

ASAM OpenX Standards for Offroad Applications

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Agenda

- Motivation for the Activity
- Operating in the Offroad Environment
 - Challenges
 - Existing standards
- ASAM Offroad Applications Proposal



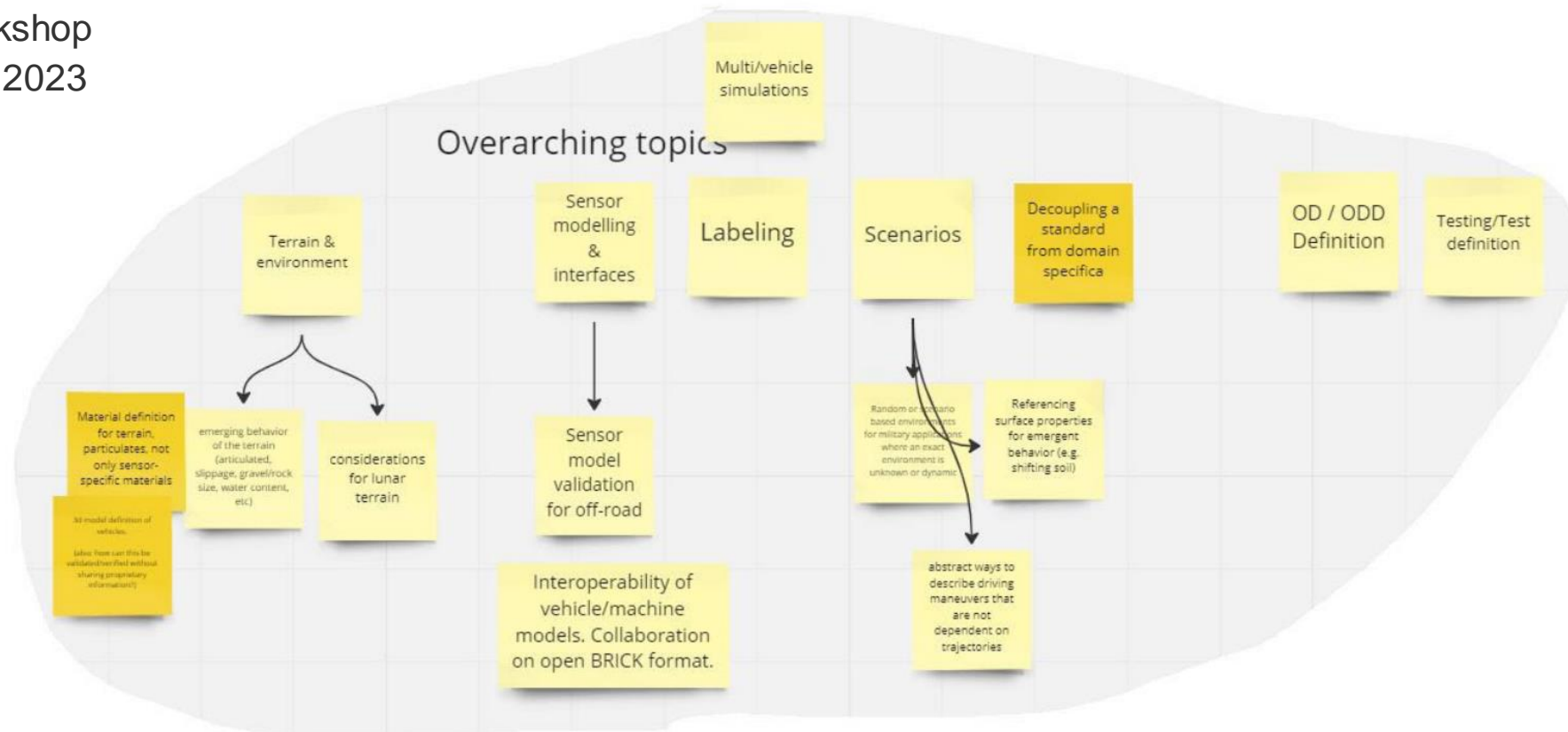
Motivation for the Activity

Offroad Applications	Workshop Poll
• Landfill	- 3%
• Construction	- 17%
• Agriculture	- 34%
• Mining	- 20%
• Military	- 6%
• Recreational	- 6%
• Other	- 10%
• Forestry	
• Space	
• Warehouses	
• Harbors	
• Maritime	



