



**UNECE**

IWG DDADWS 9th session  
Workshop on Drowsiness Requirements



# The Anatomy of Effective Attention Warnings: Building a Framework Beyond Beeps and Icons

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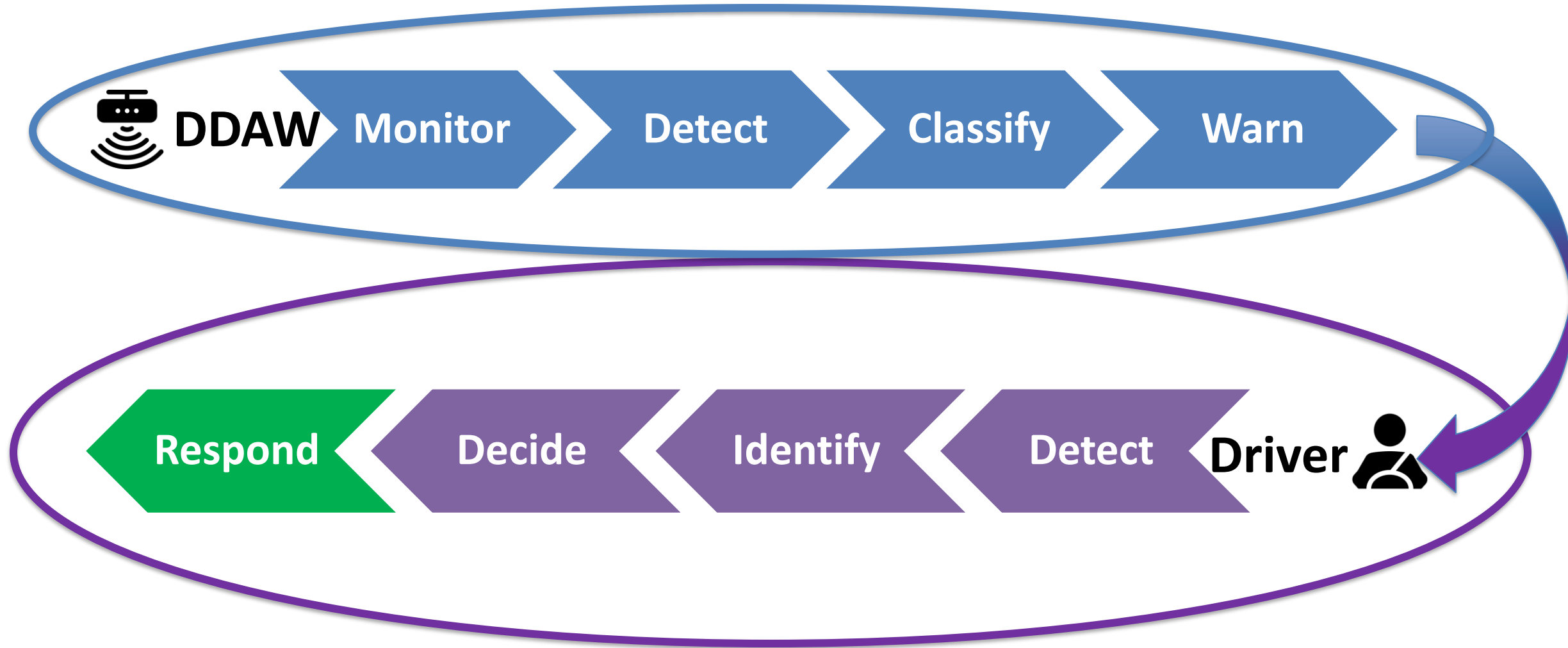


# Outline

- Recap
- Designing for people - after the detection
- How, Where, What, When and Control of warnings
- Current DDAW warnings requirements
- Good, Bad and Annoying
- Missing or Underdefined Elements
- General UNECE Driver Alerting Strategy & HMI (DASH)
- Summary



# Turning Detection into Action



Safety Depends on DDAW Detection AND Timely and Appropriate Response from Driver

# Human Information Processing Model of the Warning Process

## Perception-Response Sequence

1. **Detection:** Driver attention
2. **Identification:** Understanding
3. **Decision:** Choosing response
4. **Response:** Taking action



**Response performance** - type, appropriateness, timing, quality...

## Mediating factors:

### Human

- Individual differences
- Congruity between self awareness and detection
- Driver state, attention & workload
- Experience, expectations, trust / distrust
- Annoyance & frustration
- Attitudes and perceived control
- .....

