

Smart Motorways: how did we get here, where are we, and what do we know about safety?

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Society of Road Safety Auditors
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- The Tesla manual explains, "*Traffic-Aware Cruise Control cannot detect all objects and* ***may not brake/decelerate for stationary vehicles,*** *especially in situations when you are driving over 50mph and a vehicle you are following moves out of your driving path and a stationary vehicle or object is in front of you instead*."

- Volvo's semi-autonomous system, Pilot Assist, has the same short coming. The manual states: "***Pilot Assist will ignore the stationary vehicle*** *and instead accelerate to the stored speed*".

How did we get here?

Approach:

- Alternative to conventional widening
- Lower cost and faster delivery without DCO
- Equal or better safety performance for users
- Technology enables lane closure, speed reduction and driver information messages – supports workers (but note hard shoulder removal raises concerns for Traffic Officers)
- Lane control keeps traffic moving when a lane is closed – journey time/reliability benefits
- More resilience (rapid speed control, much faster than TTM and without orders etc)

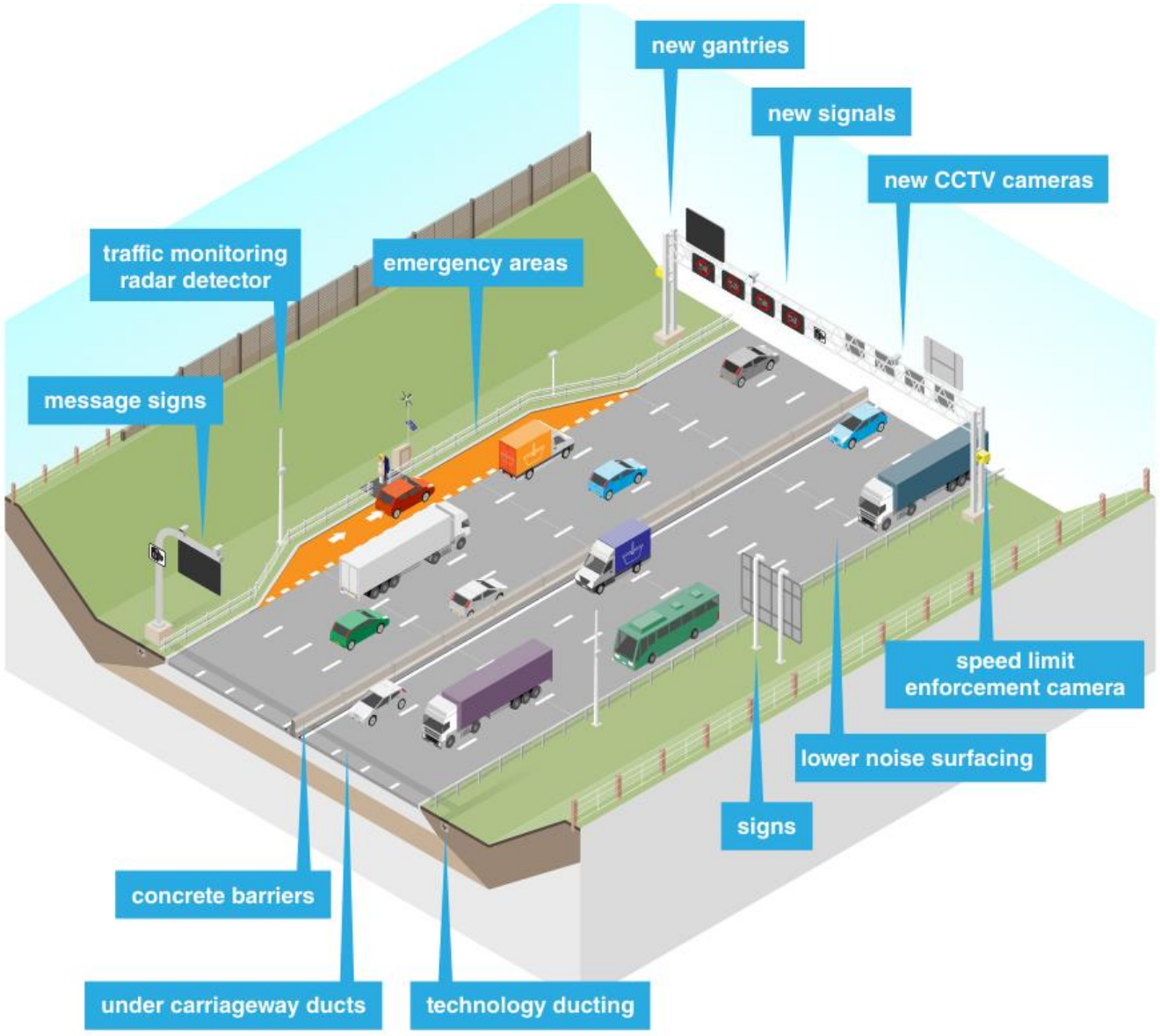
Smart Motorway features

In all formats:

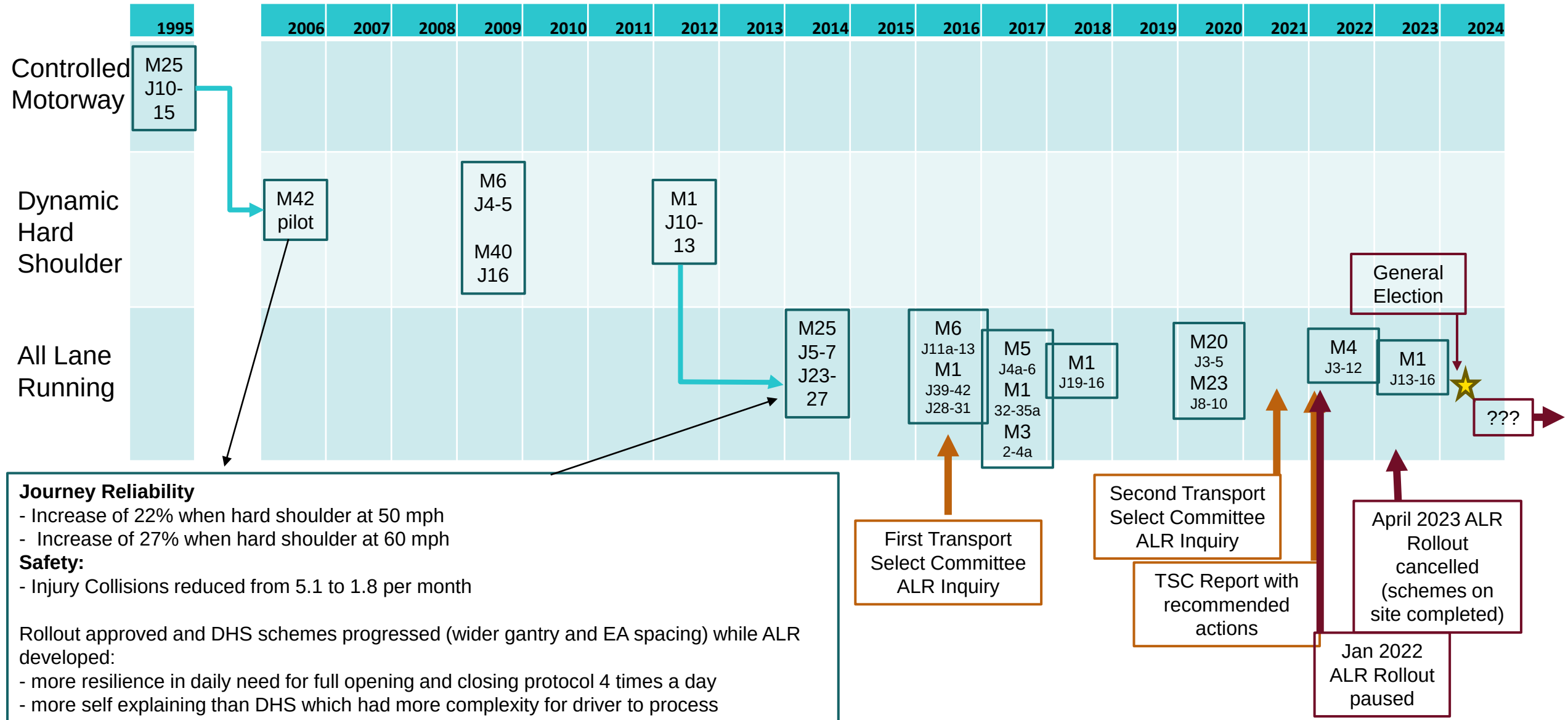
- **Technology** to monitor and control flow and speed including lane closures. Variable mandatory speed limits (red ring); TTCV; lane control (red X)
- **Connection to operations centre** control room where cctv is used to monitor once events identified
- **Traffic Officer patrol/attendance** to promptly deal with obstructions and keep lanes clear

