Integrated Vehicle-Based Safety Systems (IVBSS): Crash Warning Integration Challenges

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Current AVST Interfaces

- **Driver assistance/warning systems are slowly coming to market for light vehicles**
  - **Lane departure warning**
  - **Forward collision warning/mitigation**
- **Generally these new systems are offered in isolation**
  - **Relatively “easy” to contend with one system**
  - **“Only one system, only one alert, only one response”**

Future AVST Interfaces

- **Interfaces, and warning strategies, vary widely**
  - **Use of visual, audio or haptic modalities**
  - **Warning only, warn and intervene**
- **What happens when multiple warning systems are on one vehicle?**
  - **Lane departure, lane change/merge, forward collision, curve speed, etc. warning systems**

The Integration Challenges

- **Choice reaction time task**
  - More than one stimulus alternative, more than one response alternative
- **How do you accurately convey the warning**
  - Where is attention needed, or possibly how to react
  - Will drivers respond appropriately to multiple rare events
- **How will warnings be arbitrated?**
  - When multiple threats exist, which warning is presented
  - Can warnings be effective in series

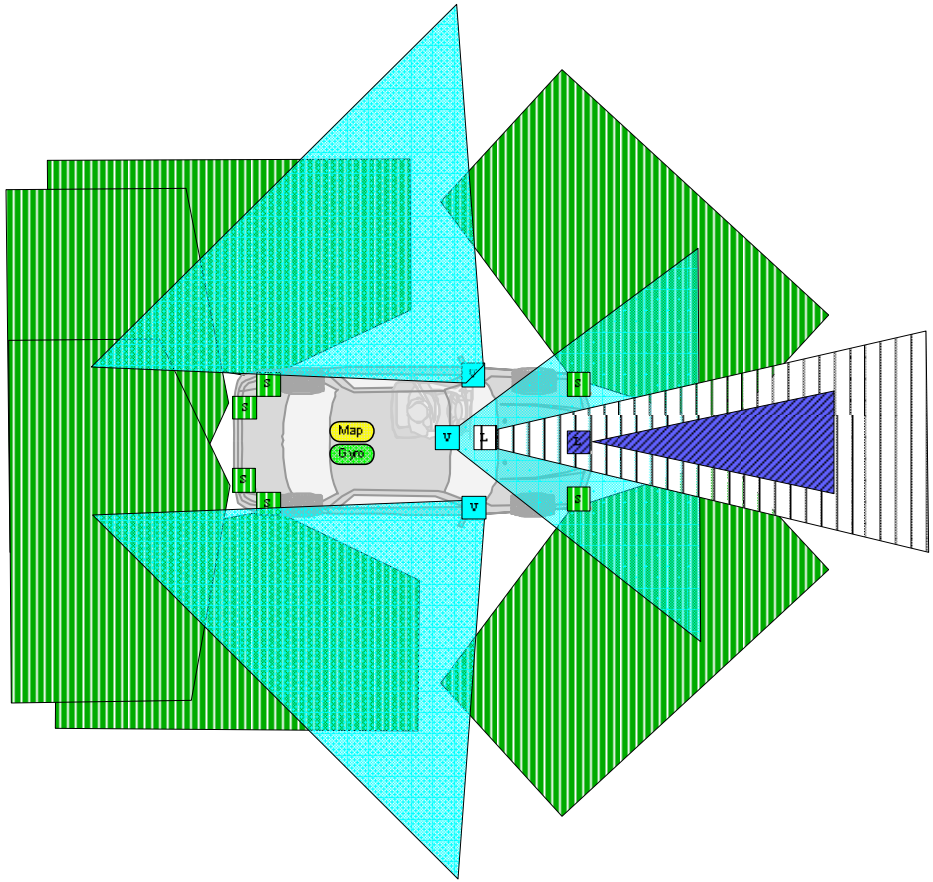
The Integration Challenges

- **Can adjustments be made to multiple systems?**
  - Sufficient space, driver understanding and recall
  - Do adaptive systems have to provide any adjustment
- **Can multi-staged warnings be used?**
  - Imminent only to reduced false/nuisance alarms
  - Two stage warnings to increase driver familiarity
- **What are the cumulative effects of warnings?**
  - Might the total number of warnings overwhelm drivers
  - Could one marginal system negate trust in other systems

