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Connected Car

In Vehicle Information System

A Safety Assessment of the Connected Car System

by

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for

Cubic and Transport Scotland

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Executive Summary

It is important that In-Vehicle Information Systems (IVIS) comply with road safety standards and guidelines, in this case the *European Statement of Principles on Human-Machine Interface* (ESoP: European Commission, 2008). This report describes work carried out for Cubic, evaluating and assessing the extent of compliance with the ESoP of a traffic information app, developed by Cubic and running on mobile phone connected to a vehicle's dashboard. A checklist developed by TRL for the UK Department for Transport was completed, following a real-world drive with the app installed in a compatible vehicle. Based on the checklist assessment, which covers system installation, information presentation, interaction with displays and control, system behaviour and information about the system, a set of recommendations have been made to Cubic. The most important of these recommendations is the user should be allowed to use the vehicle's built-in infotainment system while driving, with the app running in the background and overriding infotainment only when there are safety-related messages to be delivered. Other recommendations cover providing more information and instructions on app launch.

1. Introduction

1.1 Background

Cubic has developed a Virtual VMS/Connected Car system based on a cloud based Connected Car Hub forming a warehouse of Virtual VMS messages from traffic authorities. This hub connects to vehicles and projects guidance and warnings to drivers directly into the infotainment units deployed in production cars (see Figure 1). Thus information and warnings are no longer dependent on roadside VMS, although the visual messages conform to VMS layout.

The enabler in the car is smartphone integration where an approved app integrates with one of the systems already deployed in cars to provide the In-Vehicle signage (Virtual VMS). The MirrorLink-enabled smartphone has to be connected to any MirrorLink-enabled vehicle. The app uses the concept of a geo-gate (a geospatial gate implemented in a smartphone). This means that as a vehicle approaches a geo-gate in a defined direction the gate triggers and a message is displayed and spoken to the driver. The app runs on the smartphone, but is seen on the dashboard display and the audio is heard via the car's speakers.

Cubic and Transport Scotland needed an independent assessment of the connected car system against recognised safety standards to support a trial of the app. The assessment was carried out by a team of three assessors from the University of Leeds, United Kingdom. The basis for the assessment was evaluating conformance of the app with the *European Statement of Principles on Human-Machine Interface* (ESoP; European Commission, 2008). That conformance was assessed by means of a checklist developed for the specific purpose of assessing such conformance (Stevens et al. 2011).

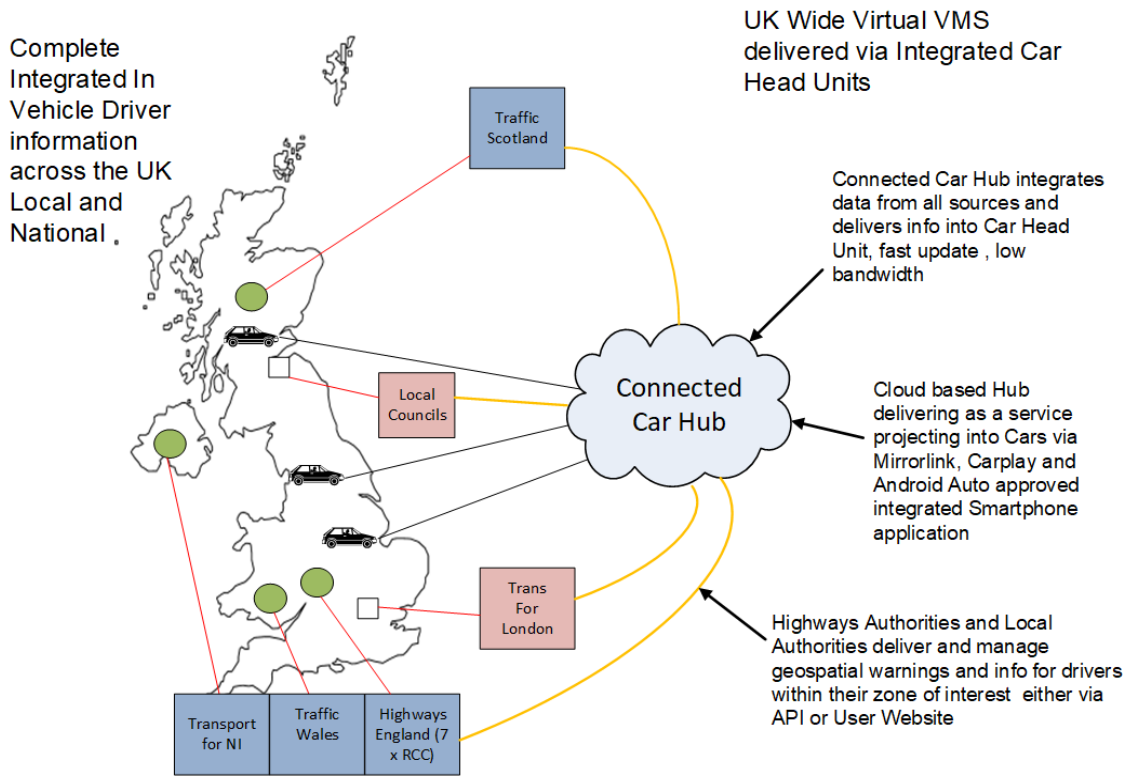


Figure 1: Overview of information flow in the Connected Car system

1.2 Current project

The University of Leeds was commissioned by Cubic to evaluate the IVIS and assess its compliance with the ESoP. The Cubic Project commenced in November 2019 in Leeds, with the objective of examining the practicability, safety and usability of the app. To ensure diversity in opinion and enable brainstorming, a team of three from the University of Leeds conducted the assessment.

The project was carried out in two stages. The first stage, was a user trial to review the app in operation in-car. A vehicle with MirrorLink capability was used. During this time assessors undertook one daytime practical evaluation. Prior to undertaking the evaluation, the assessors familiarised themselves with the app and the vehicle and a number of decisions were made about how to carry out the assessment. Following the assessments a consensus meeting was held to discuss the results, and resolve any differences between the assessors. The second stage of the project involved conducting the evaluation to assess the extent of compliance with the ESoP by means of the checklist.

2. Stage 1: User trial

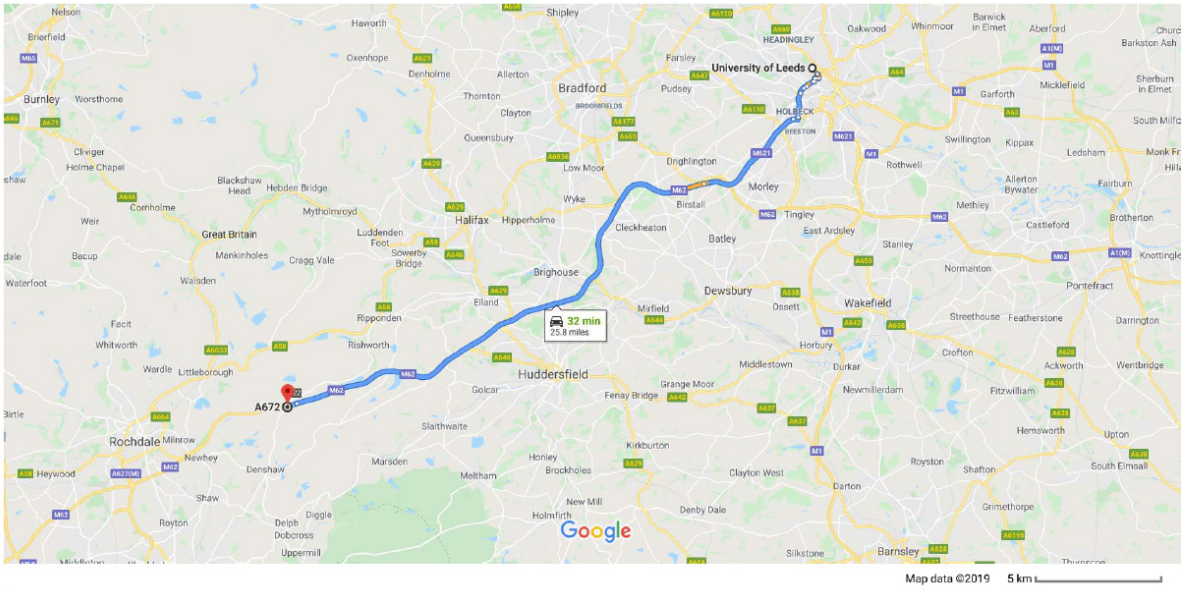
To review the app in operation in-car, a trial was carried out to assess the app from the user's point of view. The lead assessor was given instructions on how to connect the app to the vehicle by Cubic. The other two assessors were there to observe and take notes. Following familiarisation, on Thursday November 21, the team embarked on the on-road test to review and evaluate the app. The route was on a motorway chosen due to its simplicity which refers to the smooth movement of traffic flow and appropriate driving conditions. The drive was estimated to take 1 hour to complete. The test route (see Figure 2) had been suggested prior to the trial to be conducted in Leeds, United Kingdom. This was from the University of Leeds, Leeds (LS2 9JT) via the M621 and M62 to the exit for A672 (Ripponden, Sowerby Bridge) and back to the University of Leeds (51.6 miles, 64 mins).