In some formats:

- **Hard shoulder conversion** to running lane part time/full time (*not permanent or temporary as often described*)
- **Stopped Vehicle Detection** to reduce duration of live lane stops



The timeline of Smart Motorways



Journey Reliability
- Increase of 22% when hard shoulder at 50 mph
- Increase of 27% when hard shoulder at 60 mph

Safety:
- Injury Collisions reduced from 5.1 to 1.8 per month

Rollout approved and DHS schemes progressed (wider gantry and EA spacing) while ALR developed:
- more resilience in daily need for full opening and closing protocol 4 times a day
- more self explaining than DHS which had more complexity for driver to process

Where are we? 1. Definitions

	Vanilla D3M (conventional)	Controlled Motorway	Dynamic Hard Shoulder	All Lane Running	GD 300 APTR
Lanes	3 lanes	3 lanes	3 lanes off peak 4 lanes peak	4 lanes	2-3 lanes
Place of relative safety (PRS)	Hard shoulder 24/7	Hard shoulder 24/7	Off peak hard shoulder, plus Emergency Areas (laybys)	Emergency Areas (laybys)	Emergency Areas (laybys)
Speed limit (excl TTRO)	70mph	40 to 70mph	40 to 70mph	40 to 70mph	40 to 70mph
Control centre connection	Yes	Yes	Yes	Yes	Yes
Traffic Officer coverage	Yes	Yes	Yes	Yes	**Scheme-dependent**
Stopped vehicle detection (SVD)	Yes	Yes	Yes	Yes	**Scheme-dependent**

Where are we? 2. The Network

10% of motorway
is now DHS or ALR

Annex A – Smart motorways map
(correct as of June 2023)

ALR motorway
- 3 M1 Junction 13 - 16
- 4 M1 Junction 16 - 19
- 6 M1 Junction 24 - 25
- 8 M1 Junction 28 - 31
- 10 M1 Junction 32 - 35a
- 11 M1 Junction 39 - 42
- 12 M3 Junction 2 - 4a
- 14 M4 Junction 3 - 12
- 16 M5 Junction 4a - 6
- 17 M6 Junction 2 - 4 (i)
- 22 M6 Junction 11a - 13
- 23 M6 Junction 13 - 15
- 24 M6 Junction 16 - 19
- 26 M20 Junction 3 - 5
- 28 M23 Junction 8 - 10
- 30 M25 Junction 5 - 6
- 35 M25 Junction 23 - 27
- 37 M27 Junction 4 - 11
- 41 M56 Junction 6 - 8
- 43 M62 Junction 10 - 12
- 44 M62 Junction 18 - 20

i) M6 Junction 3a to 4 Controlled motorway

ALR scheme in construction
- 25 M6 Junction 21a - 26

ALR schemes cancelled
- 13 M3 Junction 9 - 14
- 33 M25 Junction 10 - 16
- 38 M40 - M42 interchange
- 45 M62 Junction 20 - 25

DHS motorway conversion to ALR cancelled
- 2 M1 Junction 10 - 13 (ii)
- 15 M4 - M5 interchange (iii)
- 18 M6 Junction 4 - 5 (iv)
- 19 M6 Junction 5 - 8 (v)
- 20 M6 Junction 8 - 10a
- 39 M42 Junction 3a - 7
- 46 M62 Junction 25 - 30 (vi)

ii) M1 Junction 11a to 12 DHS infrastructure, short link with motorway service area slip roads and no hard shoulder for part of link

iii) M4 Junction 19 to 20 M5 Junction 16 - 17
M5 Junction 15 to 16 Controlled motorway

iv) M6 Junction 4 to 4a southbound Controlled motorway

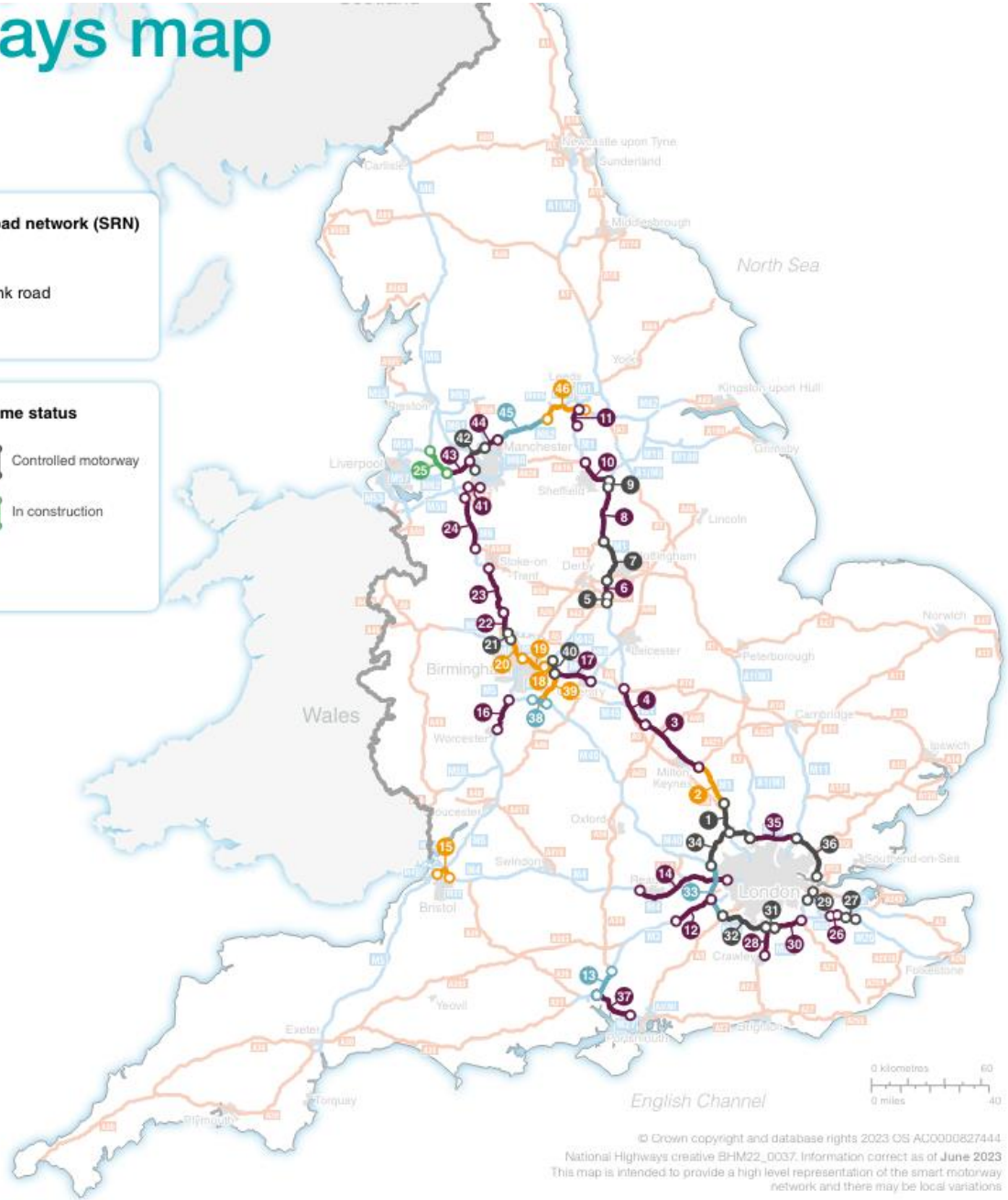
v) M6 Junction 7 to 8 DHS infrastructure, short link with no hard shoulder