### Vehicle, Task & Environment

- Warning design,
- Ambient noise, visual clutter, lighting
- Response time pressure / urgency
- Response difficulty
- Road complexity, traffic conditions
- ....

# Driver Decision → Response: DDAW Outcome

## Decision

- ✓ Recognize drowsiness
- ✗ Deny presence or extent of drowsiness

## Response

- ✗ Ignore warning, get annoyed, turn warning off
- ✓ Take action:
  - Invest effort to stay alert and pay attention
  - Press button to confirm warning
  - Compensatory action (move or change posture, raise radio volume, talk, open window...)
  - Caffeine
  - Plan a rest stop and sleep (how long?)
  - ...



# Prioritizing DDAW in Relation to Other On-board Messages

- Priority helps to determine when, where, and how system messages are displayed (ISO TS 16951: 2021)
- Priority sets the relative importance of two or more messages, which determines their ranking in a time sequence or emphasis of presentation.
- If messages are not managed properly, drivers may fail to obtain critical safety information when they need it most
- This procedure provides a basis for the management of messages competing for the driver's limited attention.

	<u>Priority Level</u>	<u>Awareness/ Action</u>
<b>3</b>	<b>Emergency</b>	<b>&lt; 2s</b>
<b>2</b>	<b>Warning</b>	<b>3 – 10s</b>
<b>1</b>	<b>Advisory</b>	<b>&gt; 10s</b>
<b>0</b>	<b>Information/ Status</b>	<b>-</b>



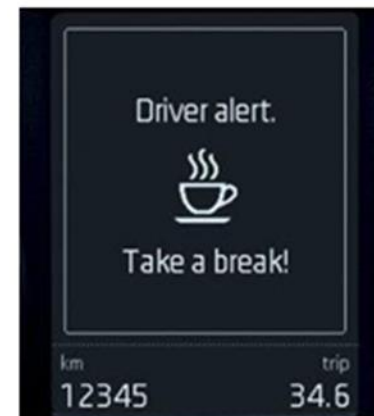
# In-Vehicle Warnings Design: Noticing Warnings

## 1. HOW the warning is presented

- **Size:** Large enough to be noticeable but not overly dominant
- **Intensity:** Brightness, loudness, or force of feedback
- **Colour:** Leveraging colour coding (e.g., red for critical and white/blue for information)
- **Modality & multimodality:** Using visual, auditory, haptic, kinesthetic, olfactory or combinations
- **Contrast & background:** Ensuring high visibility against surrounding UI elements
- **Dynamics:** Static vs. flashing vs. animated

## 2. WHERE the warning is presented

- **Visual** - centrally within the user's field of view (cluster, console, high-head down display)
- **Haptic** – seat, steering wheel, pedals, seatbelt
- **Kinesthetic** – seatbelt, brake pulse



# Comprehending Warnings

## 3. WHAT - Information Processing & Decision Support

- **Clear Messaging:** Use concise simple text, icons, or tones that unambiguously convey the intended action or hazard.
- **Avoid Ambiguity:** Ensure warnings are intuitive, with easily recognizable symbols or sounds.
- **Relevance and workload:** Avoid overloading with unnecessary information

## 4. WHEN - Temporal properties

- **Sensitivity & False Alarms:** Balancing trigger criteria and warnings to minimize unnecessary alerts
- **Timing & Frequency:** When it appears and how often it repeats
- **Duration:** How long it is displayed or remains active
- **Multi-stage & Escalation:** Gentle information at first and increasing intensity when the user does not respond
- **Prioritization:** crash imminent warnings appear before (replace) less urgent/ severe messages



- a) Signal word
- b) Hazard description
- c) Instructions for avoidance
- d) Consequences



# 5. Warning CONTROL Design Considerations

## Control Availability & Accessibility

- **On/Off Control:** Should the system have an off switch?
- **Granularity of Control:** Can users adjust sensitivity or warning types instead of just turning it off?
- **Quick Access:** Should there be a physical button (e.g., steering wheel, dashboard) or only a menu setting?



## Control Location

- **Physical vs. Digital Interface:** Hard buttons, touchscreen menus, or voice commands
- **Driver Reachability:** Placement within easy reach without diverting attention

## Control Actions & Feedback

- **Mute/Snooze:** Temporary silencing without full deactivation
- **Escalation Handling:** If the driver mutes the warning, should it automatically re-enable later?