The model of the car was a late model VW Golf with MirrorLink capability, which allows integration of the app running on a smartphone with the vehicle dashboard and infotainment system Thus the mobile phone visuals and audio are transmitted via a USB cable to the vehicle infotainment screen and audio. The messages had been pre-programmed by Cubic, so that, during the drive from east to west, a variety of messages were displayed at points along the route.

The drive took place in the day time, traffic was light (but light to medium on return), and there was dry weather and clear visibility. It was easy to connect the app to the car app. Audio and visuals (see Figure 3) were good. The messages appeared when they were programmed to on the route and were visually clear and audible. Warnings were displayed prominently and were easy to read. The text messages and symbols, which echoed those that would be displayed on Variables Message Signs (VMS) were clear, the app was not distracting, or complex. We could not measure the timing of the messages, for example the time from when one appeared in advance of an actual traffic condition and when it disappeared because the trial was not done with real messages occurring in real time. However, the time between when the messages appeared (were initially displayed) and when they disappeared was an estimated one minute. Similarly, when the car radio was switched on the app did not work. This was established during the return journey to Leeds.

Google Maps University of Leeds, Leeds LS2 9JT to A672, Ripponden, Sowerby Bridge Drive 25.8 miles, 32 min

Suggested route



via M62 32 min

Fastest route, the usual traffic 25.8 miles

Figure 2: Test route

Figure 3: Examples of messages (note that the visual display was accompanied by voice messaging)

3. Stage 2: Assessment of compliance with guidance

The second stage of this project involved completing the checklist to assess the extent of their compliance with the ESoP.

A spreadsheet version of the *Checklist for the Assessment of In-Vehicle Information Systems* (Stevens et al., 2011) was used to provide an assessment of whether or not the app complied with the European Statement of Principles. Consensus meetings were held to discuss and agree on the results and complete the check list (see Appendix 1), prior to the report being produced. The assessment was done under five broad checklist Items: system installation, information presentation, interaction with displays, system behaviour and information about the system as specified in the ESoP. Each of these contained specific questions about the app and provides three boxes ('serious', 'minor' and 'none') in which to record the degree of assessed safety concern for that aspect of the app, and an additional 'not applicable' box to note when the IVIS does not have the particular attribute the question is addressing. The 'Serious Safety Concerns' box was ticked when the use or presence of the IVIS was perceived to present a strong risk to the driver. The 'Minor Safety Concerns' box was ticked when the presence or use of the IVIS or its components was judged to present a minor risk, or the usability was compromised in some way. The 'No Safety Concerns' box was ticked when the presence or use of the IVIS did not present an unacceptable risk to the driver. The team rated the ease with which they found the app and information displayed, how clear and easy the information was to follow and whether the app had responded in the manner they had expected. In addition, visual and audio demands, timing and connectivity were evaluated.

It was appreciated that the user trial and assessment were not without their limitations, including not assessing the app in real time or in the dark. However, the evaluations illustrated that for most Checklist items (see Appendix 1) the level of app compliance with the ESoP is reasonably high. For example in the area of system installation, interaction with displays and control, system behaviour and information about the system, no serious concerns were noted. Other areas where compliance with the ESoP was evident were the ease with which information presented by the app could be comprehended by the user, as illustrated in Figure 3. Aspects of app visual display and audio properties also complied largely with the ESoP with the exception of the situation (B18) where the app appeared not to override the radio when a message was due. This was recorded as a serious concern and was 1 out of 57 items on the checklist. Similarly, some minor concerns were recorded (6 out of 57 checklist item) in interaction with displays and control (C7), system behaviour (D3 & D4) and information about the system (E1, E2 & E3).

4. Feedback to Cubic

The completed checklist was provided to Cubic, and in response Cubic provided its own reactions. Cubic accepted some, but not all of the suggested modifications to the app. The comments made by the Leeds assessors, the Cubic responses and the Leeds reactions are shown in Table 1.

Table 1: Checklist comments, Cubic responses and Leeds reactions

Ref	Comment	Cubic Response	Leeds Reaction
A3 - Minor	Depends on the vehicle being used.	Fair point, but out of our control	None
A11 - Minor	Not tested at night. Given the screen colours chosen, we do not expect this to be an issue.	Fair point, and agree it's a non-issue	None
B18 - Serious	The app did not appear to override the radio, when a message was due.	The intention is that radio is not accessible whilst app is in use. During our testing this was the case, so it's a curious one. It ties in with points made later (C7 & D3) which seem to indicate the Mirrorlink connection was not established fully.	The app did not appear to override the radio, when a message was due. This has been confirmed in subsequent discussion. Our recommendation is that the app should be able to function in the background and override the radio or other infotainment when a safety message is received. Otherwise there is a real possibility that safety messages will not be received and users will have a false sense of security.
C7 - Minor	The driver has full control over the auditory volume. However, the message volume should be controlled by the app, so that when the radio or music player is set to quiet, the driver can still hear the safety-related messages from the app.	See B18. Radio should not have been accessible.	On the test vehicle, the radio was easily accessible via a button. We expect that users would want to choose their preferred infotainment. Therefore the app should operate as a popup, overriding the infotainment when a safety message is received by the app. Otherwise safety messages will not be passed to users, resulting in a potential false sense of security.

			If the radio were to be locked out, then users would be annoyed and unlikely to use the app. This is therefore not a good solution.
D3 - Minor	Yes, the connected phone could be used for non-app activity. A message to discourage such use could be added to app launch.	See B18. Once Mirrorlink connection is established, the mobile device should blank down the screen and nothing is accessible. See also B18. I suspect the Mirrorlink connection was not established in the same way we have done in testing.	In our perspective, the Mirrorlink was established as instructed. But there is still the possibility of the USB cable to the phone being disconnected by the user while driving, so that Mirrorlink is disconnected and the phone returned to normal mode.
D4 - Minor	There were no responsibility messages.	Fair point, could be added.	Yes, we recommend adding such messages.
D5 - Minor	Users should be told when external information is not being received because of signal loss.	They are told. The green thumbs-up icon indicates comms with back-end is working. This turns to a red thumbs-down icon when connection is lost, and will be automatically re-established when possible (turning back to green). An audible beep is heard when comms is lost and/or re-established.	None. The checklist has been modified on this point.
E1 - Minor	Drivers could be advised to store the device in a secure location where it is not within eyesight.	Fair point, could be added	Yes, we recommend adding such advice.
E2 - Minor	A manual is probably not necessary, but the availability of some instructions on how to connect when the app starts would be helpful, e.g. a Help button.	Fair point, could be added	Yes, we recommend adding such advice.

E5 - Minor	As stated earlier, advice not to use the host mobile phone for non-driving-related tasks should be provided.	Accept warning would be a good idea, but Mirrorlink should actually prevent this anyway.	See D3 above.

5. Conclusions and recommendations

The approach used to evaluate the IVIS has proved valuable as a method of providing a consistent account of compliance with the ESoP. The result of this evaluation and assessment reflect an accurate, unbiased account of the real compliance situation. While stage 1 of this project illustrated the user-trial, stage 2 dealt with assessing the level of compliance. This is an effective means of gathering useful information about the app as it has provided information about compliance and non-compliance.

The evaluation also identified a number of areas where the ESoP could be strengthened. These include:

1. The app did not appear to override the radio, when a message was due
2. The driver has full control over the auditory volume of app messages. However, the message volume should be controlled by the app, so that when the radio or music player is set to quiet, the driver can still hear the safety-related messages from the app.
3. The connected phone could potentially be used for non-app activity. Therefore a message to discourage such use could be added to app launch
4. Drivers could be advised to store the device in a secure location where it is not within eyesight
5. A manual is probably not necessary, but the availability of some instructions on how to connect when the app starts would be helpful, e.g. via a help button.
6. Further information on driver responsibilities should be presented on app startup and a driver acknowledgement should be requires before app operation is enabled.