vi) M62 Junction 25 to 26 DHS infrastructure, short link with motorway service area slip roads and no hard shoulder
M62 Junction 28 to 29 Controlled motorway
M62 Junction 29 to 30 DHS infrastructure, short link with no hard shoulder (westbound only)

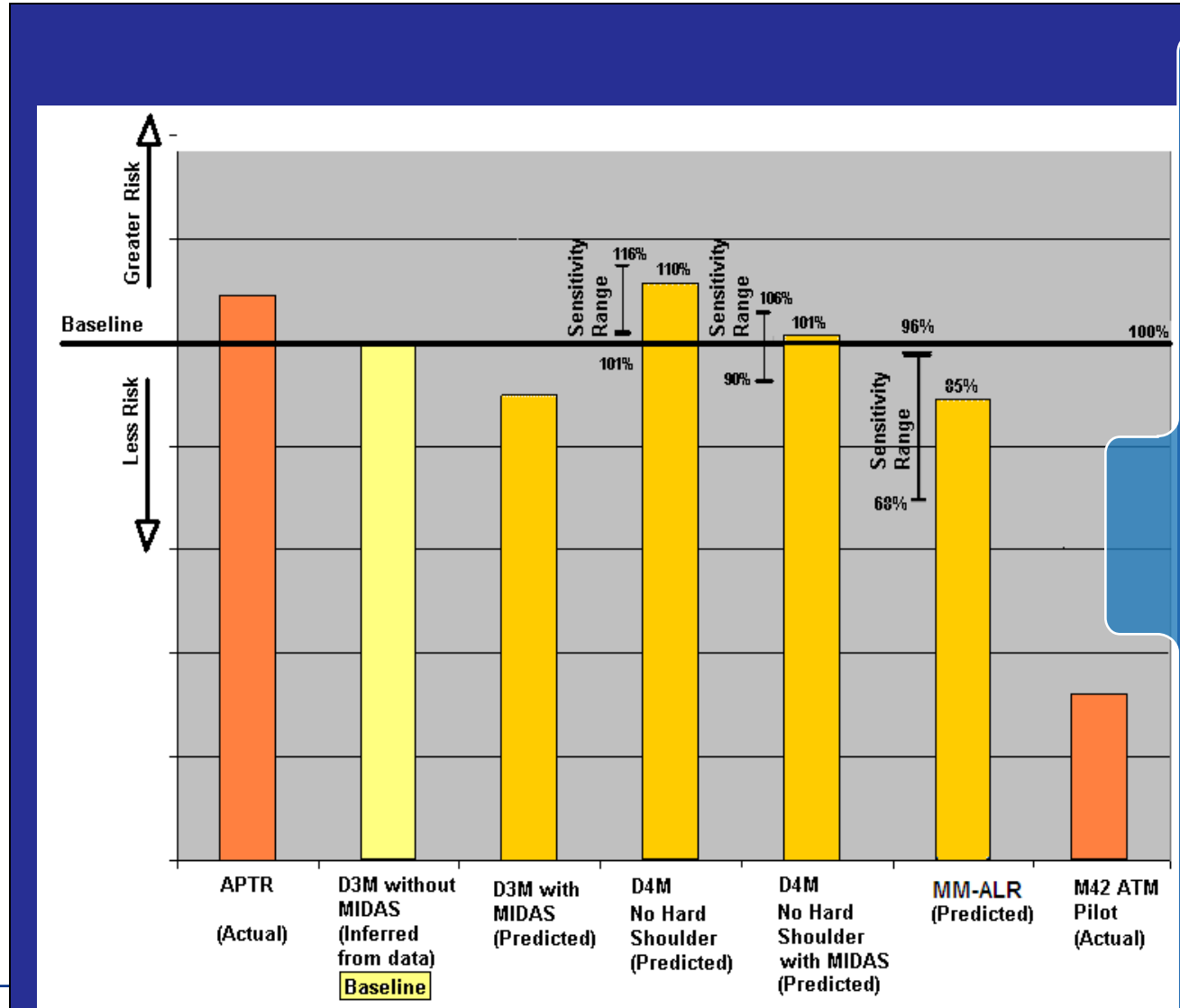
Controlled motorway
- 1 M1 Junction 6a - 10
- 5 M1 Junction 23a - 24
- 7 M1 Junction 25 - 28
- 9 M1 Junction 31 - 32
- 21 M6 Junction 10a - 11a
- 27 M20 Junction 5 - 7
- 29 M25 Junction 2 - 3
- 31 M25 Junction 6 - 7
- 32 M25 Junction 7 - 10
- 33 M25 Junction 10 - 16
- 34 M25 Junction 16 - 23
- 36 M25 Junction 27 - 30
- 40 M42 Junction 7 - 9
- 42 M60 Junction 8 - 18

England's strategic road network (SRN)
- Motorway
- All purpose trunk road
- Toll roads

Smart motorway scheme status
- ALR motorway
- Controlled motorway
- DHS motorway
- In construction
- Cancelled