Offroad Applications Ideation Group

- ASAM OpenX standards for offroad applications
- Ideation Workshop
- February 23, 2023



Offroad Challenges

Workshop

Poll

- 1 • Complex 3D terrain
- 4 • Representation of the subsurface
 - Soil strength, density, temperature, water content
 - Effects on mobility
- 2 • Sensor modeling and surface materials (including link between appearance and physical characteristics)
 - Vehicle-terrain interaction and material dynamics
 - Mud and water spray
 - Mud and snow deformation
- 4 • Accumulation of material on vehicles
- 3 • Object representation
 - Vegetation and other natural obstacles
 - Meshes, materials, physics
- 4 • Weather conditions
- 5 • Occlusion of sensors
 - Mud, snow, dirt in the air and on camera lens

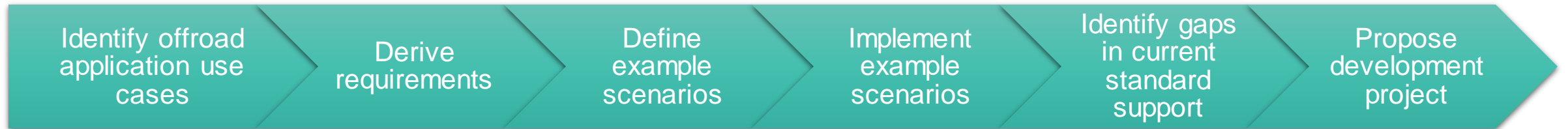


Proposed Approach

Exercise the Standards

Offroad Applications Concept Project

Hypothesis: Current standards do not adequately support requirements for offroad applications



Operations and Activities

Categorizing activities

Vehicle Movement



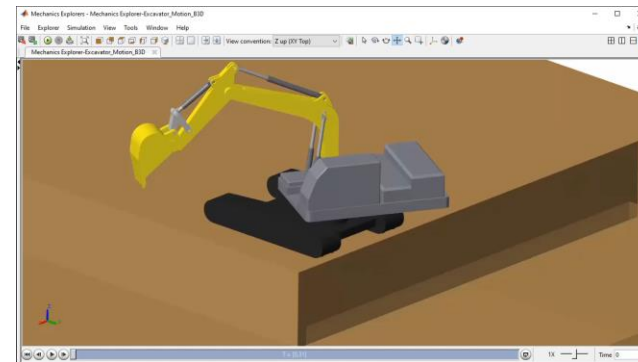
Go around?



Drive over?

- Navigation
- Vehicle-terrain interaction
- Interaction with objects

Manipulating the Environment



Excavating a pit



Manipulating material



Loading a vehicle

Use Cases Driven by Personas

- What kind of simulations do users want to build for offroad applications?



Vehicle Developer

- Develop and test mechanical, electrical, hydraulic, and electro-mechanical systems for offroad scenarios
- Build physics-based vehicle models to test vehicle behavior in 3D simulations



Autonomy Developer

- Create algorithms, software and supporting documentation for perception, planning and control of the vehicles and their support tools
- Collect sensor and mobility data for training AI/ML models
- Work with control engineers to investigate, test, and select software toolsets or hardware components and peripherals



Test Engineer

- Develop and evaluate detailed offroad test scenarios for both component and system level testing and validation.