References

European Commission (2008). Commission recommendation of 26 May 2008 on safe and efficient in-vehicle information and communication systems: update of the European Statement of Principles on human-machine interface. Brussels.

Stevens, A., Cynk, S. and Beesley, T. (2011). Revision of the checklist for the assessment of in-vehicle information systems. PPR568. TRL, Crowthorne.

Appendix: Final version of the completed checklist

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Assessment of In-Vehicle Information Systems

Section 2 - Assessment Scenario Proforma

1. IVIS under assessment

Product name and version	Connected Car App, Version 1.0.4
Manufacturer / Supplier	CUBIC
Build Status (e.g. prototype, production)	Prototype
Description of HMI Subsystems (e.g. screen, hand control)	Android phone connecting to vehicle via MirrorLink over USB
Documentation included (e.g. driver's manual)	None

2. IVIS functions included in / excluded from assessment

Functions Included	All

OR:

Functions Excluded	
Reason for exclusion (e.g. not intended for use while driving)	

3. Context and restrictions for Checklist assessment

Vehicle Make and Model	VW Golf
Driver group considered (e.g. special skill requirements)	No special group
Context of IVIS use (e.g. in a vehicle while driving, concurrent use with other IVIS)	While driving

Road type considered (e.g. urban, motorway)	Motorway
Traffic (e.g. mix and density)	Medium to heavy
Other environmental (e.g. weather, day/night time)	Daytime, clear visibility, glare from sun in one direction
External data feeds required (e.g. GPS, RDS-TMC)	MirrorLink capability on the vehicle and USB physical connection

Assessors:	Oliver Carsten, Chinebuli Uzondu and Zahara Batool
Date:	Initial assessment: 20/11/2019 Revised assessment: 11/12/2019

Part A - Installation

A1	Is the IVIS fitted in accordance with the manufacturers instructions for installing the system in vehicles?

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A
Comment	USB link. On the Golf, it was easy to store the phone away from interference with driving.			

Part A - Installation

A2	Is the IVIS securely fitted?

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A	( ) QM
Comment	Can be put in a suitable storage bin.				

Part A - Installation

A3	Once positioned and secured are the relevant components of the IVIS stable?

Concerns	○ None	◉ Minor	○ Serious	○ N/A
Comment	Depends on the vehicle being used.			

Part A - Installation

A4	Once positioned and secured are the relevant components of the IVIS free from shake?

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A
Comment	Does not apply because not using the device directly.			

Part A - Installation

A5	Are the IVIS controls easily reached by the user when driving?

	All controls needed when driving can be reached from the normal driving position.	◉ True	○ False	○ N/A
	Stretching or leaning is not required.	◉ True	○ False	○ N/A
	Awkward arm or body positions are not required.	◉ True	○ False	○ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment	Volume could be controlled directly via the car radio.			

Part A - Installation

A6	Is physical and visual access to the IVIS free from obstruction by other driver controls/displays?

	No IVIS displays are obstructed.	(●) True ( ) False ( ) N/A
	No IVIS controls are obstructed.	(●) True ( ) False ( ) N/A

Concerns	(●) None ( ) Minor ( ) Serious ( ) N/A
Comment	Display was via the vehicle's central screen

Part A - Installation

A7	Is the driver's view of the road scene free from obstruction by the IVIS?

	The swept windscreen area is fully clear.	(●) True	( ) False	( ) N/A
	The view of the mirrors is not restricted.	(●) True	( ) False	( ) N/A
	The side windows are fully clear.	(●) True	( ) False	( ) N/A

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A
Comment	Same			

Part A - Installation

A8	Is physical and visual access to primary driver controls free from obstruction by the IVIS and its mounting?

	The IVIS does not interfere with normal leg, hand and arm movements.	◉ True	○ False	○ N/A
	The IVIS does not interfere with use of the accelerator, brake or clutch.	◉ True	○ False	○ N/A
	The IVIS does not interfere with the use of the steering wheel.	◉ True	○ False	○ N/A
	The IVIS does not interfere with the direction indicators or windscreen wipers.	◉ True	○ False	○ N/A
	The IVIS does not interfere with the use of the lights.	◉ True	○ False	○ N/A
	The IVIS does not interfere with the use of the horn.	◉ True	○ False	○ N/A
	The IVIS does not interfere with use of the gear lever.	◉ True	○ False	○ N/A
	The IVIS does not interfere with use of the parking brake.	◉ True	○ False	○ N/A
	The IVIS does not interfere with the use of the hazard warning lights.	◉ True	○ False	○ N/A
	The IVIS does not interfere with the use of the de-mister controls.	◉ True	○ False	○ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment				

Part A - Installation

A9	Is physical and visual access to primary driver displays free from obstruction by the IVIS and its mounting?

	The IVIS does not obscure the display of speed.	◉ True ○ False ○ N/A
	The IVIS does not obscure the telltale display of the indicators.	◉ True ○ False ○ N/A
	The IVIS does not obscure safety warnings.	◉ True ○ False ○ N/A

Concerns	◉ None ○ Minor ○ Serious ○ N/A
Comment	

Part A - Installation

A10	Is the IVIS visual display positioned close to the driver's normal line of sight?

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A	( ) QM
Comment	Used the vehicle's own display, which in this case was well-positioned				

Part A - Installation

A11	Is the IVIS free from reflections and glare under all ambient lighting conditions?

	A manual/automatic switch between day and night modes is provided.	○ True	◉ False	○ N/A
	The IVIS is free from reflection/glare:			
	- during the day.	◉ True	○ False	○ N/A
	- during darkness.	○ True	○ False	◉ N/A

Concerns	○ None	◉ Minor	○ Serious	○ N/A
Comment	Not tested at night. Given the screen colours chosen, we do not expect this to be an issue.			

Part A - Installation

A12	Are the windscreen and windows free from reflections and/or glare caused by the display?

	The windscreen and windows are free from reflection/glare: - during the day. - during darkness.	(●) True ( ) False ( ) N/A ( ) True ( ) False (●) N/A

Concerns	(●) None ( ) Minor ( ) Serious ( ) N/A
Comment	Not tested at night. VW is responsible.

Part B - Information Presentation

B1	Are messages presented visually simple?

	The IVIS avoids the use of long messages.	(●) True	( ) False	( ) N/A
	Each message is distinct from others.	(●) True	( ) False	( ) N/A
	The meaning of the message is clear.	(●) True	( ) False	( ) N/A
	Information presented by visual and other modalities is consistent.	(●) True	( ) False	( ) N/A

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A	( ) QM
Comment	The audio messages as a supplement to the video display are a good feature				

Part B - Information Presentation

B2	Is each control easily discernible by different methods in daylight and during darkness?

	The IVIS controls can be distinguished as follows:	
	Vision:	
	- by labels/graphics/representational features.	○ True ○ False ◉ N/A
	- by colour.	○ True ○ False ◉ N/A
	- by shape.	○ True ○ False ◉ N/A
	- by brightness.	○ True ○ False ◉ N/A
	Touch:	
	- by means of clearance.	○ True ○ False ◉ N/A
	- by means of location.	○ True ○ False ◉ N/A
	- by means of grouping.	○ True ○ False ◉ N/A
	- by means of shape.	○ True ○ False ◉ N/A
	- by means of texture.	○ True ○ False ◉ N/A
	- by motion feedback.	○ True ○ False ◉ N/A
	Hearing:	
	- by auditory feedback.	○ True ○ False ◉ N/A

Concerns	○ None ○ Minor ○ Serious ◉ N/A
Comment	There are no user interaction features in the app

Part B - Information Presentation

B3	Is colour used effectively to aid coding and layout of controls?

	Red/green combinations are avoided.	○ True	○ False	◉ N/A
	Blue/yellow combinations are avoided.	○ True	○ False	◉ N/A
	Colour coding does not cause problems during darkness.	○ True	○ False	◉ N/A
	Colours used do not cause adverse visual after effects.	○ True	○ False	◉ N/A
	The meaning of colour coding is clear.	○ True	○ False	◉ N/A
	Colour coding conforms to stereotypical norms in the expected country/area of use.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment				

Part B - Information Presentation

B4	Are colours used effectively in the design and presentation of visual images?

	Colours are limited to clearly differentiated sets.	(●) True	( ) False	( ) N/A
	Colours are equally visible under night-time viewing conditions.	( ) True	( ) False	(●) N/A
	Red/green and blue/yellow colour combinations are avoided.	(●) True	( ) False	( ) N/A
	Colour displays (LED and display images) are unambiguous without full colour vision.	(●) True	( ) False	( ) N/A
	Problems of colours distorting the appearance of adjacent colours and colour after-effects are avoided.	(●) True	( ) False	( ) N/A
	Colours conform with stereotypical norms.	(●) True	( ) False	( ) N/A

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A
Comment	Colours appeared to be chosen to emulate those used on VMS signs. We did not see speed limit signs on the app, so cannot judge those.			