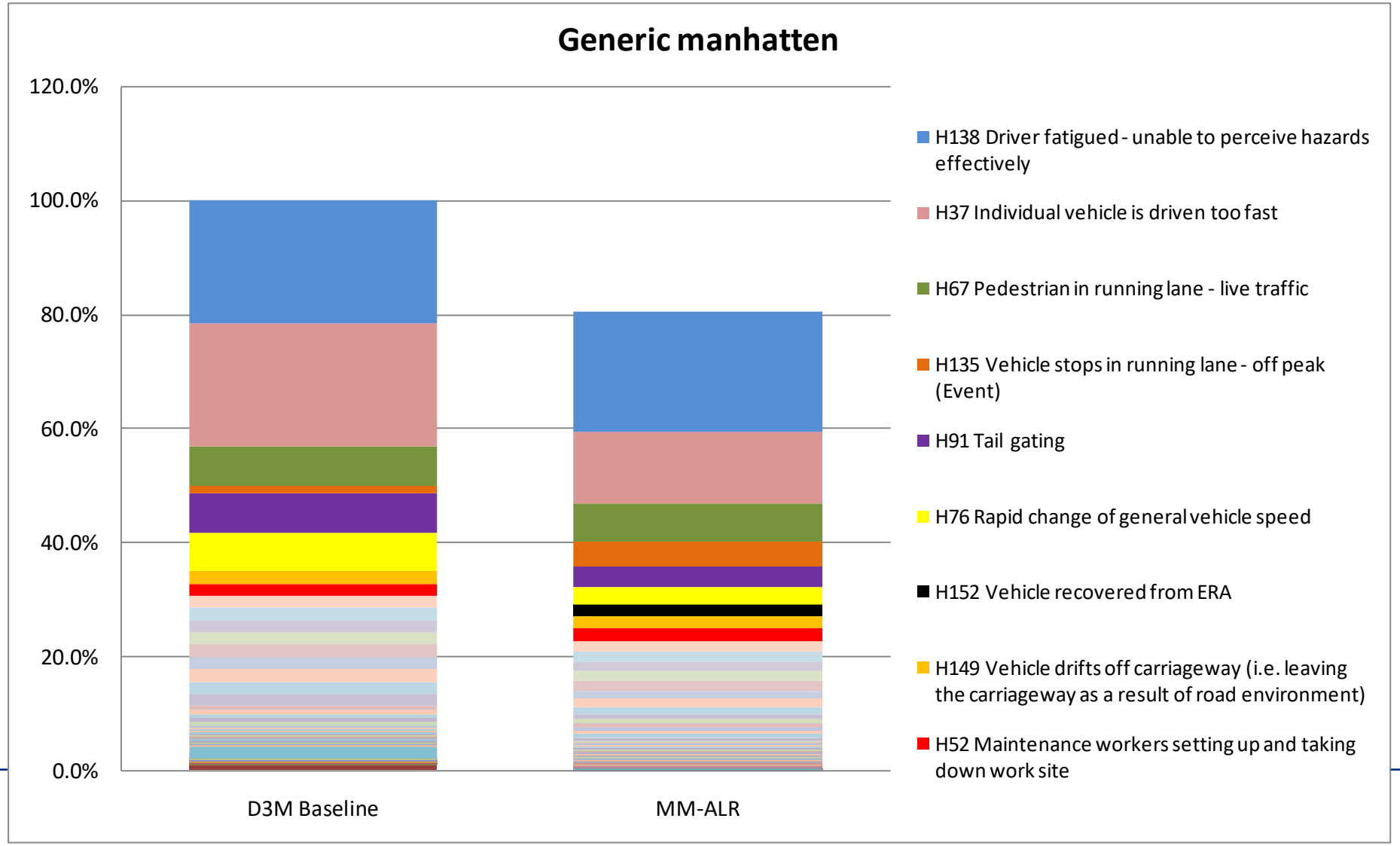


How safe is it? 1. Modelled & actuals *before* ALR implemented



- Built from a combination of experience, empirical evidence and simulation;
- ALR showed approximately 15% reduction in risk compared to baseline (D3M without MIDAS) – effectively nil detriment safety effect to achieve higher capacity

