UNITED STATES
DEPARTMENT OF TRANSPORTATION

Human Factors for Connected Vehicles Program

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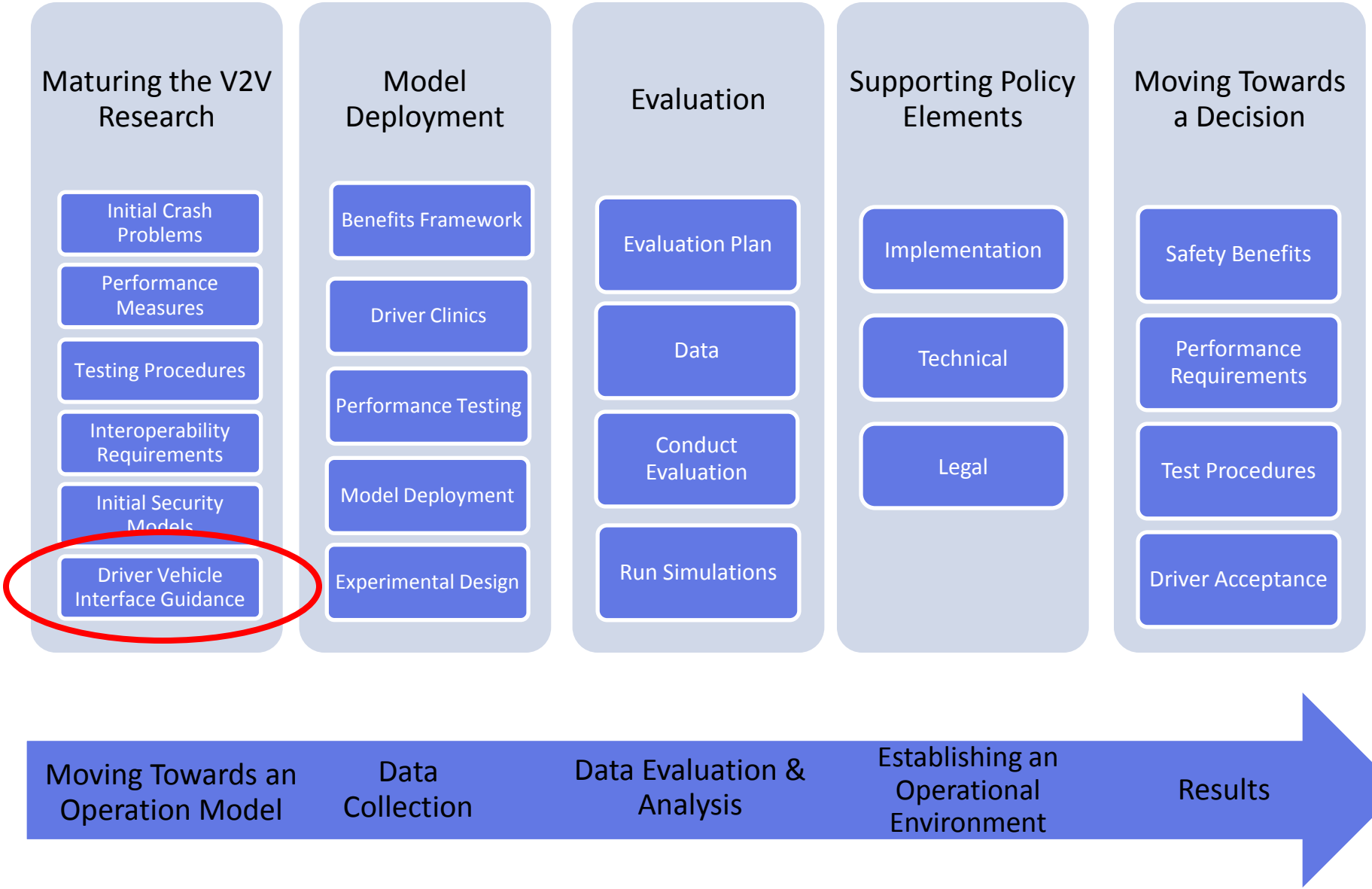
September 25, 2012