Part B - Information Presentation

B5	Are the displays lit during darkness without unduly affecting vision?

	The IVIS illumination does not distract the driver.	○ True ○ False ◉ N/A
	The IVIS illumination does not cause visual discomfort.	○ True ○ False ◉ N/A
	The IVIS illumination does not prevent the displayed information from being clearly legible.	○ True ○ False ◉ N/A
	The IVIS illumination does not cause visual after effects.	○ True ○ False ◉ N/A
	Automatic/manual dimming controls are within an acceptable range.	○ True ○ False ◉ N/A
	The IVIS internal illumination can be used without washout of the display in any conditions.	○ True ○ False ◉ N/A

Concerns	○ None ○ Minor ○ Serious ◉ N/A
Comment	Not tested

Part B - Information Presentation

B6	Does the lighting of controls during darkness affect vision?

	Control lighting is adequate to identify the required control.	○ True	○ False	◉ N/A
	Control lighting is not so bright as to distract the driver.	○ True	○ False	◉ N/A
	Control lighting is not so bright as to cause visual discomfort or visual after effects.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	There are no app-specific controls			

Part B - Information Presentation

B7	Is the auditory message appropriate for the information to be conveyed?

	The message is short.	(●) True	( ) False	( ) N/A
	The message is simple.	(●) True	( ) False	( ) N/A
	The message does not need to be referred to later.	(●) True	( ) False	( ) N/A

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A
Comment				

Part B - Information Presentation

B8	Is information presented by speech clearly audible?

	Speech is not distorted.	◉ True	○ False	○ N/A
	Speech is clear.	◉ True	○ False	○ N/A
	Speech is at an appropriate frequency/pitch.	◉ True	○ False	○ N/A
	The language and dialect are suitable for the user population.	◉ True	○ False	○ N/A
	The language is user-selectable.	○ True	◉ False	○ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment	Language selection could be an issue for foreign drivers e.g. tourists			

Part B - Information Presentation

B9	Is the layout of graphics/representational features appropriate?

	The choice of graphics/representational features is suitable for what they represent.	◉ True	○ False	○ N/A
	The design of graphics/representational features is not too detailed or complex.	◉ True	○ False	○ N/A
	Functionally related graphics/representational features have a consistent style.	◉ True	○ False	○ N/A
	The use of text can be supported by graphics/representational features.	◉ True	○ False	○ N/A
	The use of graphics/representational features can be supported by text.	◉ True	○ False	○ N/A
	Graphics/representational features representing road signs are the same as actual road signs.	◉ True	○ False	○ N/A
	The apparent size of the display images is appropriate to their function.	◉ True	○ False	○ N/A
	Graphics/representational features are functionally grouped where possible.	○ True	○ False	◉ N/A
	Graphics/representational features are not cluttered.	◉ True	○ False	○ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment				

Part B - Information Presentation

B10	Is numerical data presented appropriately?

	An analogue format is used for fluctuating values.	○ True	○ False	◉ N/A
	An appropriate number of decimal places are used.	○ True	○ False	◉ N/A
	Numbering has appropriate units where required.	○ True	○ False	◉ N/A
	A digital display is employed for relatively steady values where the absolute numerical value needs to be known.	○ True	○ False	◉ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment				

Part B - Information Presentation

B11	Is the choice of words appropriate?

	Short words are used in preference to long ones.	◉ True	○ False	○ N/A
	The words used in the dialogue are simple and obvious.	◉ True	○ False	○ N/A
	The IVIS avoids the use of jargon when 'plain language' could be used.	◉ True	○ False	○ N/A
	The order of wording is logical and grammatically correct.	◉ True	○ False	○ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment				

Part B - Information Presentation

B12	Are abbreviations used appropriately?

	Abbreviations used aid the readability of the messages.	○ True	○ False	◉ N/A
	Abbreviations are used consistently.	○ True	○ False	◉ N/A
	Abbreviations conform to standard conventions.	○ True	○ False	◉ N/A
	Entire sentences are never made up from abbreviations.	◉ True	○ False	○ N/A
	Abbreviations are translated correctly for the country and language of their use.	○ True	○ False	◉ N/A
	Abbreviations are an appropriate method of conveying this information.	○ True	○ False	◉ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment	No use of abbreviations was observed			

Part B - Information Presentation

B13	Is the driving-relevant information correct?

	Messages contain all necessary information.	(●) True ( ) False ( ) N/A
	Information is consistent with:	
	- the legal status of the road system.	(●) True ( ) False ( ) N/A
	- external information on road signs.	(●) True ( ) False ( ) N/A
	- external information on VMS displays.	(●) True ( ) False ( ) N/A
	- external information on RDS broadcasts.	( ) True ( ) False (●) N/A
	- other external information.	( ) True ( ) False (●) N/A
	- other internal information.	( ) True ( ) False (●) N/A
	The system provides timely updated advice after non-compliance with instructions.	( ) True ( ) False (●) N/A

Concerns	(●) None ( ) Minor ( ) Serious ( ) N/A
Comment	The system seems to be designed to emulate VMS

Part B - Information Presentation

B14	Is a suitable indication given when new/updated information arrives that is directly relevant to the driver in the current driving situation?

	The method of indicating new information arriving is effective.	(●) True	( ) False	( ) N/A
	The method of indicating new information does not startle the driver.	(●) True	( ) False	( ) N/A
	The method of indicating new information is appropriate to the message being conveyed	(●) True	( ) False	( ) N/A
	The information is up to date and relevant to the current, real-time situation.	(●) True	( ) False	( ) N/A

Concerns	(●) None	( ) Minor	( ) Serious	( ) N/A
Comment	System was observed in "faked" mode			

Part B - Information Presentation

B15	Is information of higher safety relevance given higher priority?

Concerns	(●) None ( ) Minor ( ) Serious ( ) N/A
Comment	All the nessages were safety-relevant. We assume message priority would be the same as for VMS messages and would be decided by the road authority.

Part B - Information Presentation

B16	Where the volume of auditory output cannot be adjusted, does it present any concerns?

	Auditory output is loud enough to be heard under all driving conditions.	○ True ○ False ◉ N/A
	Auditory output is not so loud that it may mask audible warnings from within the vehicle.	○ True ○ False ◉ N/A
	Auditory output is not so loud that it may mask audible warnings from outside the vehicle.	○ True ○ False ◉ N/A

Concerns	◉ None ○ Minor ○ Serious ○ N/A
Comment	Audio volume can be adjusted

Part B - Information Presentation

B17	Is the use of Head Up Displays (HUDs) appropriate?

	The information is appropriate for a HUD.	○ True	○ False	◉ N/A
	HUDs do not mask any important information.	○ True	○ False	◉ N/A
	HUDs do not cause any reflections on interior surfaces.	○ True	○ False	◉ N/A
	HUDs do not distract the driver.	○ True	○ False	◉ N/A
	HUDs are free from the effects of glare.	○ True	○ False	◉ N/A
	HUDs have an appropriate brightness and contrast.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	Not applicable. No HUD was present.			

Part B - Information Presentation

B18	Does presentation of information by the IVIS in combination with other vehicle systems cause conflicts?

	When a visual display is shared between IVIS functions, conflicts will not arise between them.	○ True ○ False ◉ N/A
	When an auditory message is presented, other auditory outputs (eg the radio) will mute.	○ True ◉ False ○ N/A

Concerns	○ None ○ Minor ◉ Serious ○ N/A
Comment	The app did not appear to override the radio, when a message was due. This has been confirmed in subsequent discussion. Our recommendation is that the app should be able to function in the background and override the radio or other infotainment when a safety message is received. Otherwise there is a real possibility that safety messages will not be received and users will have a false sense of security.

Part C - Interaction with Displays and Controls

C1	Is the driver able to keep at least one hand on the steering wheel while interacting with the IVIS?

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	There are no controls in the app			

Part C - Interaction with Displays and Controls

C2	Is it easy to navigate through the IVIS menus?

	There are an appropriate number of menus, sub-menus and final options.	○ True	○ False	◉ N/A
	The user can move from menu to sub menu easily.	○ True	○ False	◉ N/A
	The user can move back through sub-menus easily.	○ True	○ False	◉ N/A
	The users are allowed to move backward and correct mistakes.	○ True	○ False	◉ N/A
	There is a cancel or escape button provided in the menu.	○ True	○ False	◉ N/A
	The user is not trapped deep within the menu structure.	○ True	○ False	◉ N/A
	Menu labels are easy to understand.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	There are no menus			

Part C - Interaction with Displays and Controls

C3	Is the manual-visual interaction short or interruptible?