How safe is it? 1. Big picture of hazards – and ethics of net gain



Relationship between risk and collision data

a) Change in risk from all hazards vs change in collisions of all types

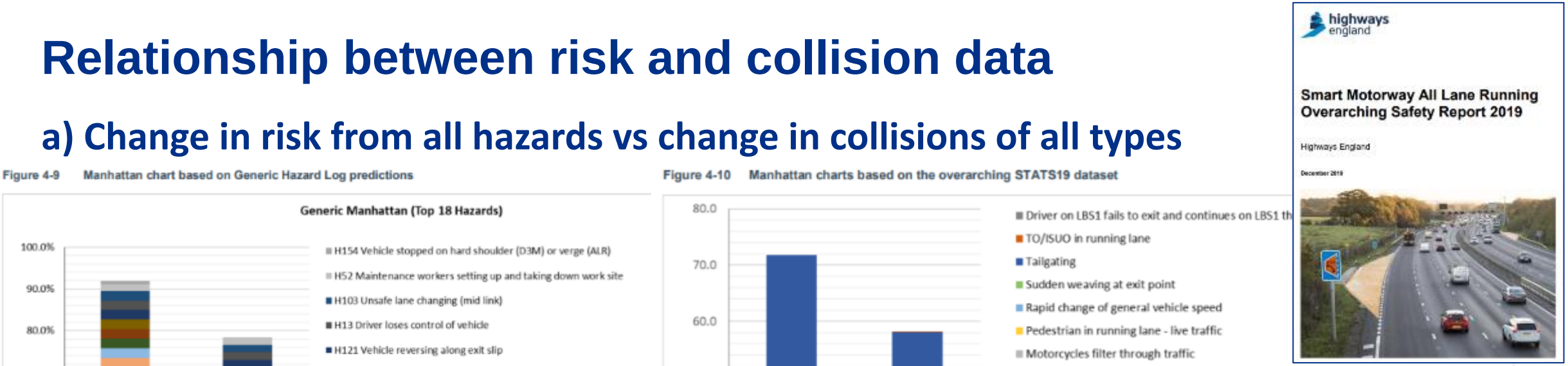


Figure 4-9 Manhattan chart based on Generic Hazard Log predictions

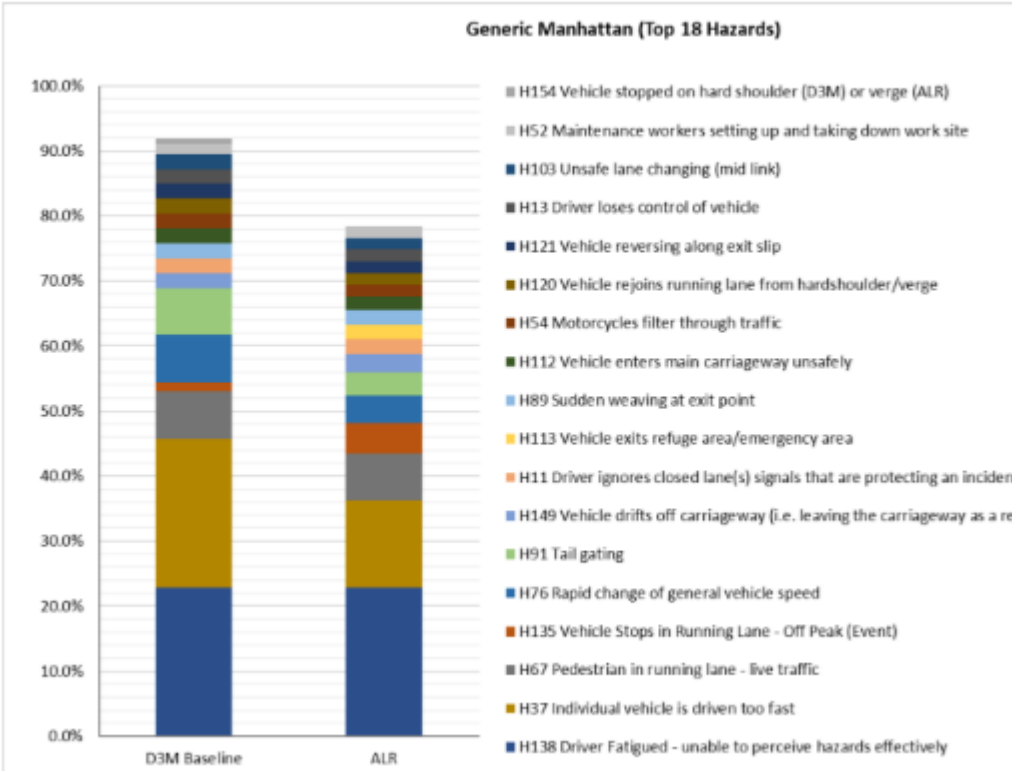
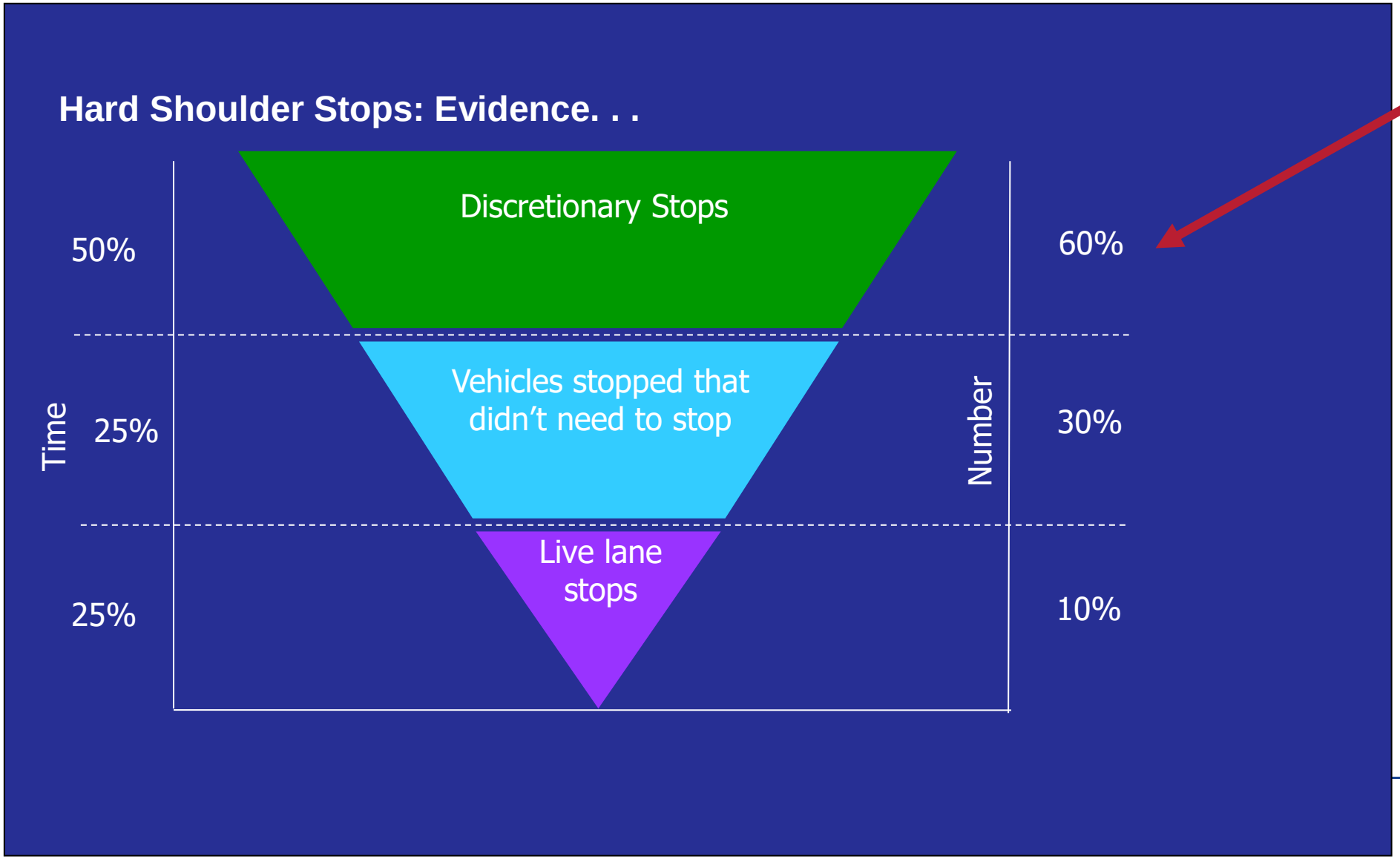


Figure 4-10 Manhattan charts based on the overarching STATS19 dataset

- **Data supports safety case for all SM forms inc ALR**
- **Live lane breakdowns occur less often than predicted ; they account for a minority of fatal collisions**.
- **Most collisions caused by human error** not breakdown (as elsewhere)

- **Eye tracking: drivers attend more when no hard shoulder**
- **1 stop per refuge per 4 hrs**
- **71% of stops are non-emergency**

Drivers' role in safety? Journey preparedness in collision prevention



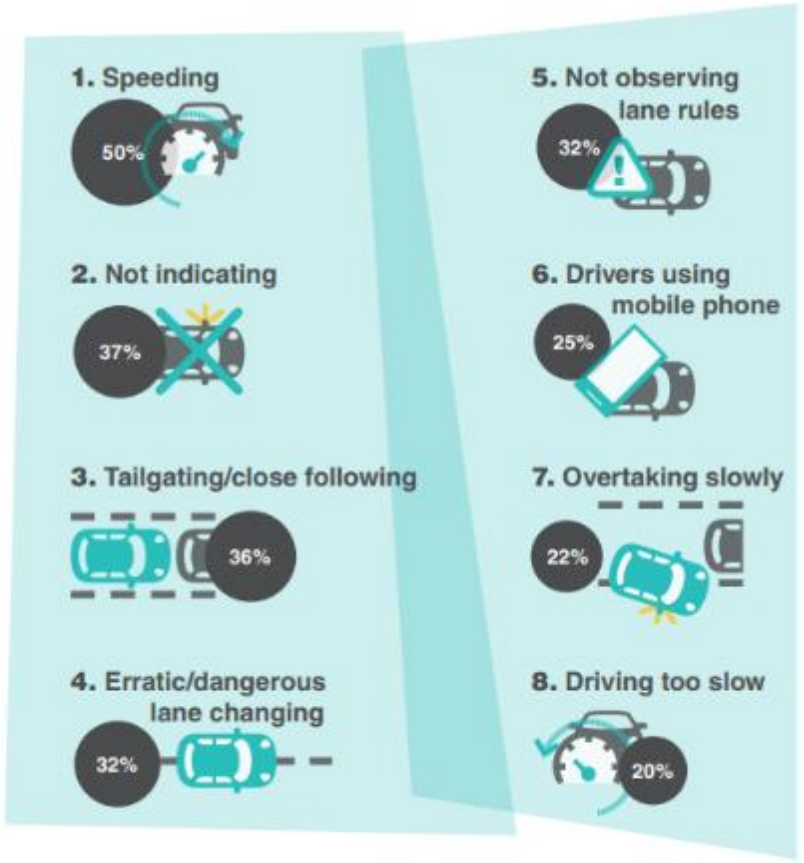
Over 70% of stops in emergency areas (laybys) are illegal discretionary stops