System Integration Engineer

- Create scenarios to help understand the requirements for systems.
- Create schematic representations of mechanical, electrical, hydraulic, and electro-mechanical systems
- Work with other disciplines to create the specifications that outline the control system logic necessary for haul truck functions



Site Manager

- Manage and assess the application of vehicle systems on-site.
- Work with the environment, health, and safety teams and security teams to conduct regular risk assessments
- Maintain a risk register and develop and implement risk mitigation plans

Technical Requirements Driven by Use Cases



Vehicle Developer

- Represent vehicle components relevant to VTI/mobility
- Represent driveline/powertrain for the vehicle
- Modelling of heavy machinery on soft terrain (deep tracks)
- Represent vehicle loads including specification of type and volume of material being transported and estimating effects caused by the load including stability, traction, deformation of road surfaces, and maneuverability
- Evaluate or optimize efficiency of vehicle systems in the operating environment



Autonomy Developer

- Model vehicle perception and mobility and dynamics as it traverses an offroad environment
- Model GPS sensor data accounting for effects of vehicle movement, terrain, and vegetation including loss of signal, multipath, etc.
- Model common sensors (e.g., LiDAR, EO camera, IR, radar, GPR, etc.) accounting for effects of vehicle movement, terrain, and vegetation including occlusion, material attribution, etc.



Test Engineer

- Evaluate or optimize efficiency of vehicle systems in the operating environment
- Represent effects of adverse conditions (dust, standing water, mud, etc.) on terrain properties and on sensors (e.g., occlusions from dust clouds, water spray, water or mud on lenses, etc.)
- Estimate effects of vegetation on sensors and vehicle mobility
- Extract sensing and mobility data for learning how to traverse terrain



System Integration Engineer

- Generate prior information to the autonomy stack (e.g., simulate extraction of maps, etc. from previous drives, UAS, or other sources)
- Represent vehicle loads including specification of type and volume of material being transported and estimating effects caused by the load including stability, traction, deformation of road surfaces, and maneuverability
- Share and reuse off-road scenarios in a common format for shared understanding



Site Manager

- Incorporate fuel depot/charging stations (capacity, charge/refuel rate)
- Collecting performance data for benchmarking systems

Scenarios

Moving from Point A to Point B

1. Following a Path
2. Finding a Path
3. Carrying a Load
4. Using Sensors to Respond to the Environment
5. Navigating without GPS

1
2
3
2
5

Vehicle Interaction

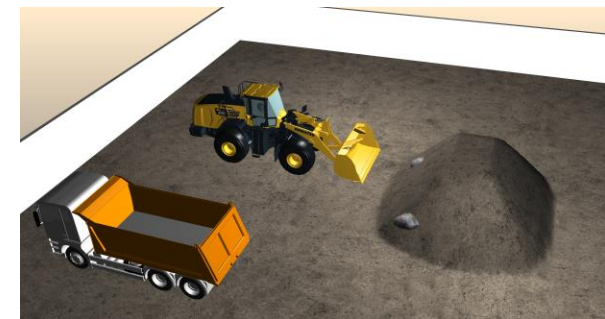
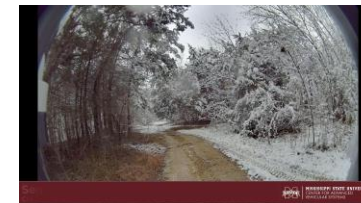
6. Following a Lead Vehicle
7. Dealing with Environmental Effects
8. Interacting with Traffic
9. Incorporating Drones / Ground-Air Vehicle Teaming

