



# Strategies for Addressing Uncertain Missions and Uncertain Technologies

*ART-005*

**Sponsor: OUSD(R&E)**

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- Phenomena, Uncertainties & Strategies
  - Automotive vs. Defense Domains
  - Strategy Framework
  - Automotive vs. Defense Uncertainties
  - Strategies vs. Uncertainties
- Overall Approach
  - Underlying Model Structure
  - Representations Employed
  - ***Uncertainty Management Advisor***
- Autonomous Vehicle Case Study
  - Market Needs vs. Enabling Technologies
  - OEM Investors' Attributes of Interest
  - Alternative Investment Scenarios
  - Expected Utilities of Scenarios
  - Overall Investment Strategy



# Phenomena, Uncertainties & Strategies

- Automotive vs. Defense Domains
- Strategy Framework
- Automotive vs. Defense Uncertainties
- Strategies vs. Uncertainties

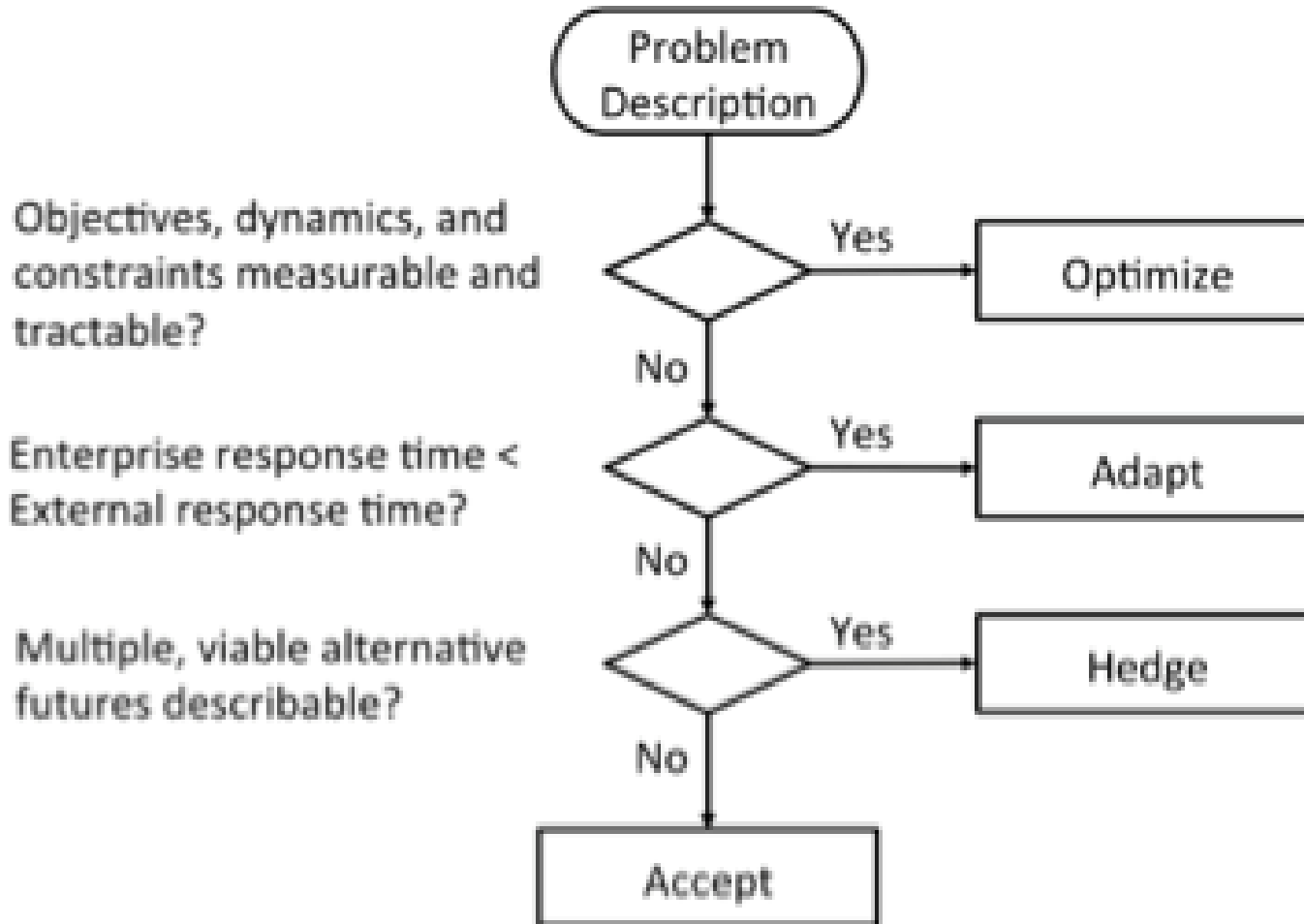


# Automotive vs. Defense Domains

<b>Automotive Domain</b>	<b>Defense Domain</b>
<b>Economy</b>	<b>Geopolitics</b>
- Geopolitics (e.g., Regulations, Tariffs, War)	- Military Conflict (i.e., Hot War)
- GDP & Inflation (e.g., Recession)	- Geopolitical Tension (e.g., Grey Zone Conflicts)
- Financial Markets (e.g., Interest Rates)	- Civil Wars (e.g., Migration)
- Energy Markets (e.g., Fuel Prices)	- Soft Power (e.g., Alliances)
<b>Market</b>	<b>Economics</b>
- Market Growth/Decline (e.g., Consumers)	- GDP Growth/Decline
- Segment Market Saturation (e.g., Sedans)	- Inflation/Deflation
- External Competitors (Companies)	- Domestic & Allies' Defense Budgets
- Internal Competitors (Brands)	- Congressional Priorities (e.g., Jobs)
<b>Company Priorities</b>	<b>Defense Priorities</b>
- Market Strategy (e.g., Positioning, Pricing)	- Engagement Strategies
- Product Management (e.g., Processes)	- Missions Envisioned