Rate of 'Live Lane' breakdowns = 0.4 / day per carriageway mile

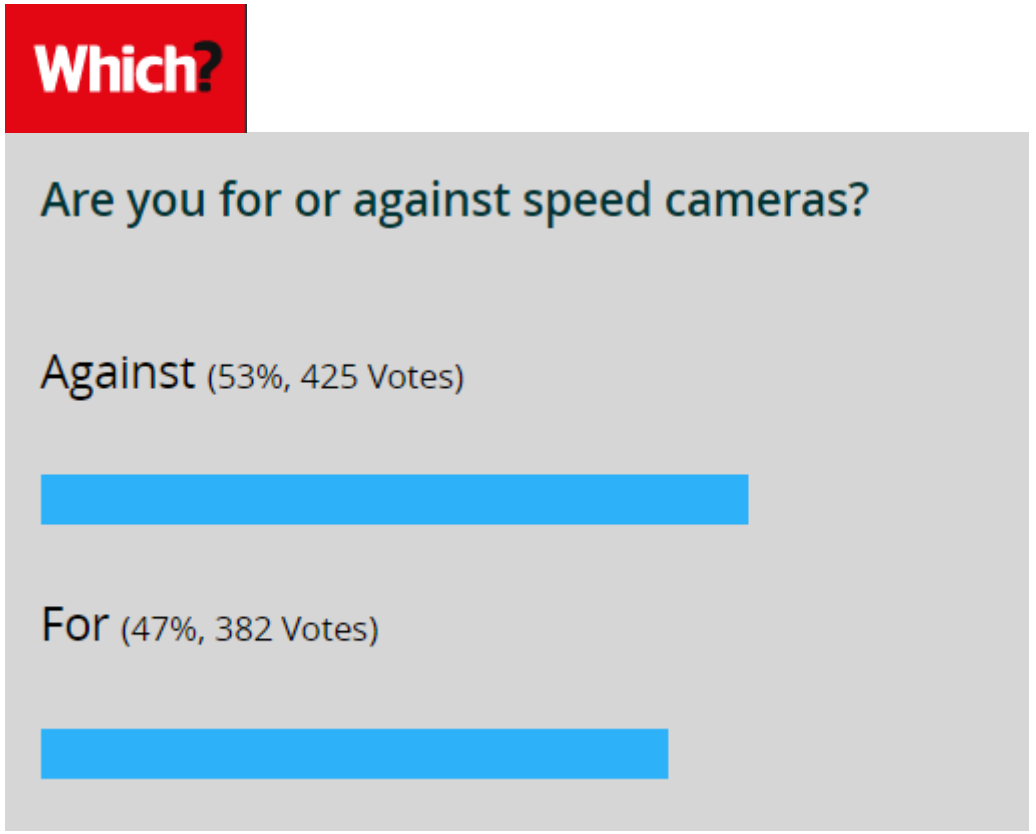
Of which. . .
- 11,200 run out of fuel per annum
- 38,700 tyre failures per annum of which approx. 4,700 requires lane closures
- 1,650 vehicle fires per annum

Beliefs versus behaviour: the role of cognitive dissonance and biases

Figure 6
Percentage of respondents who observed behaviours of other people during last journey on the SRN (Highview survey, 2019)



Sample size 21,479.



What does this mean for messaging and network operation?

How safe is it? 1. Third year stocktake of ALR performance

High level findings:

- Of the 4 formats and many safety metrics, no format is best in all cases
- Live-lane-stops account for just 3.9% collisions
- 96.1% involve only moving vehicles.

Full disclosure of all data so independent analysis can be done by any interested party

High level findings: ALR schemes

Statistically significant reduction in

- All collisions
- Casualty rates

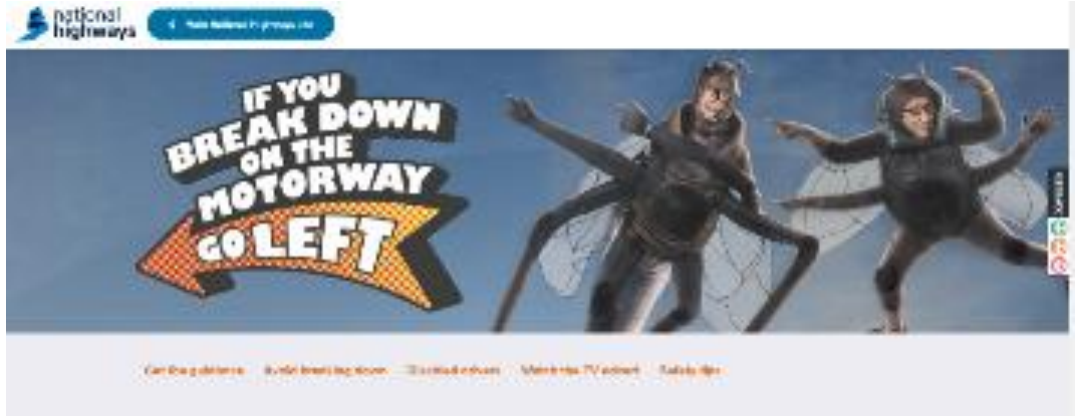
Reduction in:

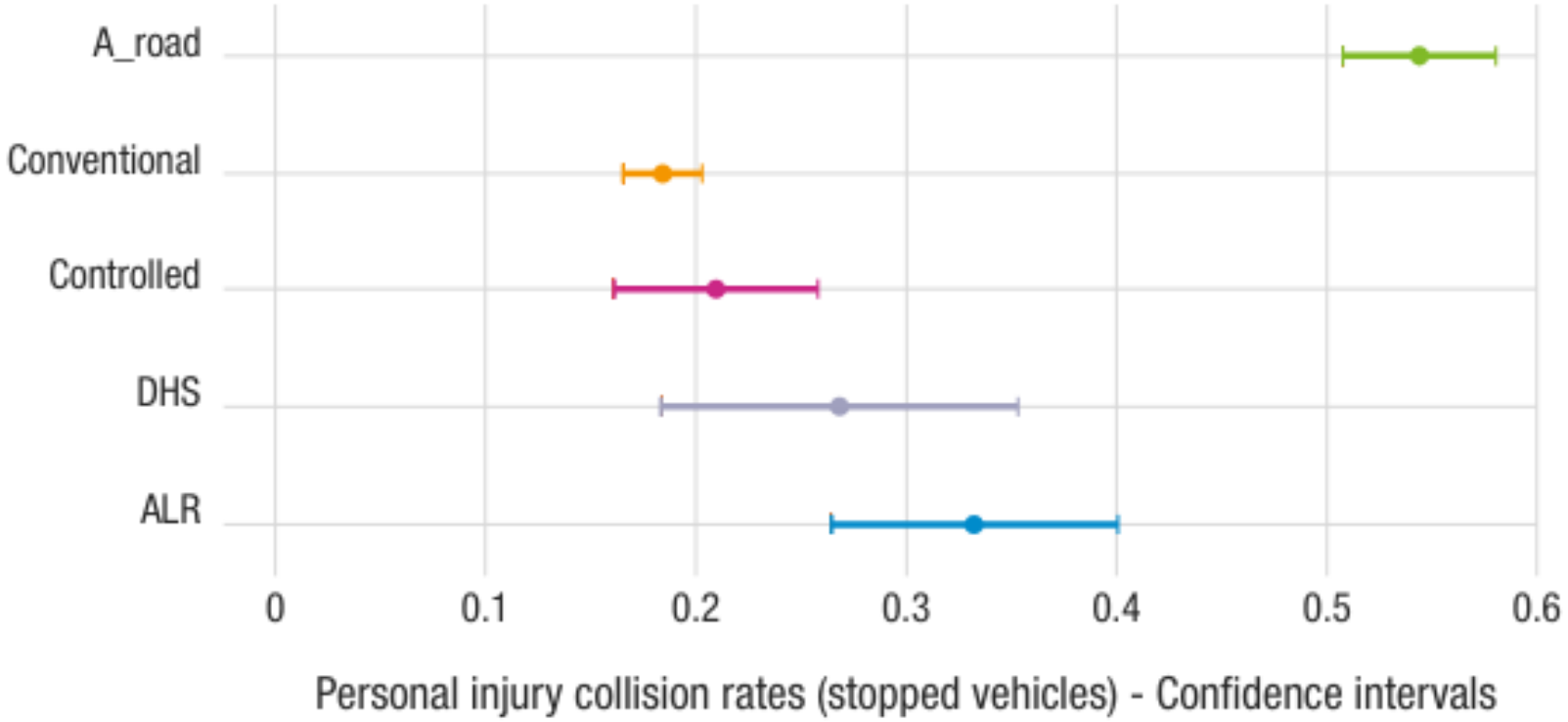
- FWI rates
- Most collision types

Lower Live lane stop collision rate than expected

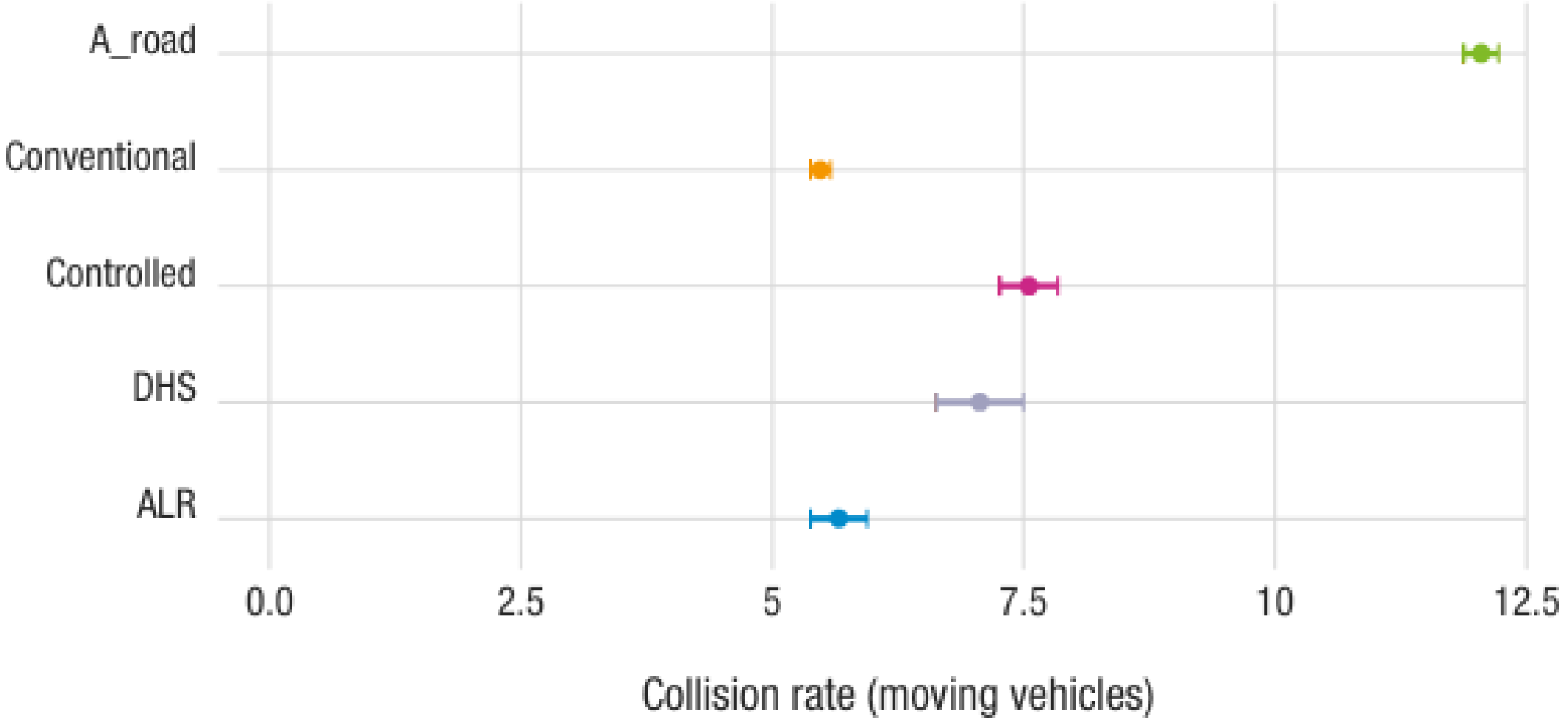
Conventional	Controlled	Dynamic	ALR
Highest KSI collisions			
Lowest collisions (all severity) Best for stopped-vehicle collisions [3.9%] (though SVD and more EAs likely to reduce difference from other forms		Lowest moving-vehicle collisions [96.1%]	
Lowest stopped-vehicle-collison rate			Highest stopped vehicle collision rate (likely to fall with SVD)

How safe is it? 1. Third year stocktake of ALR performance – stopped vehicle collisions





How safe is it? 1. Third year stocktake of ALR performance – moving vehicles (96.1% PICs)



Basket of metrics – priority for most severe injury

Table 1

Headline five-year average (2017-2021) injury-adjusted metrics per road type[51]

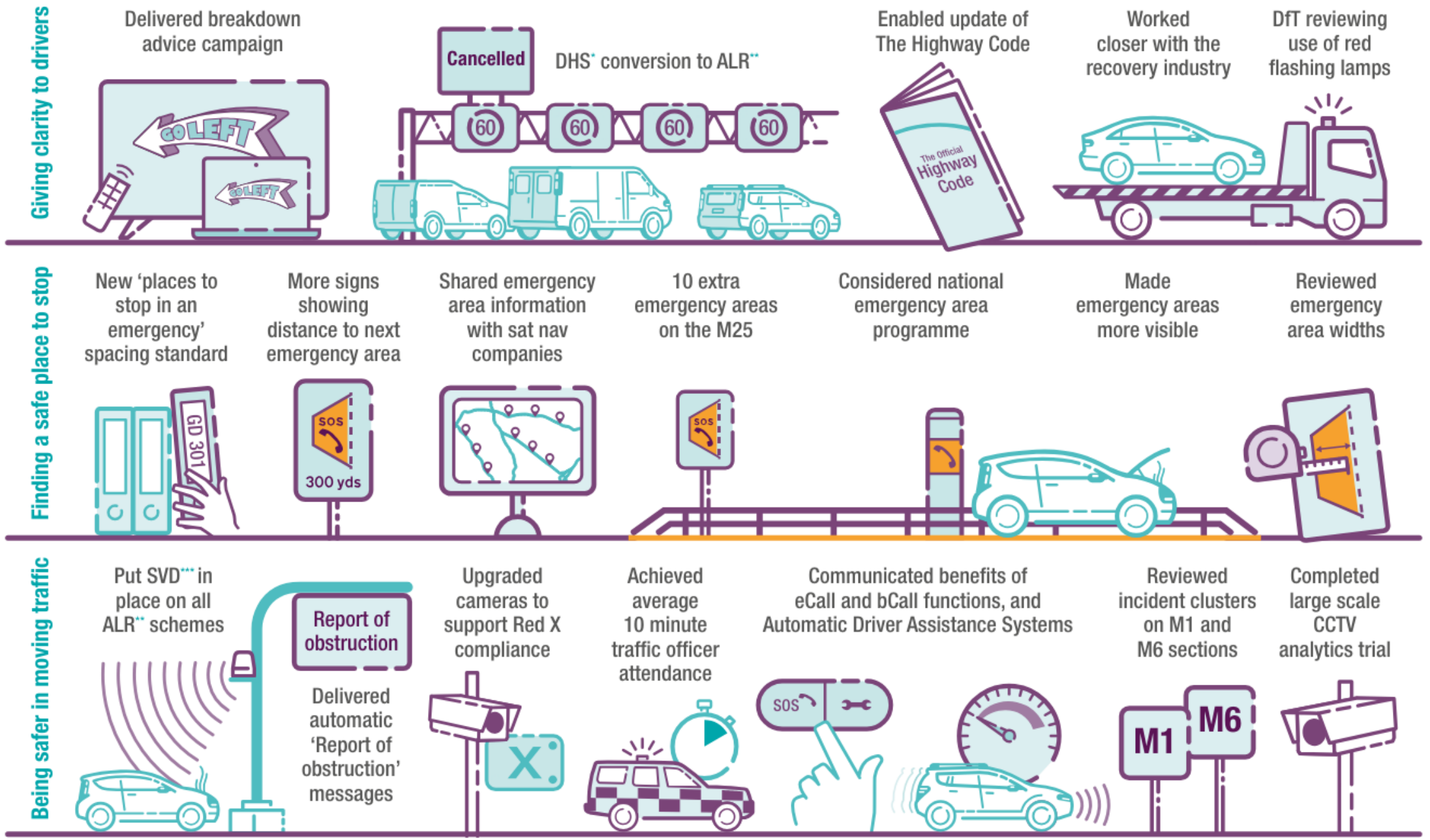
Description: Across all collisions, all three types of smart motorway continue to be better than conventional motorways for those metrics which consider the most significant impacts, such as deaths or serious injuries