4
6
6
5

Load and Haul

10. Loading a Hauler - Hauler
11. Loading a Hauler – Excavator
12. Evaluating fuel efficiency

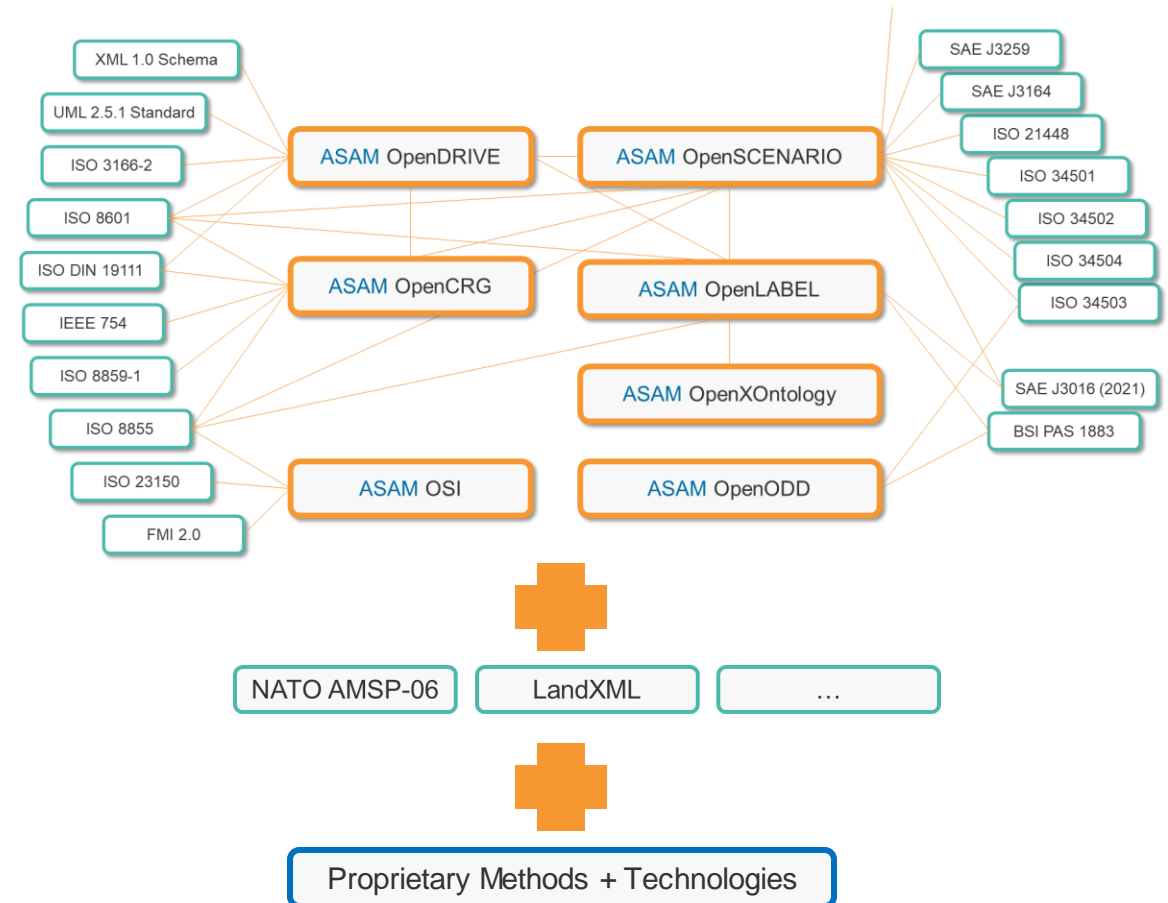
6
7
8



R. Luck, 2011. [Caterpillar haul truck, Luminant Energy Kossé Ignite mine][Photograph]
<https://www.flickr.com/photos/rvnluck/5556726421/>, CC-BY-SA

Standards

- ASAM OpenX Simulation Standards
 - OpenCRG
 - OpenDRIVE
 - OpenSCENARIO
 - OSI
 - OpenODD
 - OpenLABEL
 - OpenMATERIAL
 - OpenTEST
- External related standards - Terrain, drivable area, and materials
 - Landxml 1.2 (infra model 4.0.4)
 - ISO 15143-4
 - ISO 7334
 - EMESRT PR5A
 - ISO 21815
 - ISO 6165
 - NATO AMSP-06
- Proprietary solutions
 - e.g., Algoryx agxTerrain implementation