- Dealer Management (e.g., Incentives)	- Adversary Capabilities
- Financial Management (e.g., Investments)	- Capabilities Required
- Brand Management (e.g., Rebadging)	- Emerging Technologies
<b>Vehicle</b>	<b>Platform</b>
- Price	- Performance
- Design	- Schedule
- Quality	- Cost



# Strategy Framework





# Automotive vs. Defense Uncertainties

Automotive Domain Uncertainties	Defense Domain Uncertainties
Customer future preferences	Mission plans will remain relevant
Customers future purchases will favor our offerings vs. competitors	Mission platforms will remain superior to adversaries' capabilities
Performance of our offerings after development	Performance of mission platforms after development
Affordability over the coming years	Affordability over the coming years
Budgets for our offerings across a range of future needs	Budgets for mission platforms across a range of future needs
Supply chains will be economical, efficient and secure	Supply chains will be economical, efficient and secure
Competitors' capabilities will not be perceived to be superior	Adversaries' capabilities will be inferior, and certainly not superior
Our enterprise will continue to support our endeavors	Ensuring that sponsors, e.g., Congress, will continue to provide support



# Strategies vs. Uncertainties

<b>Requirements Uncertainty</b>	<b>Definitely Required</b>	<b>Hedge Via Partnership</b>	<b>Hedge Via Larger R&amp;D Investment</b>	<b>Optimize Technology Capability</b>
	<b>Possibly Required</b>	<b>Hedge Via Partnership</b>	<b>Hedge Via Smaller R&amp;D Investment</b>	<b>Adapt If Requirement Emerges</b>
	<b>Not Required</b>	<b>Accept Current Situation</b>	<b>Accept Current Situation</b>	<b>License Patents To Others</b>
		<b>Not Feasible</b>	<b>Possibly Feasible</b>	<b>Fully Feasible</b>
		<b>Technology Uncertainty</b>		