Source: Analysis from National Highways

Data based on STATS19 with minor amendment[52]

		PIC	PIC per hmvm	FWI	FWI per hmvm	KSI	KSI per hmvm
Types of motorway	Conventional	2,423	5.67	155	0.36	615	1.45
	ALR	335	5.99	20	0.35	82	1.43
	DHS	219	7.32	9	0.31	34	1.14
	Controlled	534	7.76	21	0.31	90	1.31
A-roads (on SRN)		4,045	12.59	286	0.89	1,172	3.65

Delivering improvements - progress made on 2020 Action Plan



*DHS: Dynamic hard shoulder **ALR: All lane running ***SVD: Stopped vehicle detection

CRE23_0104 Stocktake progress – Last updated 29/09/2023

Customer perceptions of smart motorways

Key points emerging from the research

- Many drivers will continue to believe, even if they feel safe on a smart motorway, that they would be *even safer* with a hard shoulder.
- The visible, physical hard shoulder has been taken away, but the individual compensating features are less visible and aren't viewed as part of an overall *system* working to keep drivers safe.
- Drivers are conscious that if they break down, their safety is dependent on others following the rules and they see too many people ignoring them, in particular the 'red X'.

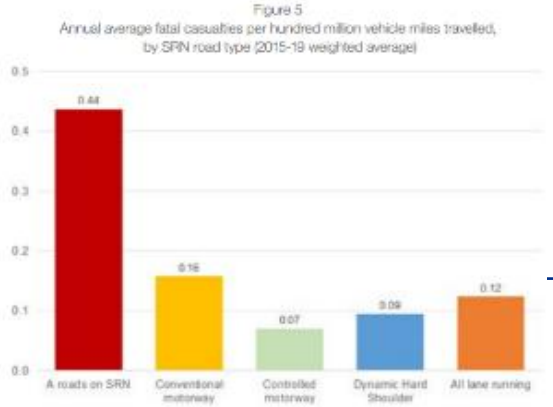
Survey of **20,000 people including people who don't drive on SM**

- 54% fairly or very confident on SM
- 25% not very/not at all confident on SM

For **those who do drive on SM**

- 82% fairly or very confident on SM
- Therefore experience offsets instinctive fear of LLS (which dominates anxiety but is <4% collisions)

Likelihood of nervous drivers not using the safest roads for their journeys (TSC evidence) – media hold responsibility for misreporting



Overstated journey benefits: do they affect safety?

Time saving benefits of M25 upgrade ‘eaten up by growth’

Roads

19 April 2021

M25: all-lane running near Junction 25

The extra capacity created by a smart motorway scheme on the M25 was quickly eaten up by traffic growth, which eliminated the time saving benefits used to justify the investment, says a new research paper.

David Metz, honorary professor at the Centre for Transport Studies, University College London, has explored the effect of Highways England’s project to convert the hard shoulder into a running lane between junctions 23 and 27 of the M25.

The M25 traffic model used to justify the smart motorway investment substantially underestimated this increase in traffic volume, while overestimating the average increase in speed for most drivers, put at about 10 km per hour. The benefit-cost ratio was estimated to be 2.9, that is, £2.90 of economic benefit for every £1 invested. Since the travel time savings didn’t last beyond the first year after opening, the actual benefit-cost ratio was much lower.

SM-ALR Monitoring

M25 J23-27 Second Year Evaluation Report

Highways England

March 2017

M25 J23-J27		
Flows	J23-6: Significant (10%) flow increase achieved and capacity for more growth In particular 17% J24-25 CW. All higher than national trends.	↑
Average journey time	JTs returned close to pre-scheme levels but have been worse if scheme not built. CW 3% increase overall, ACW 0.5% decrease.	↔
Journey time reliability	Slight improvement day-to-day on both carriageways	↑
Safety	No significant change after taking into account background trends. Scheme has met its safety objectives.	↔

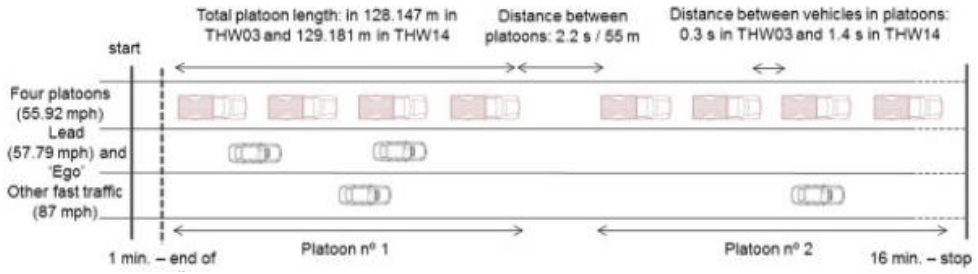
Future-proofing –
how might driver-assistance and highly automated vehicles change SM safety?

electronically-locked headway
versus human-judged Sub-conscious behaviours: herd effects

Intelligent Speed Assistance

☺ Reduce speed variance

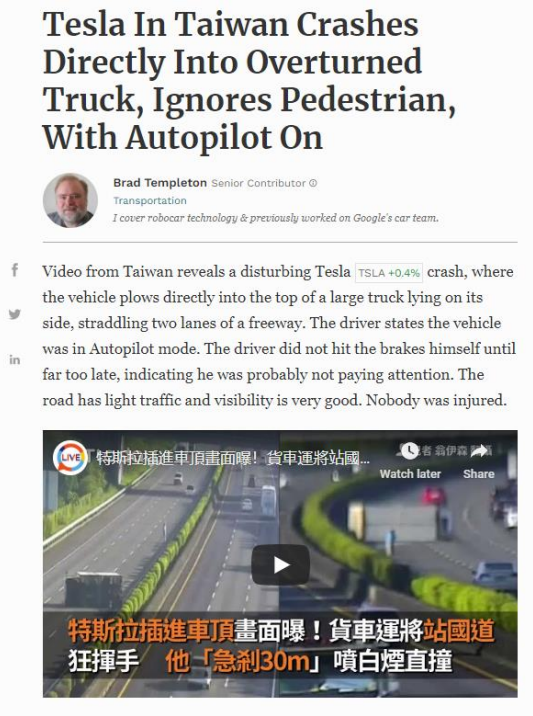
☺ Reduce % above speed limit and enforceable threshold



Lane Keep Assist?

? Will it be better or worse than humans at reading tramlines?

Mixed fleet is worst case



Autonomous braking

☺ reduce shunts

☹ It doesn't always work; potential for over-trust

If you have been,
thanks for listening!

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M62 junction 30 dynamic hard shoulder motorway