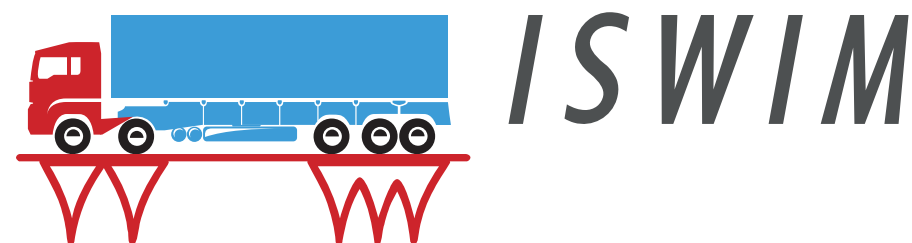




An open assessment tool for standardized performance measures of long combination vehicles

Bengt Jacobson (Chalmers),
Sogol Kharrazi (VTI),
Niklas Fröjd (Volvo GTT),
Toheed Ghandriz (Volvo Technology & Chalmers), and
Omar Bagdadi (Swedish Transport Agency)



6 - 10 November 2023
Brisbane, Australia



Project behind this research: *Performance Based Standards II,* 2018-2021



- The project is one of many projects which have led to that Sweden will allow HCT (34.5 m, 74 ton) from 2023-12-01.
- The “OpenPBS” is an assessment tool which was developed in one of the work packages.

Project partners:



Lastbils kalkylatorn (LBK), in use since 2017, for {25.25 m, 74 ton}

TRANSPORT STYRELSEN

Lastbils kalkylator

Steg 1 av 4

Första fordonet
Dragbil
Registreringsnummer (valfritt): **URL312**
Fordonstyp: Dragbil

Andra fordonet
Link
Registreringsnummer (valfritt): **DXB170**
Fordonstyp: Link

Tredje fordonet
Påhängsvagn
Registreringsnummer (valfritt): **RCS736**
Fordonstyp: Påhängsvagn

Nästa

TRANSPORT STYRELSEN

Lastbils kalkylator

Steg 3 av 4

Dragbil
Axeltryck
Axel 1: **7** ton
Axel 2: **7** ton
Axel 3: **7** ton

Link
Lasthöjd per unit: **4** m
Axeltryck
Axel 4: **7** ton

Beräkna















Beräkningsresultat

✓ Kombinationen uppfyller gränsvärdena

Kombination	PBS measure	Required Gränsvärde	Calculated Beräknat värde
Sidostabilitet	SRT	≥ 3.5 m/s ²	3.5 ✓
Dämpning	YD	≥ 0.15	0.46 ✓
Bakåtförstärkning	RWA	≤ 2.4	1.2 ✓
Spåravvikelse	HSTO	≤ 0.40 m	0.14 ✓
Backtagning	GA	≥ 1.0 %	2.5 ✓

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Knocking on open doors? Motivation to HCT and PBS

	startability		Swept path		Rearward amplif. High speed off-tracking
	gradeability		Steer tyre friction demand		Yaw damping
	Acceleration capacity		Static rollover threshold		Handling quality
	Overtaking provision		Directional stability while braking		Cross-wind sensitivity
	Tracking ability Straight path		Ride quality		

picture from HAN (Joop Pauwelussen)

PBS

HCT/LCV



*Some sort of
agreement of how
to assess PBS
(such as LBK and/or
open PBS tool)*

*Transport
efficiency,
including CO₂*

OpenPBS is modelled for arbitrary number of units and 16 PBS measures



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Main motivation	PBS measure		Short
	Name	Abbreviation	Measure
Transport efficiency	Startability	SA	Uphill grade
Transport efficiency	Gradeability	GA	Uphill grade
Transport efficiency	Acceleration Capability	AC	Time
Safety	Braking Stability in a Turn	BST	Braking distance
Safety, yaw stability	Rearward Amplification	RWA	Yaw Velocity amplification from first to last unit
Safety	Yaw Damping	YD	Yaw Angle damping over oscillations on worst unit
Safety	High Speed Transient Off Tracking	HSTO	Off-tracking between first and last axle in ISO lane change
Safety	High Speed Steady State Off Tracking	HSSO	Off-tracking between first and last axle
Safety, roll-over	Load Transfer Ratio	LTR	Off-tracking between first and last axle
Safety, roll-over	Steady state Rollover Threshold	SRT	Lateral acceleration
Transport efficiency	Low Speed Swept Path	LSSP	Path width between wheels outer edges
Transport efficiency	Tracking Ability on a Straight Path	TASP	Off-tracking between first and last axle
Transport efficiency	Frontal Swing	FS	First unit front body reaching distance outside defined path
Transport efficiency	Tail Swing	TS	Last unit rear body reaching distance outside defined path
Transport efficiency	Friction demand on Steering Tyres	FDST	#Force in ground plane under steered axles
Transport efficiency	Friction demand on Drive Tyres	FDDT	#Force in ground plane under driven axles

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Envisioned solution and top level requirements on an open PBS tool



What does “open” mean?