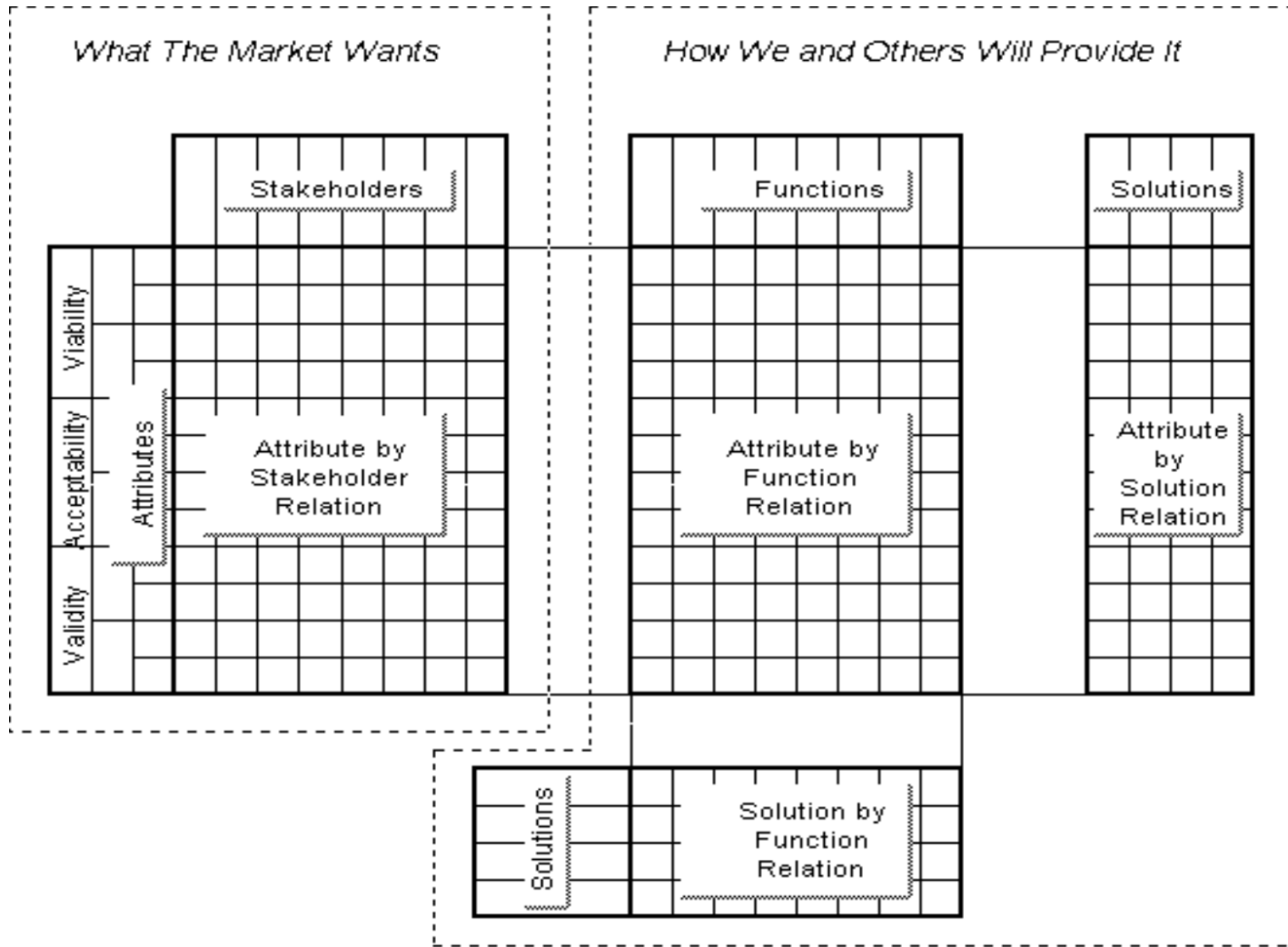
# Overall Approach

- Underlying Model Structure
- Representations Employed
- ***Uncertainty Management Advisor***





