



Teleoperation: The Potential for a BSI Standard



NOVA MODUS

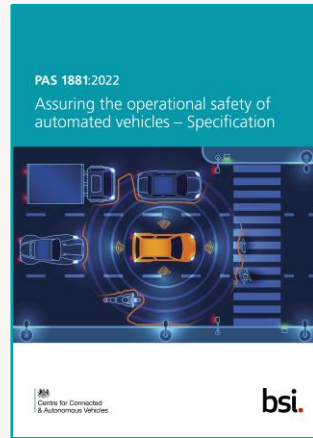
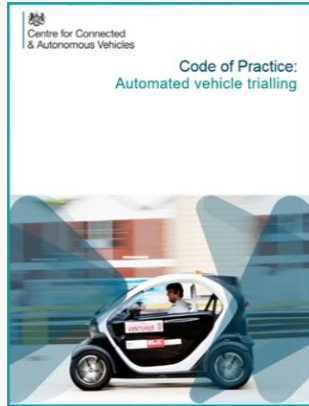
John McNicol



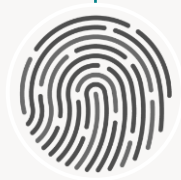
By Royal Charter

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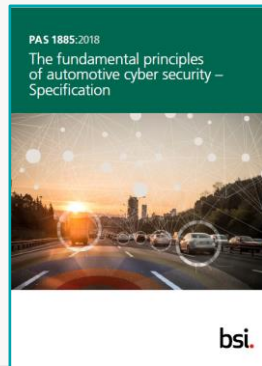
BSI PAS 1880 Series: good practice for CAV trials and testing



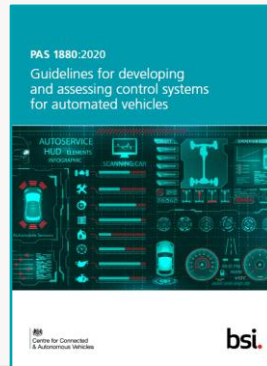
PAS 1881:2022
Safety of AV Trials and Testing – Spec



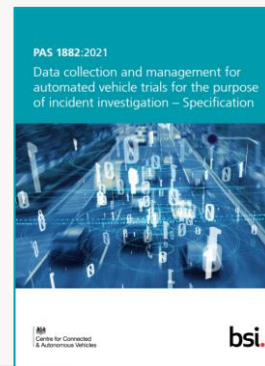
PAS 1885:2018
Principles of Automotive Cyber Security



PAS 1880:2020
Guidelines for Developing and Assessing Control Systems



PAS 1882: 2021
Data Collection and Management during AV trials – Incident Investigation Spec



PAS 1883:2020
Operational Design Domains taxonomy for an ADS – Spec



PAS 1884:2021
Safety Operators in automated vehicle testing and trials – Guide



CAV Standards Explorer

Online searchable database of standards relevant to CAVs.

Organised by Theme, Status, etc.

Selected for relevance, not exhaustive

Web links to standards' details (selection)

Free to use

Let us know of any Standards not included but you think are important! cav@bsigroup.com

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CAV Standards Explorer

The explorer is an online database to help search for relevant connected and automated vehicle (CAV) standards that are published or in development. You can search for a standard by keyword, standard number or thematic area (safety & assurance, perception, decision making & AI, security, data, digital infrastructure and human factors).

Standards have been categorized using the six roadmap themes so a standard may appear multiple times in a search as it relates to multiple areas.

remote

Standard	Theme	Status	Issuing Body	Link
GB/T 303-12 Remote control assist system for vehicle driving	Perception & Decision making	IN DEVELOPMENT	Other	
GB/T 303-12 Remote control assist system for vehicle driving	Safety & Assurance	IN DEVELOPMENT	Other	
GB/T 303-12 Remote control assist system for vehicle driving	Human Factors	IN DEVELOPMENT	Other	
ISO/NP 7856 Intelligent transport systems — Remote support for LSAD system (RS-LSADS) — Performance requirements, system requirements and performance test procedures	Safety & Assurance	IN DEVELOPMENT	BSI	
ISO/NP 7856 Intelligent transport systems — Remote support for LSAD system (RS-LSADS) — Performance requirements, system requirements and performance test procedures	Digital Infrastructure	IN DEVELOPMENT	BSI	

CAV Standards Gaps Tool

Online collection of 'Gaps' where some standardization is needed.

Graphical display

Organised by Theme

Free to use

Let us know of any Gaps not included but you think are important! cav@bsigroup.com

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CAV Standards Gaps Tool

Following consultation with UK industry, a number of priority areas have been identified where further information is needed to support the safe testing, trialling and deployment of connected and automated vehicles (CAVs).