	The interaction requires 3 inputs or less.	○ True	○ False	◉ N/A
	If the interaction takes more than 3 inputs, the sequence is interruptible.	○ True	○ False	◉ N/A
	The IVIS does not make choices for the user even if there is an input delay.	○ True	○ False	◉ N/A
	The driver can defer responding to the IVIS without loss of system status.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	There is no manual visual interaction, except when the driver has to resume app to screen connection if using the radio or other infotainment activity.			

Part C - Interaction with Displays and Controls

C4	Is the driver able to resume an interrupted dialogue with the IVIS at the point of interruption or at another logical point?

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	No dialogue			

Part C - Interaction with Displays and Controls

C5	Is the IVIS free from “machine pacing”?

	The speed at which the IVIS presents and replaces information is appropriate.	◉ True	○ False	○ N/A
	Information is presented sufficiently in advance of a driving decision.	○ True	◉ False	○ N/A
	The auditory information is automatically repeated when appropriate.	○ True	◉ False	○ N/A
	The auditory information can be repeated on request by the user.	○ True	◉ False	○ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	We have been unable to verfify whether messages come too early or too late in relation to e.g. an "event".			

Part C - Interaction with Displays and Controls

C6	Is the IVIS control layout suitable for safe operation?

	Each control can be used without inadvertently activating another control.	○ True	○ False	◉ N/A
	The layout of the controls is conducive to them being located non-visually.	○ True	○ False	◉ N/A
	If integrated controls are used, they are used appropriately.	◉ True	○ False	○ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment	Vehicle volume control was available and made the appropriate adjustment in the app's speech volume,			

Part C - Interaction with Displays and Controls

C7	Is the volume of auditory output adjustable over a reasonable range?

	Auditory output can be adjusted to: - be heard under all driving conditions. - a level that will not startle the driver.	◉ True ○ False ○ N/A ◉ True ○ False ○ N/A

Concerns	○ None ◉ Minor ○ Serious ○ N/A
Comment	The driver has full control over the auditory volume. However, the message volume should be controlled by the app, so that when the radio or music player is set to quiet, the driver can still hear the safety-related messages from the app.

Part C - Interaction with Displays and Controls

C8	Is immediate feedback provided when an input error is made?

	The user can see/hear immediately if they have made an input error or incompatible choice.	○ True ○ False ◉ N/A
	The system provides timely updated advice after non-compliance with instructions.	○ True ○ False ◉ N/A

Concerns	○ None ○ Minor ○ Serious ◉ N/A
Comment	

Part C - Interaction with Displays and Controls

C9	Is control activation feedback adequate and appropriate?

	Control activation is indicated by: - displacement feedback. - visual feedback. - auditory feedback.	○ True ○ False ◉ N/A
	The user can see/hear immediately that the IVIS is responding to their input.	○ True ○ False ◉ N/A
	The IVIS can cope with fast sequential data input.	○ True ○ False ◉ N/A
	Visual feedback persists long enough to permit vision to the road to be maintained and the feedback not be lost.	○ True ○ False ◉ N/A

Concerns	○ None ○ Minor ○ Serious ◉ N/A
Comment	There is no user input and therefore no feedback.

Part C - Interaction with Displays and Controls

C10	Following control activation feedback, is the required information provided within an appropriate timescale?

	The IVIS informs the user that it is “busy”.	○ True	○ False	◉ N/A
	User frustration from slow response is unlikely.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	No user input			

Part C - Interaction with Displays and Controls

C11	Can dynamic non-safety related information be deselected?
	The user is able to turn off non-safety related information.

○ True	○ False	◉ N/A	

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	All the messages are safety-related.			

Part C - Interaction with Displays and Controls

C12	Is the design of the IVIS controls suitable for their function?

	Controls do not perform more than two functions.	○ True	○ False	◉ N/A
	Where a control has two actions, they cannot be easily confused.	○ True	○ False	◉ N/A
	Where a control has two actions, they do not need to be carried out simultaneously.	○ True	○ False	◉ N/A
	Rotary knobs/multi-rotational knobs/thumb wheels etc. are only used to transmit continuous information.	○ True	○ False	◉ N/A
	Control actions are consistent with conventions adopted: - in the rest of the vehicle.	○ True	○ False	◉ N/A
	- in the national location where the IVIS is to be used.	○ True	○ False	◉ N/A
	Control labels are consistent with conventions adopted: - in the rest of the vehicle.	○ True	○ False	◉ N/A
	- national location where the IVIS is to be used.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	No controls			

Part C - Interaction with Displays and Controls

C13	Is the use of non-contact input controls (e.g. speech) appropriate for their function?

	Non-contact input controls do not require time critical responses.	○ True	○ False	◉ N/A
	Long speech input is not required.	○ True	○ False	◉ N/A
	Speech recognition can be turned off and another method of input is provided.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment				

Part C - Interaction with Displays and Controls

C14	Are touchscreens easy to use?

	The size of the ‘active’ areas is sufficient.	○ True	○ False	◉ N/A
	There is sufficient separation space between ‘active’ areas.	○ True	○ False	◉ N/A
	Input feedback is adequate.	○ True	○ False	◉ N/A
	The sensitivity of the active areas is appropriate.	○ True	○ False	◉ N/A

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment	The app was linked to the vehicle's built-in touchscreen (if available).			

Part D - System Behaviour

D1	Does the IVIS display distracting images unrelated to driving?

	The IVIS limits visual information available when the vehicle is moving.	◉ True	○ False	○ N/A
	Visual information does not have a dynamic component.	◉ True	○ False	○ N/A
	All dynamic visual images relate closely to driving.	○ True	○ False	◉ N/A

Concerns	◉ None	○ Minor	○ Serious	○ N/A
Comment				

Part D - System Behaviour

D2	Does the behaviour of the IVIS adversely interfere with displays or controls required for the primary driving task and for road safety?

	The IVIS does not override information that is required for safe driving.	◉ True ○ False ○ N/A
	The IVIS does not obstruct other safety systems.	◉ True ○ False ○ N/A

Concerns	◉ None ○ Minor ○ Serious ○ N/A
Comment	

Part D - System Behaviour

D3	Are system functions that are not intended to be used by the driver when driving impossible to interact with when the vehicle is in motion?

Concerns	○ None	◉ Minor	○ Serious	○ N/A
Comment	Yes, the connected phone could be used for non-app activity. A message to discourage such use should be added to app launch.			

Part D - System Behaviour

D4	Does the supplier make it sufficiently clear that the driver retains absolute responsibility for the operation of the vehicle and compliance with traffic regulations regardless of information provided by the IVIS?

	The user instructions clearly state that the driver retains overall responsibility for vehicle operation.	○ True ○ False ◉ N/A
	The user instructions clearly state that the driver retains responsibility for complying with traffic regulations.	○ True ○ False ◉ N/A
	The IVIS itself displays clear responsibility messages.	○ True ◉ False ○ N/A

Concerns	○ None ◉ Minor ○ Serious ○ N/A
Comment	There were no responsibility messages.

Part D - System Behaviour

D5	Is information presented to the driver about current status and any malfunction within the IVIS?

	The user is informed when the auditory output has been turned off.	○ True ◉ False ○ N/A
	The user is informed when the IVIS malfunctions.	○ True ◉ False ○ N/A
	The user is informed when there is a loss of external information.	◉ True ○ False ○ N/A

Concerns	◉ None ○ Minor ○ Serious ○ N/A
Comment	The green thumbs-up icon indicates comms with back-end is working. This turns to a red thumbs-down icon when connection is lost, and will be automatically re-established when possible (turning back to green). An audible beep is heard when comms is lost and/or re-established.

Part E - Information about the System

E1	Does information available to the driver include clear recommendations for installation of the IVIS?

Concerns	○ None	◉ Minor	○ Serious	○ N/A
Comment	Drivers could be advised to store the device in a secure location where it is not within eyesight.			

Part E - Information about the System

E2	Does the information available to the driver include adequate instructions for use and maintenance?

	There is a user manual.	○ True	◉ False	○ N/A
	The IVIS displays help information.	○ True	◉ False	○ N/A
	The consequence of non-compliance with instructions is clearly stated.	○ True	◉ False	○ N/A
	Maintenance procedures for the equipment are clearly prescribed.	○ True	◉ False	○ N/A

Concerns	○ None	◉ Minor	○ Serious	○ N/A
Comment	A manual is probably not necessary, but the availability of some instructions on how to connect when the app starts would be helpful, e.g. a Help button.			