Some Current Efforts

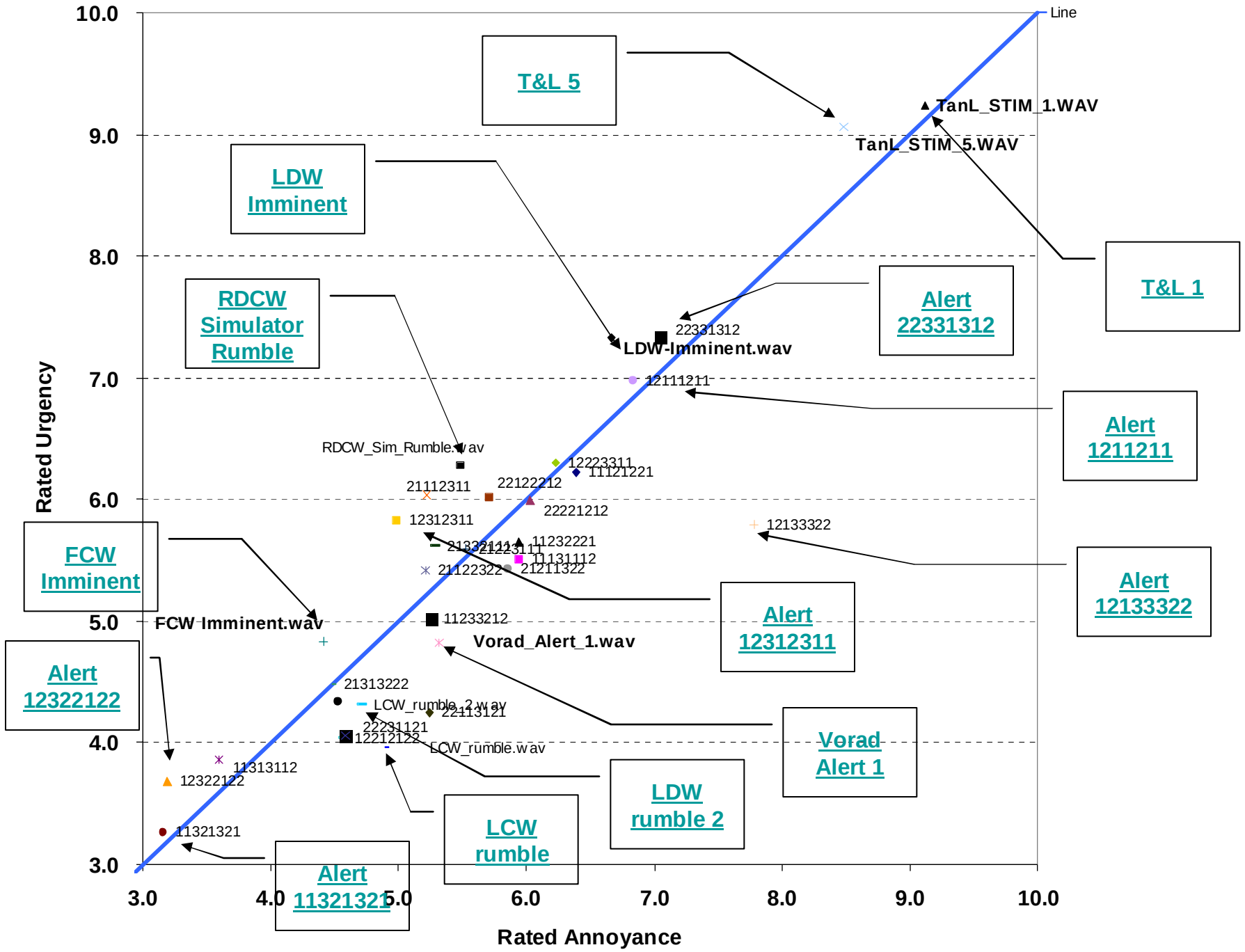
- **Limited guidance is available**
  - **Either basic and applied research**
  - **Battelle report**
- **Integrated Vehicle-Based Safety Systems Field Operational Test (IVBSS FOT)**
  - **Cooperative agreement between U.S. DOT and a team led by UMTRI**
  - **Integrate lane departure, lane change/merge, forward collision, curve speed warning**
  - **In both passenger cars and commercial trucks**

IVBSS Sensor Configuration



Some IVBSS Research Questions

- **When there are multiple threats should:**
  - **Only 1 warning be presented or,**
  - **Subsequent warnings presented with a delay**
- **Auditory warning characteristics:**
  - **Can warning localization convey threat type**
  - **Effects of repetitions and pauses in warnings**
  - **Urgency vs. annoyance trade-off**
  - **Recognition and reaction time to earcons vs. more abstract tones**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9.0
8.0
7.0
6.0
5.0
4.0
3.0
Rated Urgency
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Rated Annoyance
Line
T&L 5
TanL_STIM_1.WAV
TanL_STIM_5.WAV
LDW Imminent
RDCW Simulator Rumble
Alert 22331312
T&L 1
22331312
LDW-Imminent.wav
12111211
Alert 1211211
RDCW_Sim_Rumble.wav
12223311
11121221
21112311
22122212
22221212
12312311
12133322
FCW Imminent
11232221
11131112
21122322
21211322
Alert 12133322
FCW Imminent.wav
11233212
Alert 12312311
Vorad_Alert_1.wav
Alert 12322122
21313222
LCW_rumble_2.wav
22113121
22231121
12212122
LCW_rumble.wav
11313112
12322122
Vorad Alert 1
LDW rumble 2
11321321
LCW rumble
Alert 11321321

Earcons vs. Abstract Tones

- **Lane departure examples:**
  - **earcon**  **abstract** 
- **As a group, earcons:**
  - **Took less time to learn,**
  - **Had the fewest number of errors,**
  - **Had the shortest reaction times**

Simulator Testing

- **Examine responses to multiple warnings**
  - **Warning confusability**
  - **Varied timing between warnings**
- **General strategy of grouping warnings**
  - **Warnings associated with longitudinal control**
    - **Forward crash warning, curve speed warning**
    - **Decrease your speed**
  - **Warnings associated with lateral control**
    - **Lateral drift warning, lane change/merge**
    - **Remain in your lane**

Overall

- Integrated warning systems interfaces pose a significant challenge
- There very little research in this area
- Training will become increasingly important
  - Example anti-lock braking systems
- Common approaches across the industry will become increasingly important
- Shift toward crash mitigation over warning systems will help

Questions?

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