NHTSA
www.nhtsa.gov

V2V Safety Framework



Human Factors for Connected Vehicles

- **Outcome Goal**
  - Connected Vehicle technologies and applications will have Driver Vehicle Interfaces (DVI) that effectively communicate safety and various levels of non-safety driving related information while managing workload and minimizing distraction
- **Product Goal**
  - Human Factors Guidelines to ensure interfaces are effective without increasing distraction or creating high workload
    - Produced in time to inform 2013 Agency Decision

Program Scope

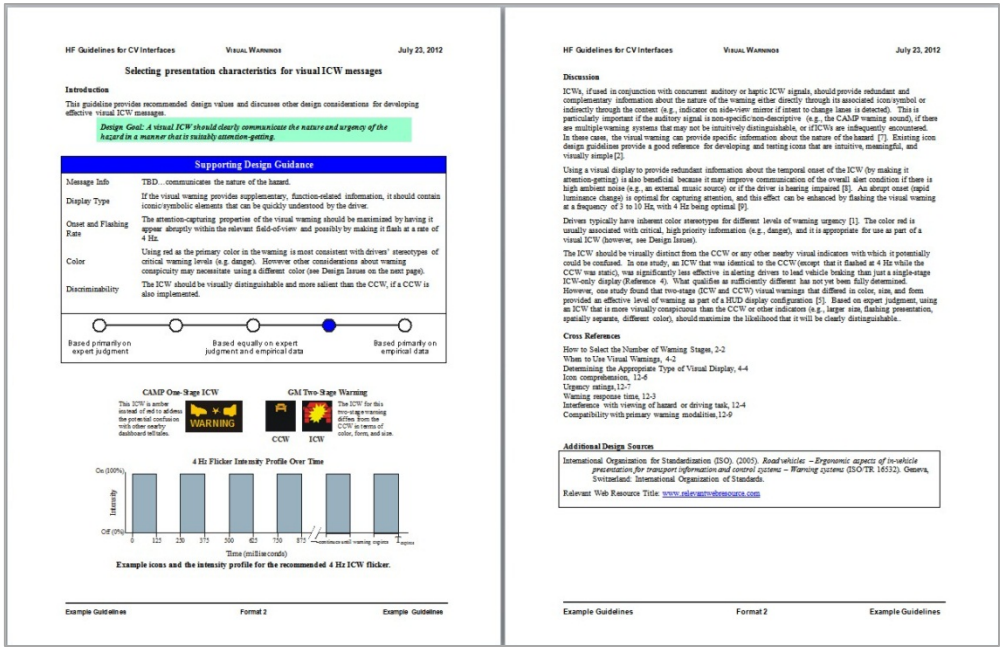
- **Multiple User Groups**:
  - Light vehicles
  - Commercial Vehicles
  - Transit operators
  - Age groups: Older and Younger drivers

- **Multiple Applications**:
  - V2V and V2I
  - Safety, Mobility, Sustainability
    - Special concern about **non-safety** applications
  - Original equipment, Nomadic (carry-in) devices, software "Apps"

Focus is on "Connected" Applications

HFCV Guidelines

- Human Factors Guidelines for Connected Vehicle Systems
- Focus will be on Driver-Vehicle Interfaces (DVI) for:
  - Safety and Non-Safety applications
  - Integrated and aftermarket devices
- Will inform 2013 Agency decision



HF Guidelines for CV Interfaces — Visual Warnings — July 23, 2012

Selecting presentation characteristics for visual ICW messages

Introduction

This guideline provides recommended design values and discusses other design considerations for developing effective visual ICW messages.

Design Goal: A visual ICW should clearly communicate the nature and urgency of the hazard in a manner that is suitably attention-getting.

Supporting Design Guidance

Message Info	TBD…communicates the nature of the hazard.
Display Type	If the visual warning provides supplementary, function-related information, it should contain iconic/symbolic elements that can be quickly understood by the driver.
Onset and Flashing Rate	The attention-capturing properties of the visual warning should be maximized by having it appear abruptly within the relevant field-of-view and possibly by making it flash at a rate of 4 Hz.
Color	Using red as the primary color in the warning is most consistent with drivers' stereotypes of critical warning levels (e.g. danger). However other considerations about warning conspicuity may necessitate using a different color (see Design Issues on the next page).
Discriminability	The ICW should be visually distinguishable and more salient than the CCW, if a CCW is also implemented.