The gaps tool below illustrates these priority areas, categorized by theme and sub-topic. Click on each theme to view the gaps.

Filter: All

Safety & Assurance	Digital Infrastructure	Human Factors
AI Perception & Decision Making	Security	Data

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CAV Standards Roadmap

'At a glance' quick reference document to signpost relevant standards.

All standard organisations, BSI, ISO, ITU, ASAM

Selected for relevance, not exhaustive

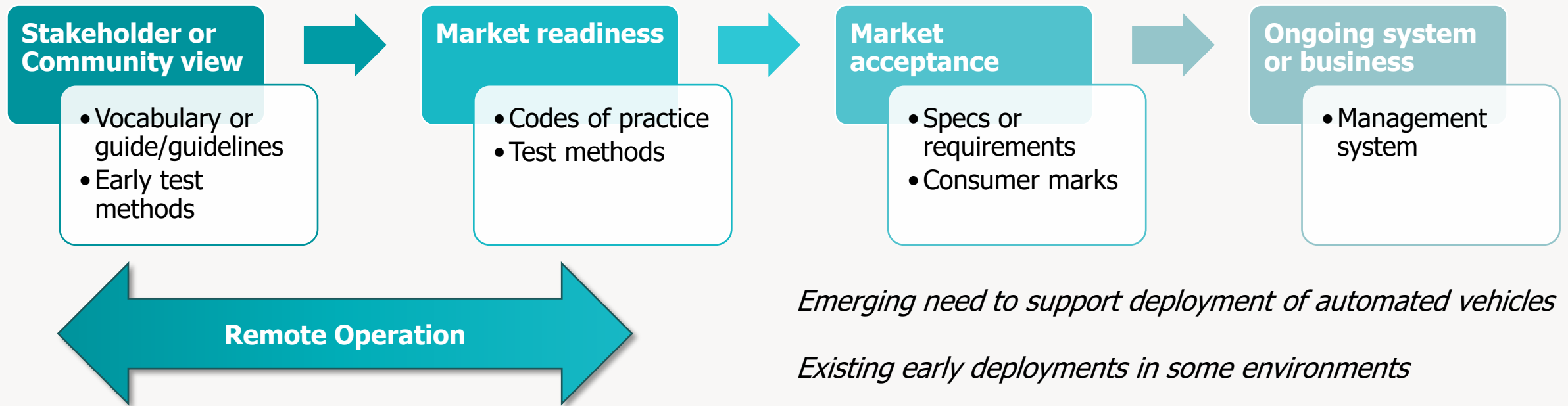
Recently published standards & guidance

Standards currently in development

Gaps where some standardization is needed including live BSI projects

Type of 'Standards' vs Market Readiness

- The type of standards needed varies according to maturity of technology, nature of technology and industry sector
- Good practice can support market growth and confidence



O'Sullivan and Brévignon-Dodin, *Role of Standardisation in support of Emerging Technologies*, Institute for Manufacturing, University of Cambridge

Teleoperation: The Potential for a BSI Standard

1. To understand aspects of remote operation of vehicles
 - ▶ Technologies / Human Factors / Risks / Safety / Commercial / Legal
 - ▶ By engaging with UK CAV trials & international practitioners
2. To then capture best practice that could be 'standardized'
 - ▶ Capture approaches & processes used by experienced players
 - ▶ Assess the practicality of 'standardization' and value to users
3. Validate Conclusions with Stakeholders
 - ▶ Workshops with UK CAV Stakeholders
 - ▶ Present potential scope of a PAS / Flex / Standardization project(s)
4. Report with Recommendations
 - ▶ Publish report including the scope of standardization project(s)

Classes of Remote Operation

Supervision of automation but no intervention

- ▶ Assumes automated operation to Level 4/5
- ▶ Decision support. Legal liability is unchanged
- ▶ Human advises / provides additional information



Remote Monitoring



Remote Assistance



Remote Driving

An almost continuous spectrum dependent on Use Case and implementation

Intervention

- ▶ Human provides next movement
- ▶ Send a path to avoid stationary obstacles for example?
- ▶ Short term driving control for complex manoeuvres
- ▶ Interaction with law enforcement & emergency services etc
- ▶ Possible transition / handover / HMI issues
- ▶ Intervention may need to start with stationary vehicle?