## Safety Considerations

- **Override Limitations:** Preventing users from disabling essential safety features
- **Acknowledgment Mechanism:** Confirming awareness of the warning to dismiss it

# Draft Driver Warning requirements (DDAW 08-03)

- 5.3.3. The emission of drowsiness warnings by the DDAW system may be automatically deactivated under conditions in which other driving assistance system are warning about an imminent danger or a critical situation.
- 5.3.3.1. The drowsiness warning function should be automatically reactivated as soon as the conditions that led to its deactivation are no longer present.
- 5.5.2.2. In addition, the manufacturer may implement an information strategy on the HMI prior to the warning.

## Provides some requirements on:

- **WHEN (prioritization)**



## 5.6. HMI requirements

### 5.6.1. Warning nature

5.6.1.1. Visual and acoustic or any other warning (including haptic) used by the DDAW system to alert the driver shall be presented as soon as possible after occurrence of the trigger behaviour and may cascade and intensify until acknowledgement thereof by the driver.

Can be accepted as acknowledgement by the driver: an improvement of the driving behaviour based on the input/s used for the DDAW system (strategy to be described in the documentation provided by the manufacturer).

### **Provides some requirements for:**

- **HOW (multimodality)**
- **WHEN (escalation, timing) and**
- **CONTROL (acknowledgement)**



## 5.6.2. Visual warning

- 5.6.2.1. The visual warning shall be located so as to be readily visible and recognisable in daylight and at night-time by the driver and distinguishable from other alerts.
- 5.6.2.2. The visual warning shall be a steady or flashing indication (e.g. tell-tale, pop-up message).
- 5.6.2.3. Any new symbols developed for the purpose of a DDAW system visual warning are recommended to be constructed using similar elements to and keeping coherence with ISO 2575
- 5.6.2.4. The contrast of the symbol with the background in sun light, twilight and night conditions are recommended to be in accordance with ISO 15008.
- 5.6.2.5. The following visual alert and background colour combinations should not be used: red/green; yellow/blue; yellow/red; red/violet.

### **Provides some requirements for:**

- **WHERE (location)**
- **HOW (flashing, symbol, contrast for legibility across conditions, avoid poor contrast)**
- **WHAT (standard symbol)**



### 5.6.3. Acoustic warning

5.6.3.1. The acoustic warning shall be easily recognised by the driver.

5.6.3.2. A majority of the acoustic warning shall fall within the frequency spectrum of 200-8000 Hz and amplitude range of 50-90 dB. The vehicle manufacturer may adjust the amplitude depending on the surrounding noise level.

5.6.3.3. If speech alerts are utilised, the vocabulary used shall be consistent with any text used as part of the visual alert.

5.6.3.4. The audible portion of the alert shall last for at least the duration that allows the driver to understand it.

### 5.6.4. Haptic warning

5.6.4.1. The haptic warning shall be noticeable by the driver and be provided directly or indirectly through any interface expected to attract the attention of the driver.

#### **Provides some requirements for:**

- **HOW (acoustic properties, haptics)**
- **WHERE (location of haptics)**
- **WHEN (duration)**
- **WHAT (speech content and consistency)**



# Examples of DDAW Compliant Warnings: The Good, The Bad and The Annoying

	Good	Bad	Annoying/ Startling
How	3-stage warning, 1) static white text information to 2) amber visual symbol, escalating to 3) red flashing with acoustic tone (20dB over masked threshold to max 90dB) with haptic seat	Single stage steady white symbol 1 cm <sup>2</sup> with 200 hz short tone at 50dB not adapted to ambient noise	Single stage flashing bright red lights and symbol coupled with 200hz speech warning at 90dB
What	ISO drowsy eyes symbol with information then amber caution Display of drowsiness level Text message information “drowsiness detected” and recommend driver to “take a break” Escalates to red flashing warning “take a break as soon as possible”	No information other than ISO coffee cup symbol, which does not communicate urgency or required action.  No escalation and limited redundancy	ISO drowsy eyes symbol Frequent voice repeating “Danger Drowsy” speech message with no clear action. Continuous haptic vibration
Where	Visual - high instrument cluster ( $\pm 15^\circ$ ) Haptic – seatback	Visual - on rearview mirror	Visual - entire dash Haptic – steering wheel
When	As soon as drowsiness detected. Escalates if no driver acknowledgement or impairment increases Prioritized to avoid masking more urgent safety-critical alerts	Displayed eventually “when possible” regardless of other priority signals	Displayed when possible and continuously regardless of other priority signals