Based primarily on expert judgment — Based equally on expert judgment and empirical data — Based primarily on empirical data

CAMP One-Stage ICW — GM Two-Stage Warning

4 Hz Flicker Intensity Profile Over Time

Example icons and the intensity profile for the recommended 4 Hz ICW flicker.

Example Guidelines — Format 2 — Example Guidelines

HF Guidelines for CV Interfaces — Visual Warnings — July 23, 2012

Discussion

ICWs, if used in conjunction with concurrent auditory or haptic ICW signals, should provide redundant and complementary information about the nature of the warning either directly through its associated icon/symbol or indirectly through the context (e.g., indicator on side-view mirror if intent to change lanes is detected). This is particularly important if the auditory signal is non-specific/non-descriptive (e.g., the CAMP warning sound), if there are multiple warning systems that may not be intuitively distinguishable, or if ICWs are infrequently encountered. In these cases, the visual warning can provide specific information about the nature of the hazard [7]. Existing icon design guidelines provide a good reference for developing and testing icons that are intuitive, meaningful, and visually simple [2].

Using a visual display to provide redundant information about the temporal onset of the ICW (by making it attention-getting) is also beneficial because it may improve communication of the overall alert condition if there is high ambient noise (e.g., an external music source) or if the driver is hearing impaired [8]. An abrupt onset (rapid luminance change) is optimal for capturing attention, and this effect can be enhanced by flashing the visual warning at a frequency of 3 to 10 Hz, with 4 Hz being optimal [9].

Drivers typically have inherent color stereotypes for different levels of warning urgency [1]. The color red is usually associated with critical, high priority information (e.g., danger), and it is appropriate for use as part of a visual ICW (however, see Design Issue).

The ICW should be visually distinct from the CCW or any other nearby visual indicators with which it potentially could be confused. In one study, an ICW that was identical to the CCW (except that it flashed at 4 Hz while the CCW was static), was significantly less effective in alerting drivers to lead vehicle braking than just a single-stage ICW-only display (Reference 4). What qualifies as sufficiently different has not yet been fully determined. However, one study found that two-stage (ICW and CCW) visual warnings that differed in color, size, and form provided an effective level of warning as part of a HUD display configuration [5]. Based on expert judgment, using an ICW that is more visually conspicuous than the CCW or other indicators (e.g., larger size, flashing presentation, spatially separate, different color), should maximize the likelihood that it will be clearly distinguishable..

Cross References

How to Select the Number of Warning Stages, 2-2
When to Use Visual Warnings, 4-2
Determining the Appropriate Type of Visual Display, 4-4
Icon comprehension, 12-6
Urgency ratings, 12-7
Warning response time, 12-3
Interference with viewing of hazard or driving task, 12-4
Compatibility with primary warning modalities, 12-9