Part E - Information about the System

E3	Are the IVIS instructions correct and simple?

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment				

Part E - Information about the System

E4	Are IVIS instructions in languages or forms designed to be understood by the intended group of drivers?

Concerns	○ None	○ Minor	○ Serious	◉ N/A
Comment				

Part E - Information about the System

E5	Do instructions provide sufficiently clear recommendations for non-use of any of the IVIS functions whilst driving?

	User is advised not to access help function while the vehicle is in motion.	○ True ○ False ◉ N/A
	User is advised not to configure IVIS features when the vehicle is in motion.	○ True ○ False ◉ N/A
	User is advised not to use any free-standing equipment when the vehicle is in motion.	○ True ◉ False ○ N/A

Concerns	○ None ◉ Minor ○ Serious ○ N/A
Comment	As stated earlier, advice not to use the host mobile phone for non-driving-related tasks should be provided.

Part E - Information about the System

E6	Does the product information accurately convey the IVIS functionality?

	Product information is correct.	○ True ○ False ◉ N/A
	Product information distinguishes between functions which are intended to be used while driving and those which are not.	○ True ○ False ◉ N/A

Concerns	○ None ○ Minor ○ Serious ◉ N/A
Comment	

Part E - Information about the System

E7	Does the product information make it clear if special skills are required to use the IVIS as intended by the manufacturer?

	User is advised if special skills are required to use the IVIS.	○ True ○ False ◉ N/A
	User is advised if the IVIS is not suitable for particular users.	○ True ○ False ◉ N/A

Concerns	○ None ○ Minor ○ Serious ◉ N/A
Comment	

Part E - Information about the System

E8	Are unrealistic expectations and encouragement of unsafe use avoided?

	The packaging does not promote inappropriate use of the IVIS.	◉ True ○ False ○ N/A

Concerns	◉ None ○ Minor ○ Serious ○ N/A
Comment	

UNIVERSITY OF LEEDS

Assessment of In-Vehicle Information Systems

Section 3 - Checklist Questions and Scoring Sheet

Part A - Installation

A1	Is the IVIS fitted in accordance with the manufacturers instructions for installing the system in vehicles?
Concerns	**NONE**
Comment	USB link. On the Golf, it was easy to store the phone away from interference with driving.

A2	Is the IVIS securely fitted?
Concerns	**NONE**
Comment	Can be put in a suitable storage bin.

A3	Once positioned and secured are the relevant components of the IVIS stable?
Concerns	**MINOR**
Comment	Depends on the vehicle being used.

A4	Once positioned and secured are the relevant components of the IVIS free from shake?
Concerns	**NONE**
Comment	Does not apply because not using the device directly.

A5	Are the IVIS controls easily reached by the user when driving?	
	All controls needed when driving can be reached from the normal driving position.	**TRUE**
	Stretching or leaning is not required.	**TRUE**
	Awkward arm or body positions are not required.	**TRUE**
Concerns	**NONE**	
Comment	Volume could be controlled directly via the car radio.	

A6	Is physical and visual access to the IVIS free from obstruction by other driver controls/displays?	
	No IVIS displays are obstructed.	**TRUE**
	No IVIS controls are obstructed.	**TRUE**
Concerns	**NONE**	
Comment	Display was via the vehicle's central screen	

A7	Is the driver's view of the road scene free from obstruction by the IVIS?	
	The swept windscreen area is fully clear.	**TRUE**
	The view of the mirrors is not restricted.	**TRUE**
	The side windows are fully clear.	**TRUE**
Concerns	**NONE**	
Comment	Same	

A8	Is physical and visual access to primary driver controls free from obstruction by the IVIS and its mounting?	
	The IVIS does not interfere with normal leg, hand and arm movements.	**TRUE**
	The IVIS does not interfere with use of the accelerator, brake or clutch.	**TRUE**
	The IVIS does not interfere with the use of the steering wheel.	**TRUE**
	The IVIS does not interfere with the direction indicators or windscreen wipers.	**TRUE**
	The IVIS does not interfere with the use of the lights.	**TRUE**
	The IVIS does not interfere with the use of the horn.	**TRUE**
	The IVIS does not interfere with use of the gear lever.	**TRUE**
	The IVIS does not interfere with use of the parking brake.	**TRUE**
	The IVIS does not interfere with the use of the hazard warning lights.	**TRUE**
	The IVIS does not interfere with the use of the de-mister controls.	**TRUE**
Concerns	**NONE**	
Comment		

A9	Is physical and visual access to primary driver displays free from obstruction by the IVIS and its mounting?

	The IVIS does not obscure the display of speed.	**TRUE**
	The IVIS does not obscure the telltale display of the indicators.	**TRUE**
	The IVIS does not obscure safety warnings.	**TRUE**
Concerns	**NONE**	
Comment		

A10	Is the IVIS visual display positioned close to the driver's normal line of sight?	
Concerns	**NONE**	
Comment	Used the vehicle's own display, which in this case was well-positioned	

A11	Is the IVIS free from reflections and glare under all ambient lighting conditions?	
	A manual/automatic switch between day and night modes is provided.	**FALSE**
	The IVIS is free from reflection/glare: - during the day.	**TRUE**
	- during darkness.	**N/A**
Concerns	**MINOR**	
Comment	Not tested at night. Given the screen colours chosen, we do not expect this to be an issue.	

A12	Are the windscreen and windows free from reflections and/or glare caused by the display?	
	The windscreen and windows are free from reflection/glare: - during the day.	**TRUE**
	- during darkness.	**N/A**
Concerns	**NONE**	
Comment	Not tested at night. VW is responsible.	

Part B - Information Presentation

B1	Are messages presented visually simple?	
	The IVIS avoids the use of long messages.	**TRUE**
	Each message is distinct from others.	**TRUE**

	The meaning of the message is clear.	**TRUE**
	Information presented by visual and other modalities is consistent.	**TRUE**
Concerns	**NONE**	
Comment	The audio messages as a supplement to the video display are a good feature	

B2	Is each control easily discernible by different methods in daylight and during darkness?	
	The IVIS controls can be distinguished as follows:	
	Vision:	
	- by labels/graphics/representational features.	**N / A**
	- by colour.	**N / A**
	- by shape.	**N / A**
	- by brightness.	**N / A**
	Touch:	
	- by means of clearance.	**N / A**
	- by means of location.	**N / A**
	- by means of grouping.	**N / A**
	- by means of shape.	**N / A**
	- by means of texture.	**N / A**
	- by motion feedback.	**N / A**
	Hearing:	
	- by auditory feedback.	**N / A**
Concerns	**N / A**	
Comment	There are no user interaction features in the app	

B3	Is colour used effectively to aid coding and layout of controls?	
	Red/green combinations are avoided.	**N / A**
	Blue/yellow combinations are avoided.	**N / A**
	Colour coding does not cause problems during darkness.	**N / A**
	Colours used do not cause adverse visual after effects.	**N / A**
	The meaning of colour coding is clear.	**N / A**

	Colour coding conforms to stereotypical norms in the expected country/area of use.	**N/A**
Concerns	**N/A**	
Comment		

B4	Are colours used effectively in the design and presentation of visual images?	
	Colours are limited to clearly differentiated sets.	**TRUE**
	Colours are equally visible under night-time viewing conditions.	**N/A**
	Red/green and blue/yellow colour combinations are avoided.	**TRUE**
	Colour displays (LED and display images) are unambiguous without full colour vision.	**TRUE**
	Problems of colours distorting the appearance of adjacent colours and colour after-effects are avoided.	**TRUE**
	Colours conform with stereotypical norms.	**TRUE**
Concerns	**NONE**	
Comment	Colours appeared to be chosen to emulate those used on VMS signs. We did not see speed limit signs on the app, so cannot judge those.	