# Missing or Underdefined Elements in DDAW Draft

## 1. HOW – Presentation and Modality

- Lack of quantitative criteria for visibility/audibility under ambient noise, glare, or vibration
- Multimodal coordination: No requirement that visual, auditory, and haptic cues be synchronized or matched in urgency
- Cross-system harmonization: No rule ensuring DDAW aligns with the warning strategy used by other vehicle/ADAS/ADS systems
- Accessibility: No provisions for colour vision deficiency, hearing loss, or ergonomic reach



# Missing or Underdefined Elements in DDAW Draft

## 2. WHAT – Message Content and Meaning

- Severity classification: No differentiation between information/advisory/warning/emergency levels or escalation logic
- Message semantics: No requirement that the meaning convey safety relevance rather than commanded behavior (e.g., “Drowsiness detected” vs “Take a break”)
- System confidence: No optional indication of detection reliability or uncertainty



# Missing or Underdefined Elements in DDAW Draft

## 3. WHERE – Location

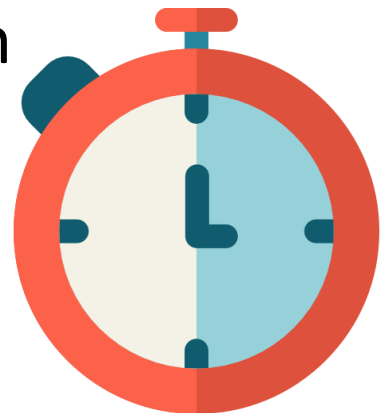
- Primary field of view guidance: No explicit requirement that the visual alert appear in or near the driver's forward view (instrument cluster)
- Integration with other HMIs: No guidance on integration within the vehicle display ecosystem (cluster, HUD, centre stack)



# Missing or Underdefined Elements in DDAW Draft

## 4. WHEN – Timing, Escalation, and Priority

- Trigger delay: No limit on the delay between detection and cue onset.
- Escalation logic: Terms such as “cascade” or “intensify” are undefined — no clear escalation levels or timing intervals.
- Conflict and masking management: No rule defining how concurrent warnings are prioritized or prevented from overlapping with infotainment or other ADAS/ADS alerts.
- Suppression transparency: No requirement to inform drivers when DDAW is temporarily suppressed.
- Nuisance control: No limits on repetition or snooze intervals to prevent habituation.



# Missing or Underdefined Elements in DDAW Draft

## 5. CONTROL – Activation and Settings

- Persistence logic: No definition of warning persistence or reactivation logic
- Warning transparency: No requirement that the driver be informed why a warning occurred or why it stopped
- Fallback or escalation: No requirement for an additional haptic or automation response if the driver fails to respond (e.g., mitigated-risk maneuver)



# General UNECE Driver Alerting Strategy & HMI (DASH)

1. **Detection-Response Link** – clarify what constitutes the desired response options
2. **Warning Priority & Classification** – warning hierarchy/levels and general priorities
3. **Presentation (How)** – Modalities, minimum perceptibility
4. **Location (Where)** – Primary display locations and integration without masking or ducking
5. **Timing & Escalation** – Timing of stages, minimum detection to cue time
6. **Message Content & Meaning** – Clear unambiguous messages, confidence levels
7. **Control & Persistence** – Driver controls (mute, snooze, sensitivity), persistence and re-alert logic, mitigation if the driver fails to respond
8. **Accessibility** – commonality, special needs
9. **Transparency and Feedback** – indications of system status and changes

# Summary

- Accurate drowsiness detection is only part of the challenge — HMI requirements are equally critical and must be clearly specified, since whole-system performance (including driver response) may fall outside compliance verification
- For DDAW, the Driver Alerting Strategy and HMI is the easy part — we already know how to design effective warnings
- Evidence-based best practices should guide warning requirements, while allowing flexibility for innovation to avoid unsafe or ineffective implementations
- All warnings should clarify their meaning, be easy to notice and understand, appear at the right time, and work reliably across users and environments
- There is a need for a general framework within UNECE to structure how automotive information and warnings are specified across regulations

# References

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