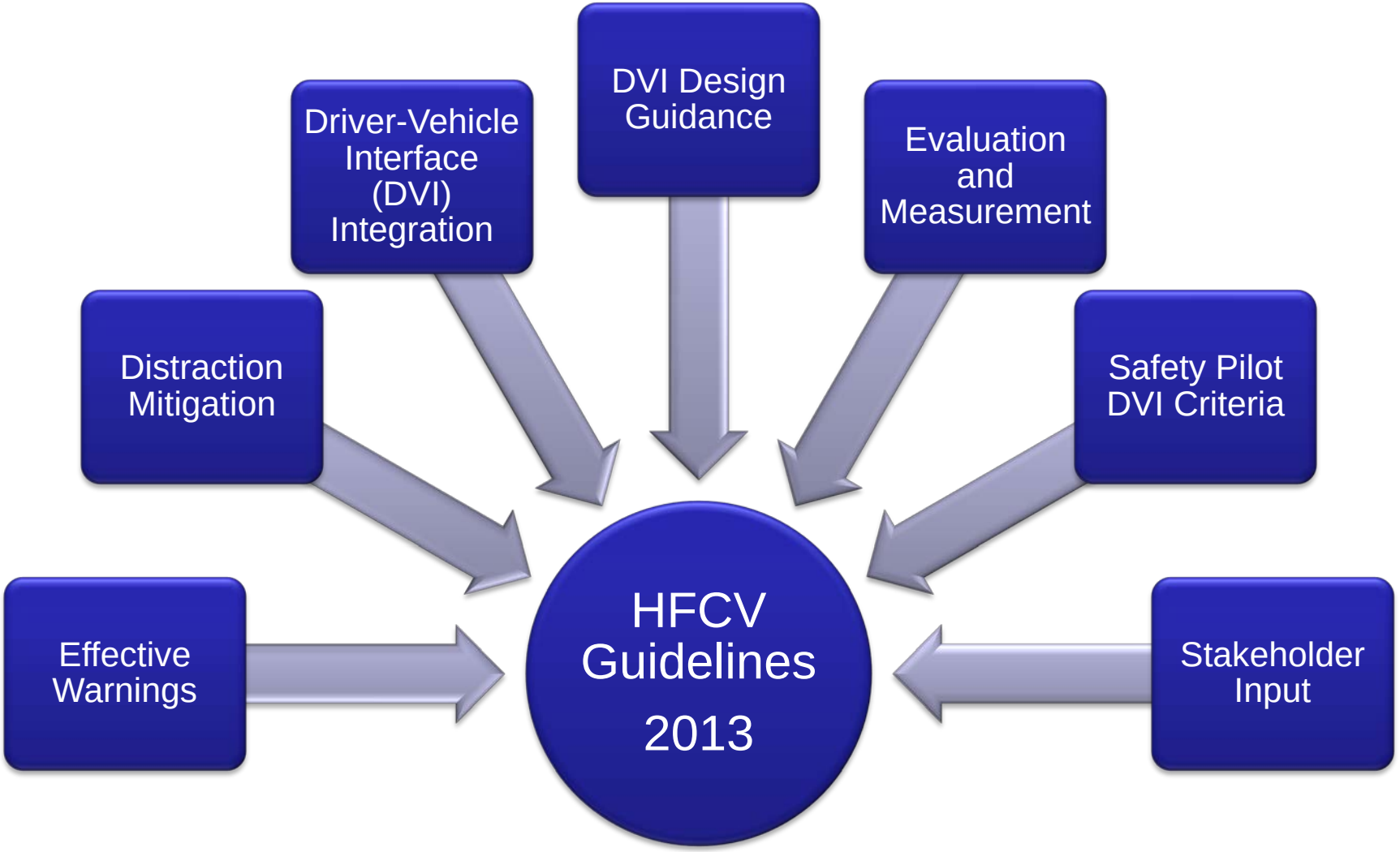
Additional Design Sources

International Organization for Standardization (ISO). (2005). *Road vehicles – Ergonomic aspects of in-vehicle presentation for transport information and control systems – Warning systems* (ISO/TR 16532). Geneva, Switzerland: International Organization of Standards.

Relevant Web Resource Title: www.relevantwebresource.com

Example Guidelines — Format 2 — Example Guidelines

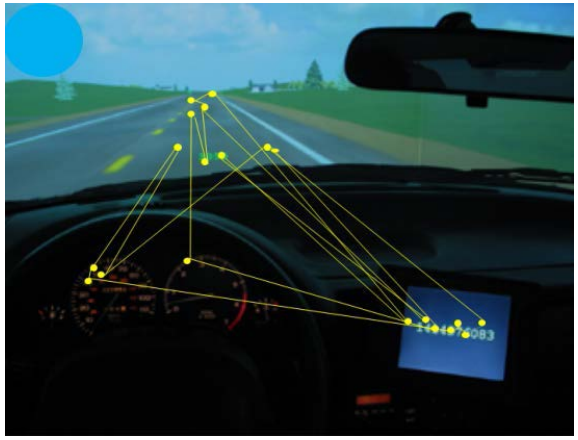
Generating the Guidelines



Phase 1 Accomplishments (2011)

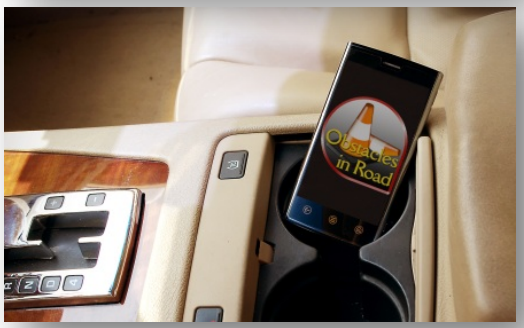
- Effective Warnings Research
  - Six (6) studies investigating a range of issues for warning design
  - Final Report being prepared for publication