B5	Are the displays lit during darkness without unduly affecting vision?	
	The IVIS illumination does not distract the driver.	**N/A**
	The IVIS illumination does not cause visual discomfort.	**N/A**
	The IVIS illumination does not prevent the displayed information from being clearly legible.	**N/A**
	The IVIS illumination does not cause visual after effects.	**N/A**
	Automatic/manual dimming controls are within an acceptable range.	**N/A**
	The IVIS internal illumination can be used without washout of the display in any conditions.	**N/A**
Concerns	**N/A**	
Comment	Not tested	

B6	Does the lighting of controls during darkness affect vision?	
	Control lighting is adequate to identify the required control.	**N/A**
	Control lighting is not so bright as to distract the driver.	**N/A**
	Control lighting is not so bright as to cause visual discomfort or visual after effects.	**N/A**

Concerns	**N / A**
Comment	There are no app-specific controls

B7	Is the auditory message appropriate for the information to be conveyed?	
	The message is short.	**TRUE**
	The message is simple.	**TRUE**
	The message does not need to be referred to later.	**TRUE**
Concerns	**NONE**	
Comment		

B8	Is information presented by speech clearly audible?	
	Speech is not distorted.	**TRUE**
	Speech is clear.	**TRUE**
	Speech is at an appropriate frequency/pitch.	**TRUE**
	The language and dialect are suitable for the user population.	**TRUE**
	The language is user-selectable.	**FALSE**
Concerns	**NONE**	
Comment	Language selection could be an issue for foreign drivers e.g. tourists	

B9	Is the layout of graphics/representational features appropriate?	
	The choice of graphics/representational features is suitable for what they represent.	**TRUE**
	The design of graphics/representational features is not too detailed or complex.	**TRUE**
	Functionally related graphics/representational features have a consistent style.	**TRUE**
	The use of text can be supported by graphics/representational features.	**TRUE**
	The use of graphics/representational features can be supported by text.	**TRUE**
	Graphics/representational features representing road signs are the same as actual road signs.	**TRUE**
	The apparent size of the display images is appropriate to their function.	**TRUE**
	Graphics/representational features are functionally grouped where possible.	**N / A**

	Graphics/representational features are not cluttered.	**TRUE**
Concerns	**NONE**	
Comment		

B10	Is numerical data presented appropriately?	
	An analogue format is used for fluctuating values.	**N / A**
	An appropriate number of decimal places are used.	**N / A**
	Numbering has appropriate units where required.	**N / A**
	A digital display is employed for relatively steady values where the absolute numerical value needs to be known.	**N / A**
Concerns	**NONE**	
Comment		

B11	Is the choice of words appropriate?	
	Short words are used in preference to long ones.	**TRUE**
	The words used in the dialogue are simple and obvious.	**TRUE**
	The IVIS avoids the use of jargon when ‘plain language’ could be used.	**TRUE**
	The order of wording is logical and grammatically correct.	**TRUE**
Concerns	**NONE**	
Comment		

B12	Are abbreviations used appropriately?	
	Abbreviations used aid the readability of the messages.	**N / A**
	Abbreviations are used consistently.	**N / A**
	Abbreviations conform to standard conventions.	**N / A**
	Entire sentences are never made up from abbreviations.	**TRUE**
	Abbreviations are translated correctly for the country and language of their use.	**N / A**
	Abbreviations are an appropriate method of conveying this information.	**N / A**
Concerns	**NONE**	

Comment	No use of abbreviations was observed

B13	Is the driving-relevant information correct?	
	Messages contain all necessary information.	**TRUE**
	Information is consistent with:	
	- the legal status of the road system.	**TRUE**
	- external information on road signs.	**TRUE**
	- external information on VMS displays.	**TRUE**
	- external information on RDS broadcasts.	**N / A**
	- other external information.	**N / A**
	- other internal information.	**N / A**
	The system provides timely updated advice after non-compliance with instructions.	**N / A**
Concerns	**NONE**	
Comment	The system seems to be designed to emulate VMS	

B14	Is a suitable indication given when new/updated information arrives that is directly relevant to the driver in the current driving situation?	
	The method of indicating new information arriving is effective.	**TRUE**
	The method of indicating new information does not startle the driver.	**TRUE**
	The method of indicating new information is appropriate to the message being conveyed	**TRUE**
	The information is up to date and relevant to the current, real-time situation.	**TRUE**
Concerns	**NONE**	
Comment	System was observed in "faked" mode	

B15	Is information of higher safety relevance given higher priority?
Concerns	**NONE**
Comment	All the nessages were safety-relevant. We assume message priority would be the same as for VMS messages and would be decided by the road authority.

B16	Where the volume of auditory output cannot be adjusted, does it present any concerns?

	Auditory output is loud enough to be heard under all driving conditions.	**N/A**
	Auditory output is not so loud that it may mask audible warnings from within the vehicle.	**N/A**
	Auditory output is not so loud that it may mask audible warnings from outside the vehicle.	**N/A**
Concerns	**NONE**	
Comment	Audio volume can be adjusted	

B17	Is the use of Head Up Displays (HUDs) appropriate?	
	The information is appropriate for a HUD.	**N/A**
	HUDs do not mask any important information.	**N/A**
	HUDs do not cause any reflections on interior surfaces.	**N/A**
	HUDs do not distract the driver.	**N/A**
	HUDs are free from the effects of glare.	**N/A**
	HUDs have an appropriate brightness and contrast.	**N/A**
Concerns	**N/A**	
Comment	Not applicable. No HUD was present.	

B18	Does presentation of information by the IVIS in combination with other vehicle systems cause conflicts?	
	When a visual display is shared between IVIS functions, conflicts will not arise between them.	**N/A**
	When an auditory message is presented, other auditory outputs (eg the radio) will mute.	**FALSE**
Concerns	**SERIOUS**	
Comment	The app did not appear to override the radio, when a message was due. This has been confirmed in subsequent discussion. Our recommendation is that the app should be	

Part C - Interaction with Displays and Controls

C1	Is the driver able to keep at least one hand on the steering wheel while interacting with the IVIS?
Concerns	**N/A**
Comment	There are no controls in the app

C2	Is it easy to navigate through the IVIS menus?

	There are an appropriate number of menus, sub-menus and final options.	**N / A**
	The user can move from menu to sub menu easily.	**N / A**
	The user can move back through sub-menus easily.	**N / A**
	The users are allowed to move backward and correct mistakes.	**N / A**
	There is a cancel or escape button provided in the menu.	**N / A**
	The user is not trapped deep within the menu structure.	**N / A**
	Menu labels are easy to understand.	**N / A**
Concerns	**N / A**	
Comment	There are no menus	

C3	Is the manual-visual interaction short or interruptible?	
	The interaction requires 3 inputs or less.	**N / A**
	If the interaction takes more than 3 inputs, the sequence is interruptible.	**N / A**
	The IVIS does not make choices for the user even if there is an input delay.	**N / A**
	The driver can defer responding to the IVIS without loss of system status.	**N / A**
Concerns	**N / A**	
Comment	There is no manual visual interaction, except when the driver has to resume app to screen connection if using the radio or other infotainment activity.	

C4	Is the driver able to resume an interrupted dialogue with the IVIS at the point of interruption or at another logical point?	
Concerns	**N / A**	
Comment	No dialogue	

C5	Is the IVIS free from “machine pacing”?	
	The speed at which the IVIS presents and replaces information is appropriate.	**TRUE**
	Information is presented sufficiently in advance of a driving decision.	**FALSE**
	The auditory information is automatically repeated when appropriate.	**FALSE**
	The auditory information can be repeated on request by the user.	**FALSE**

Concerns	**N/A**
Comment	We have been unable to verfify whether messages come too early or too late in relation to e.g. an "event".

C6	Is the IVIS control layout suitable for safe operation?	
	Each control can be used without inadvertently activating another control.	**N/A**
	The layout of the controls is conducive to them being located non-visually.	**N/A**
	If integrated controls are used, they are used appropriately.	**TRUE**
Concerns	**NONE**	
Comment	Vehicle volume control was available and made the appropriate adjustment in the app's speech volume,	

C7	Is the volume of auditory output adjustable over a reasonable range?	
	Auditory output can be adjusted to:	
	- be heard under all driving conditions.	**TRUE**
	- a level that will not startle the driver.	**TRUE**
Concerns	**MINOR**	
Comment	The driver has full control over the auditory volume. However, the message volume should be controlled by the app, so that when the radio or music player is set to quiet, the driver can still hear the safety-related messages from the app.	

C8	Is immediate feedback provided when an input error is made?	
	The user can see/hear immediately if they have made an input error or incompatible choice.	**N/A**
	The system provides timely updated advice after non-compliance with instructions.	**N/A**
Concerns	**N/A**	
Comment		

C9	Is control activation feedback adequate and appropriate?	
	Control activation is indicated by:	
	- displacement feedback.	**N/A**
	- visual feedback.	**N/A**
	- auditory feedback.	**N/A**

	The user can see/hear immediately that the IVIS is responding to their input.	**N / A**
	The IVIS can cope with fast sequential data input.	**N / A**
	Visual feedback persists long enough to permit vision to the road to be maintained and the feedback not be lost.	**N / A**
Concerns	**N / A**	
Comment	There is no user input and therefore no feedback.	

