tracking is a combination of the two effects
- Vehicles in platoons cannot simply follow the back of the vehicle in front



Performance with Future Technologies

- Autonomous steering of trailing vehicle needs to try to follow the intended path of the front of the lead vehicle
- Needs to adapt if lead vehicle has problems achieving its intended path
- Regulators need confidence that the whole platoon will perform satisfactorily not just the individual vehicles



Conclusions

- A platoon is effectively a combination vehicle with electronic rather than physical couplings
- Behaviour of electronic couplings will be more complex
- Regulations for these vehicles will need to consider the performance of the combination as a whole
- This could be very challenging