- Distraction Mitigation Best Practices
  - Test procedures to assess distraction potential
  - Outcomes being harmonized with NHTSA Distraction Guidelines

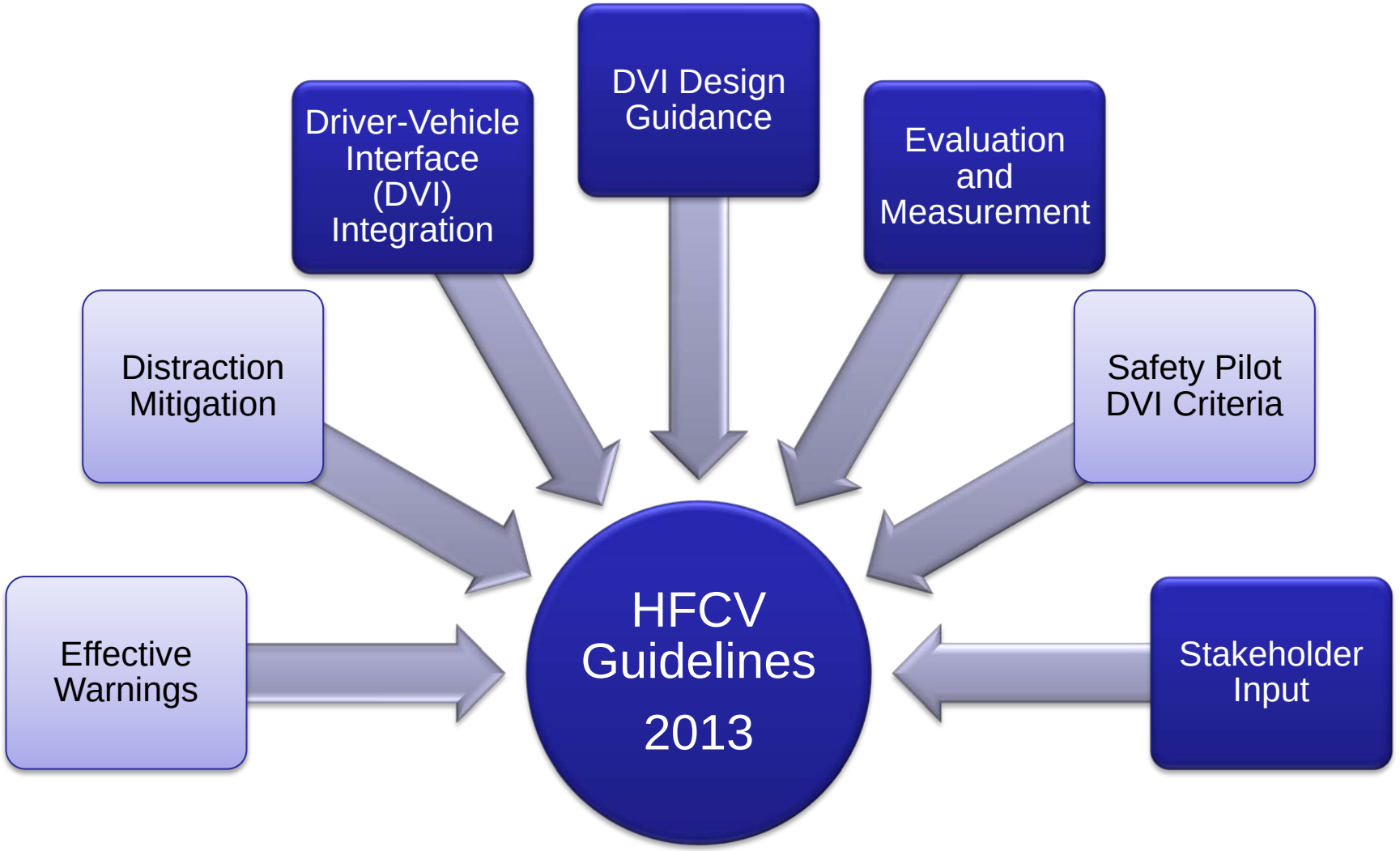


Phase 1 Accomplishments (2011)