We mean: Free of charge and Readable and Understandable

Requirements:

- PBSs independent of Vehicles (Combinations)
- Vehicles specifications (“parameters”) independent of Vehicle models (“equations”)
- Standard formats for dynamic models
- Dynamic models deducted from well-established physical laws (for additions which can handle future novel technologies such as propulsion on trailing units)

The tool (model library) we did is structured in:

- **Manoeuvres**, each incl. definitions of one or some **PBS measures**
- **Vehicle specifications** (parameters)
- **Vehicle models** (physical equations)

The tool is written in the standardized (and simulation tool independent!) format for dynamic models: **Modelica**

Two (or more) “front-ends”



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Who will use the tool?

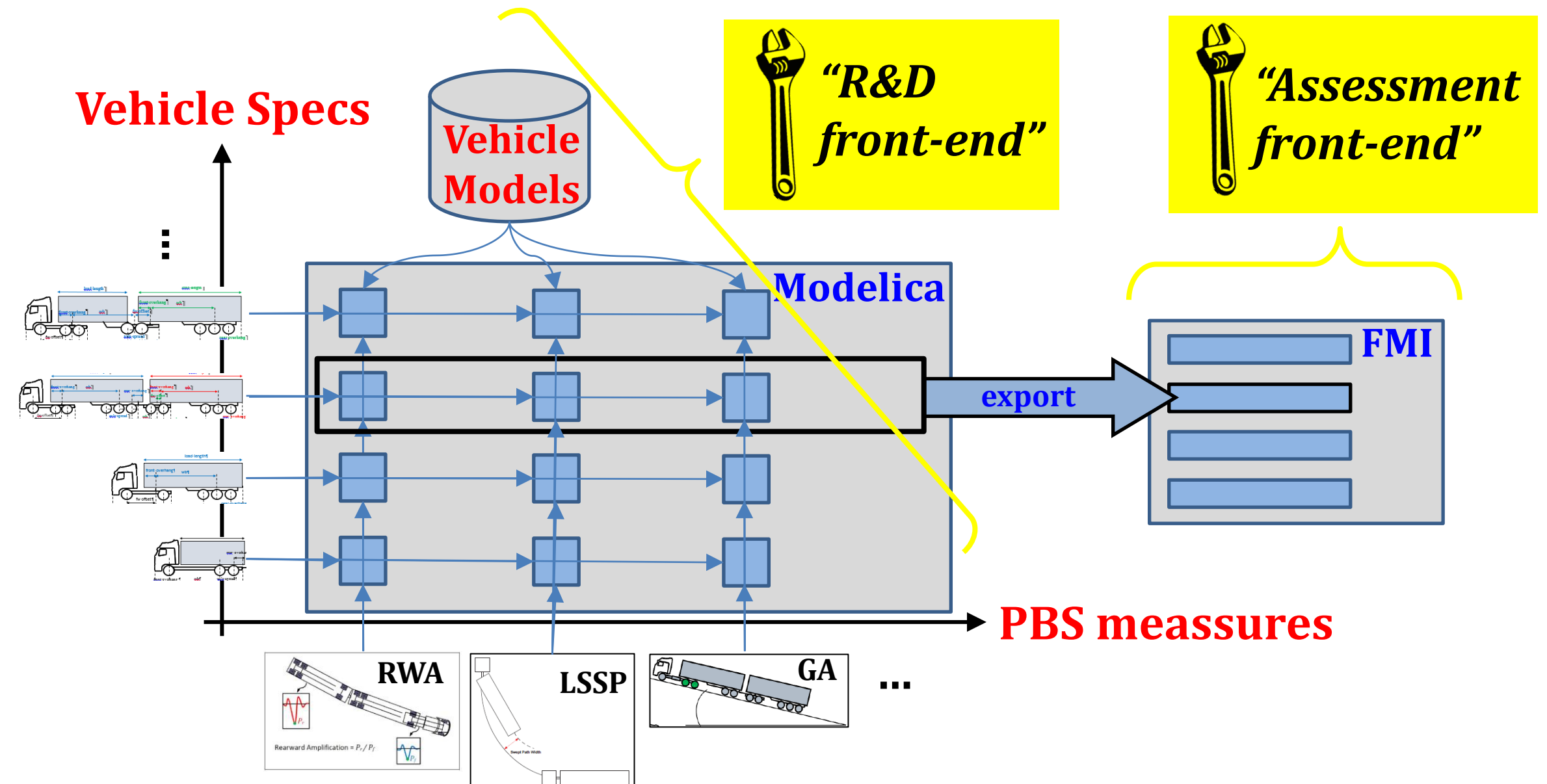
Our vision: World-wide: Transport operators, Drivers, Vehicle manufacturers, Police, Authorities

But who use LBK today?

Limited to Sweden. Transport operators, to some extent Police, Authorities and vehicle manufacturers

We think it would be good if globally used and developed. Requires different “front-ends”.

What does that different “front-ends” mean?



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2023-10-12 16:18, Slide 7

What will happen to OpenPBS?



- The project is now concluded.
- A functioning OpenPBS tool is delivered (and made available open on the web).
 - It is waiting on computer/web solutions set ups to find out if it can be the base of a next generation of LBK in Sweden (present generation handles only up to 25.25 m and 2 articulation points and some PBS measures are missing)
 - It is also occasionally used in new research projects for novel technology, such as propulsion on trailing units.
 - So: No strong effort on maintenance or updates. We welcome anyone who wants to try it/take over/develop further/...

Thanks for your attention

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