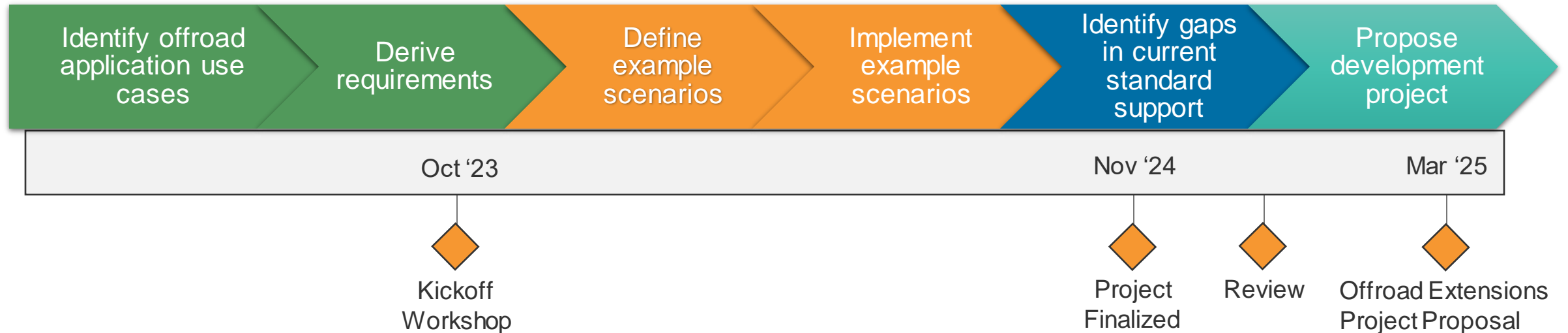
Concept Project Deliverables

- Example scenario implementation and documentation.
 - Documentation of requirements driven by offroad application
 - Evaluation of current ability to meet requirements with current standards
 - Able to meet requirement with current standard
 - Unable to meet requirement with current standards
 - Unable to demonstrate proprietary capability
 - When met, document the standard, method, and grade level of support
 - When not met, identify potential standard that could support, possible definition for that support
 - Estimate overall level of support for offroad applications
- Create a concept document for extensions and/or standards for supporting offroad applications.
- Offroad extension project proposal.

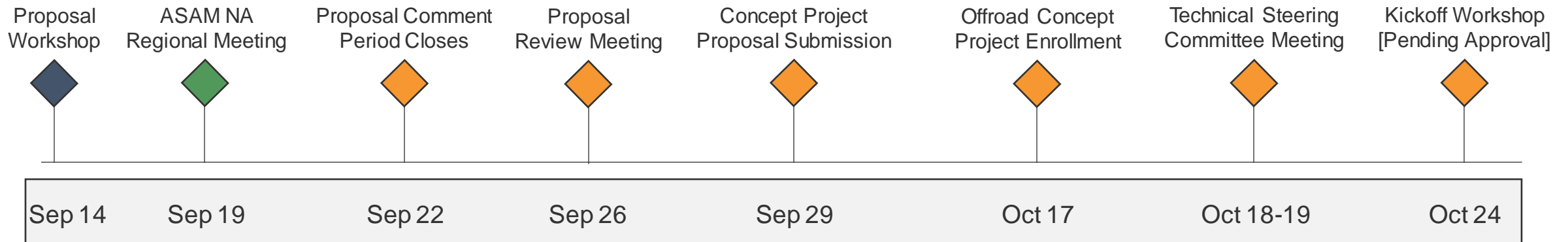
Offroad Applications Concept Project

Timeline

- Pending Approval of the Project



Concept Project Proposal Timeline



Next Steps:

The ASAM Offroad Concept Discussion has concluded following the proposal workshop and will be replaced with the new Concept Project **ASAM OpenX standards in Offroad Applications** upon approval by the Technical Steering Committee next month. This will be followed by the Kick-off workshop which will be announced at a later date.