- Integration Requirements
  - Initial test-track study examining potential integrated and portable display locations
  - Final Report being prepared for publication
- Safety Pilot DVI Design Criteria
  - Completed in March 2011

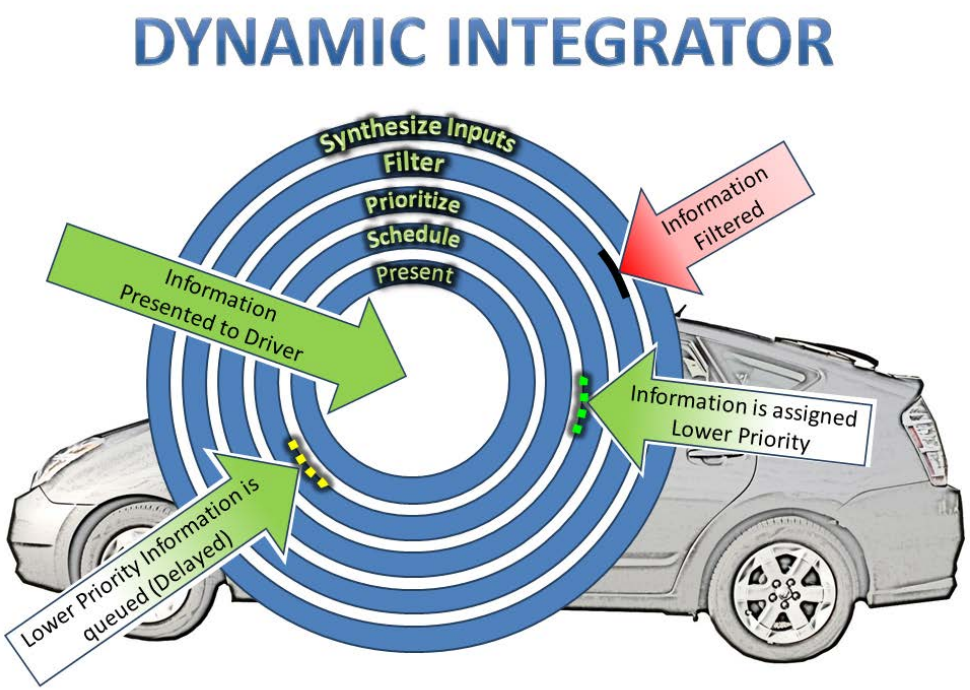


Generating the Guidelines



Phase 2 Accomplishments (ongoing)

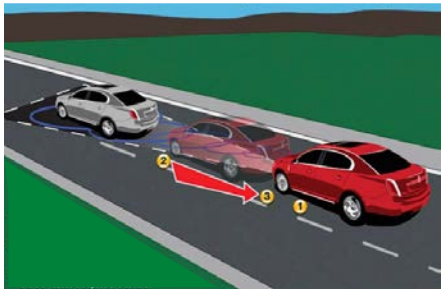
- Multi-DVI Integration Concept of Operations
- Integration Framework
  - Research to support layers
- DVI Guidance Research
  - Research focusing on CV-specific contexts
- **New Starts in 2012**
  - Portable Devices
  - Information from V2V and V2I Sources

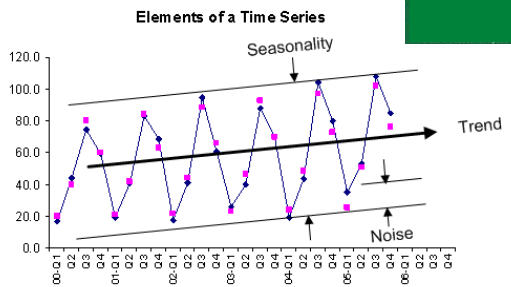


Additional HFCV Activities

- Predictive DVI Evaluation Software Tool
  - Software tool for designers to be able to estimate distraction potential or workload issues for their DVI and system configurations

- Longer-term Exposure Field Operational Experiment
  - Driver adaptation study
  - To be awarded this Fall





Upcoming Outreach Events

- Workshop at Automotive UI Conference in October

AutomotiveUI2012

- Outreach/Stakeholder Public Event planned for Fall 2012 in Washington, DC

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