C10	Following control activation feedback, is the required information provided within an appropriate timescale?	
	The IVIS informs the user that it is “busy”.	**N / A**
	User frustration from slow response is unlikely.	**N / A**
Concerns	**N / A**	
Comment	No user input	

C11	Can dynamic non-safety related information be deselected?	
	The user is able to turn off non-safety related information.	**N / A**
Concerns	**N / A**	
Comment	All the messages are safety-related.	

C12	Is the design of the IVIS controls suitable for their function?	
	Controls do not perform more than two functions.	**N / A**
	Where a control has two actions, they cannot be easily confused.	**N / A**
	Where a control has two actions, they do not need to be carried out simultaneously.	**N / A**
	Rotary knobs/multi-rotational knobs/thumb wheels etc. are only used to transmit continuous information.	**N / A**
	Control actions are consistent with conventions adopted:	
	- in the rest of the vehicle.	**N / A**
	- in the national location where the IVIS is to be used.	**N / A**
	Control labels are consistent with conventions adopted:	
	- in the rest of the vehicle.	**N / A**
	- national location where the IVIS is to be used.	**N / A**
Concerns	**N / A**	

Comment	No controls	

C13	Is the use of non-contact input controls (e.g. speech) appropriate for their function?	
	Non-contact input controls do not require time critical responses.	**N/A**
	Long speech input is not required.	**N/A**
	Speech recognition can be turned off and another method of input is provided.	**N/A**
Concerns	**N/A**	
Comment		

C14	Are touchscreens easy to use?	
	The size of the 'active' areas is sufficient.	**N/A**
	There is sufficient separation space between 'active' areas.	**N/A**
	Input feedback is adequate.	**N/A**
	The sensitivity of the active areas is appropriate.	**N/A**
Concerns	**N/A**	
Comment	The app was linked to the vehicle's built-in touchscreen (if available).	

Part D - System Behaviour

D1	Does the IVIS display distracting images unrelated to driving?	
	The IVIS limits visual information available when the vehicle is moving.	**TRUE**
	Visual information does not have a dynamic component.	**TRUE**
	All dynamic visual images relate closely to driving.	**N/A**
Concerns	**NONE**	
Comment		

D2	Does the behaviour of the IVIS adversely interfere with displays or controls required for the primary driving task and for road safety?	
	The IVIS does not override information that is required for safe driving.	**TRUE**

	The IVIS does not obstruct other safety systems.	**TRUE**
Concerns	**NONE**	
Comment		

D3	Are system functions that are not intended to be used by the driver when driving impossible to interact with when the vehicle is in motion?
Concerns	**MINOR**
Comment	Yes, the connected phone could be used for non-app activity. A message to discourage such use should be added to app launch.

D4	Does the supplier make it sufficiently clear that the driver retains absolute responsibility for the operation of the vehicle and compliance with traffic regulations regardless of information provided by the IVIS?	
	The user instructions clearly state that the driver retains overall responsibility for vehicle operation.	**N/A**
	The user instructions clearly state that the driver retains responsibility for complying with traffic regulations.	**N/A**
	The IVIS itself displays clear responsibility messages.	**FALSE**
Concerns	**MINOR**	
Comment	There were no responsibility messages.	

D5	Is information presented to the driver about current status and any malfunction within the IVIS?	
	The user is informed when the auditory output has been turned off.	**FALSE**
	The user is informed when the IVIS malfunctions.	**FALSE**
	The user is informed when there is a loss of external information.	**TRUE**
Concerns	**NONE**	
Comment	The green thumbs-up icon indicates comms with back-end is working. This turns to a red thumbs-down icon when connection is lost, and will be automatically re-established	

Part E - Information about the System

E1	Does information available to the driver include clear recommendations for installation of the IVIS?
Concerns	**MINOR**
Comment	Drivers could be advised to store the device in a secure location where it is not within eyesight.

E2	Does the information available to the driver include adequate instructions for use and maintenance?	
	There is a user manual.	**FALSE**
	The IVIS displays help information.	**FALSE**
	The consequence of non-compliance with instructions is clearly stated.	**FALSE**
	Maintenance procedures for the equipment are clearly prescribed.	**FALSE**
Concerns	**MINOR**	
Comment	A manual is probably not necessary, but the availability of some instructions on how to connect when the app starts would be helpful, e.g. a Help button.	

E3	Are the IVIS instructions correct and simple?
Concerns	**N/A**
Comment	

E4	Are IVIS instructions in languages or forms designed to be understood by the intended group of drivers?
Concerns	**N/A**
Comment	

E5	Do instructions provide sufficiently clear recommendations for non-use of any of the IVIS functions whilst driving?	
	User is advised not to access help function while the vehicle is in motion.	**N/A**
	User is advised not to configure IVIS features when the vehicle is in motion.	**N/A**
	User is advised not to use any free-standing equipment when the vehicle is in motion.	**FALSE**
Concerns	**MINOR**	
Comment	As stated earlier, advice not to use the host mobile phone for non-driving-related tasks should be provided.	

E6	Does the product information accurately convey the IVIS functionality?	
	Product information is correct.	**N/A**
	Product information distinguishes between functions which are intended to be used while driving and those which are not.	**N/A**
Concerns	**N/A**	

Comment	

E7	Does the product information make it clear if special skills are required to use the IVIS as intended by the manufacturer?	
	User is advised if special skills are required to use the IVIS.	**N / A**
	User is advised if the IVIS is not suitable for particular users.	**N / A**
Concerns	**N / A**	
Comment		

E8	Are unrealistic expectations and encouragement of unsafe use avoided?	
	The packaging does not promote inappropriate use of the IVIS.	**TRUE**
Concerns	**NONE**	
Comment		

UNIVERSITY OF LEEDS

Assessment of In-Vehicle Information Systems

Section 4 - Summary Report

Date:
Initial assessment: 20/11/2019 Revised assessment: 11/12/2019

Assessors:
Oliver Carsten, Chinebuli Uzondu and Zahara Batool

Product name and version
Connected Car App, Version 1.0.4

Context of IVIS use (e.g. static assessment, assessment while driving)
Assesment while driving

Build Status (e.g. partial software mock-up, single function assessment, overall IVIS assessment, other)
Software mockup

SUMMARY OF CHECKLIST ASSESSMENT

Serious Concerns and Reasons (refer to specific questions if necessary)
Part A - Installation
Further Comments:
Part B - Information Presentation

B18 - The app did not appear to override the radio, when a message was due. This has been confirmed in subsequent discussion. Our recommendation is that the app should be able to function in the background and override the radio or other infotainment when a safety message is received. Otherwise there is a real possibility that safety messages will not be received and users will have a false sense of security.;

Further Comments:

Part C - Interaction with Displays and Controls

Further Comments:

Part D - System Behaviour

Further Comments:

Part E - Information about the System

Further Comments:

Minor Concerns and Reasons (refer to specific questions if necessary)

Part A - Installation

A3 - Depends on the vehicle being used.;
A11 - Not tested at night. Given the screen colours chosen, we do not expect this to be an issue.;

Further Comments:

Part B - Information Presentation

Further Comments:

Part C - Interaction with Displays and Controls

C7 - The driver has full control over the auditory volume. However, the message volume should be controlled by the app, so that when the radio or music player is set to quiet, the driver can still hear the safety-related messages from the app.;

Further Comments:

Part D - System Behaviour

D3 - Yes, the connected phone could be used for non-app activity. A message to discourage such use should be added to app launch.;
D4 - There were no responsibility messages.;

Further Comments:

Part E - Information about the System

E1 - Drivers could be advised to store the device in a secure location where it is not within eyesight.;
E2 - A manual is probably not necessary, but the availability of some instructions on how to connect when the app starts would be helpful, e.g. a Help button.;
E5 - As stated earlier, advice not to use the host mobile phone for non-driving-related tasks should be provided.;

Further Comments:

Overall Assessment

Generally favourable. Most of our previous comments have been addressed.

The major improvement that we recommend regards interaction between the app and the vehicle's infotainment system. On the test vehicle, the radio was easily accessible via a button. We expect that users would want to choose their preferred infotainment. Therefore the app should operate as a popup, overriding the infotainment when a safety message is received by the app. Otherwise safety messages will not be passed to users, resulting in a potential false sense of security.

If the radio were to be locked out, then users would be annoyed and unlikely to use the app. This is therefore not a good solution.

ADDITIONAL COMMENTS AND DESIGN RECOMMENDATIONS

Additional Comments

Recommendations