Longer term control of the entire DDT

- ▶ Teleoperation (over a *public telecom* network?)
- ▶ Need for an Operational Design Domain?
- ▶ Legal liability for driving behaviour transfers to remote operator

Important Factors to Consider

1. Safety of Human Driving through Sensors

- ▶ Cameras: Field of View. Resolution. Stereo vision for depth perception. Refresh. Colour
- ▶ Additional Sensors: Range information. Extended & enhanced visibility. Proximity
- ▶ Human Factors: Handover. Situational Awareness. Passenger comfort

2. Connectivity from Remote Operator to Vehicle

- ▶ Coverage. End-to-End. Bandwidth. Latency. Resilience. Failsafe (Handover?)

3. Safe Remote Control of Vehicles (Interfaces)

- ▶ Safety measures & standards for *drive by wire* vehicles
- ▶ Feedback loops in the absence of motion cues

4. Remote Operator Performance

- ▶ Distractions & fatigue & cognitive load (supervising multiple vehicles?)
- ▶ Absence of motion cues
- ▶ Timing for safe handover to remote operator

Teleoperation: Potential BSI Standard #1

System Performance *for a specific Use Case*

1. Class of Remote Operation = what type/level of intervention/control is allowed
 - ▶ Monitoring / Assistance / Driving / Emergency Stop / MRM
2. Operating Environment (ODD including network performance & traffic etc)
3. Operating Speed (maximum is limited by network performance etc.)
4. Operator Perception (Fields of View. Resolution. Latency. Colour. Proximity)
5. Remote Vehicle Control (based on current type approval requirements?)
6. Information the vehicle should supply to the remote operator
 - ▶ In addition to camera feeds: e.g. status especially performance of a CAV ADS

How to test (*and certify for a safety case*) in-situ per deployment

Teleoperation: Potential BSI Standard #2

Training, Testing & Licensing for Remote Operators *for a specific Use Case*

1. Legal Definitions for, and Liabilities of, Remote Operators
 - ▶ For each specific Use Case (e.g. yard truck operators not allowed on public roads)?
2. Class of Remote Operation = what type/level of intervention/control is allowed
 - ▶ Monitoring / Assistance / Driving / Emergency Stop / MRM
3. Required Training / Experience = Driving Licence for Use Case (e.g. PSV/HGV)
 - ▶ Specific to system? Specific to vehicle type? Specific to ODD?
4. Human Machine Interface = what information is displayed/communicated & how
 - ▶ In addition to camera feeds: e.g. status especially performance of a CAV ADS

How to test (*and certify for a safety case*) in-situ per deployment

A Straw Poll: Which Standard is Most Important/Urgent?

Training & Testing Remote Operators

1. Legal Definitions and Liabilities
2. Class of Remote Operation
3. Training Required
4. Driving Experience Required
5. Operators Environment
6. Human Machine Interface & information the vehicle should supply to operator

How to test in-situ per deployment

System Performance

1. Class of Remote Operation
2. Operating Environment
3. Operating Speed
4. Operator Perception
5. Remote Vehicle Control
6. Information the vehicle should supply to the remote operator

How to test in-situ per deployment

Teleoperation: The Potential for a BSI Standard

1. What teleoperation standard would be useful?

- ▶ Industry / Operators / Regulators / Enforcement / Safety

2. Broad Range of Different Use Cases

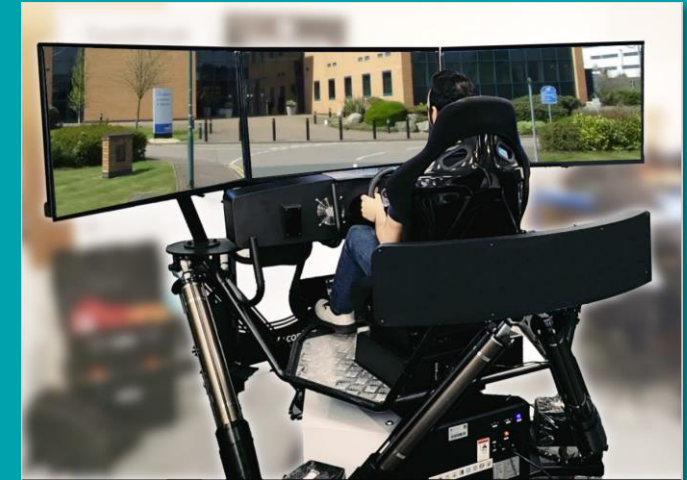
- ▶ Substantially different technology & operator requirements
- ▶ Can a single standard support several Use Cases?

3. Alignment/Divergence from automation

- ▶ Current teleoperation industry seldom for road-going CAVs

4. Proposed two Flex standards to be developed

- ▶ Guidance on Systems & Performance
- ▶ Guidance on Operators & Operations



Standardizing remote
operation of vehicles

July 2022

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