*Draft proposal document is now available.
To join the ideation group and/or access the
proposal document please contact:*

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Call for Participation

- Currently enrolling participants for the concept project
 - Enrollment open soon on the ASAM website
 - Open through Oct 17
- *Who should participate?*
 - Interest in offroad ground vehicle application areas
 - Expertise in application domains
 - Expertise across OpenX standards and other related standards
 - Developers and users of M&S tools
 - Ground vehicle developers

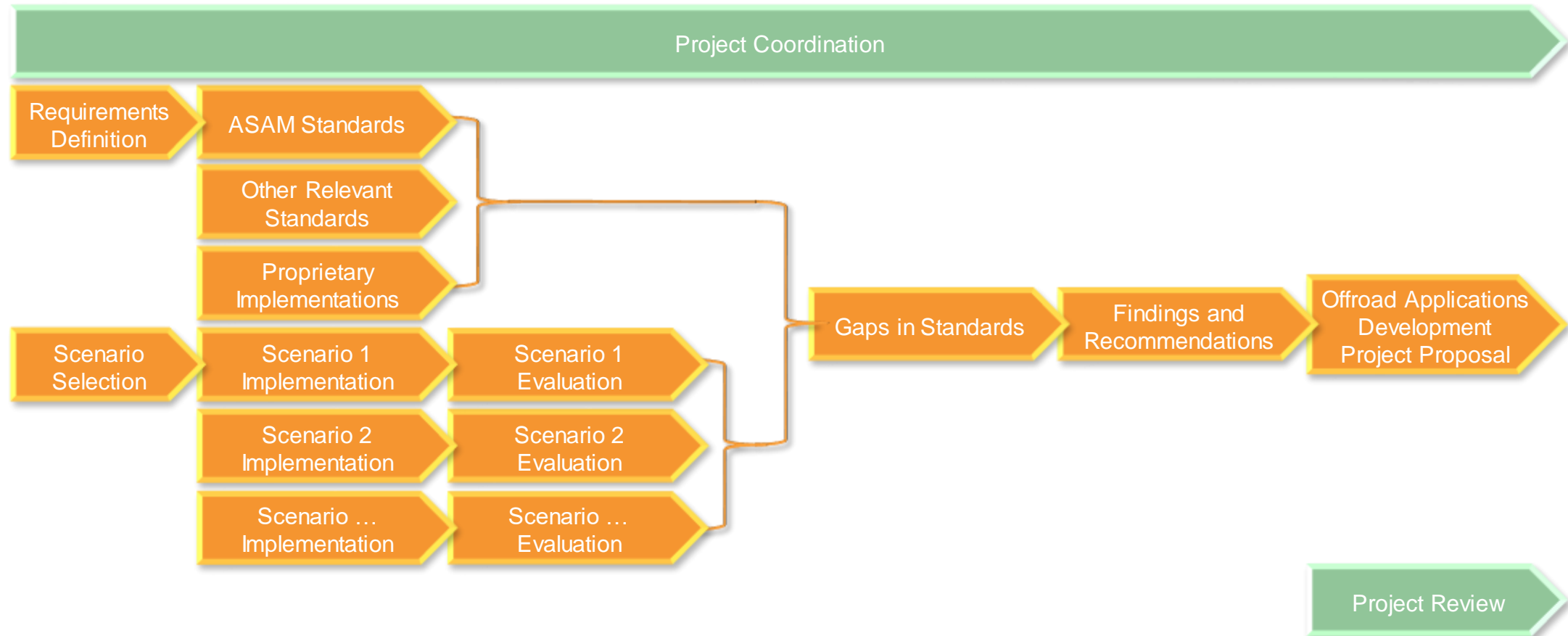
To join, contact:

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Project Activities



Offroad Applications Concept Project

Proposed Approach – Exercise the Standards

Hypothesis: Current standards do not adequately support requirements for offroad applications