# Underlying Model Structure



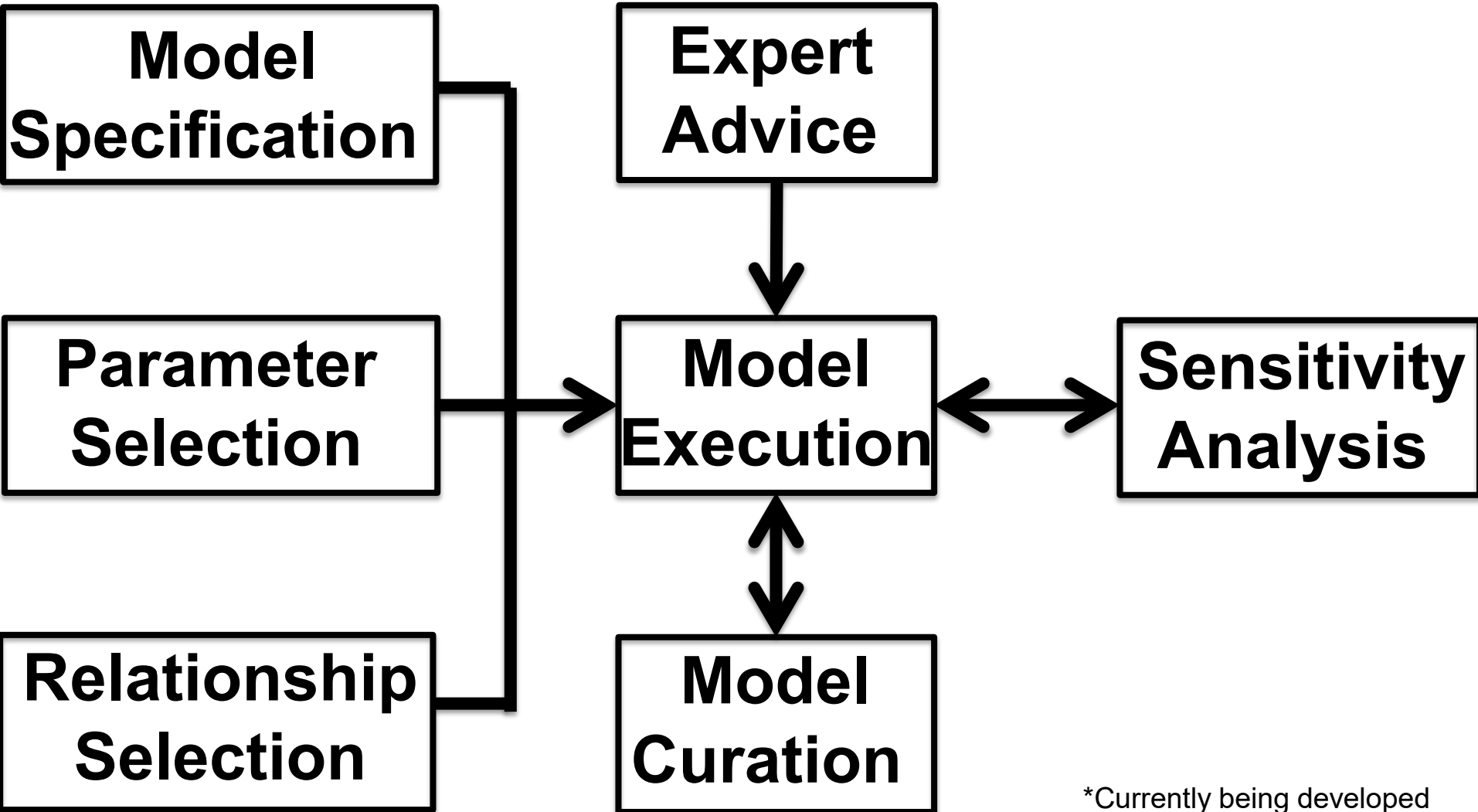


# Representations Employed

- Set-Based Design (Sobek, Ward & Liker, 1999)
- Quality Function Deployment (Hauser & Clausing, 1988)
- Design Structure Matrices (Eppinger & Browning, 2012)
- Multi-Stakeholder, Multi-Attribute Utility Theory (Keeney & Raiffa, 1993)



# ***Uncertainty Management Advisor\****



\*Currently being developed



# Autonomous Vehicle Case Study

- Market Needs vs. Enabling Technologies
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# Market Needs vs. Enabling Technologies

Needs	Technologies				
	Hardware	Software	Sensors	Networks	HMI
Displays & Controls	Hardware for Displays & Controls	Tutoring System for HMI Use	Use and Misuse of Displays & Controls	Access to Device Failure Information	Auditory, Braille, Haptic, Tactile & Visual Displays
Locating & Identifying Vehicle	Vehicle-Mounted Sensors	Recognition Software	Integration of Sensed Information	Sensors of External Networks	Portrayal of Vehicle & Location
Passenger Profiles, Privacy	Phone or Smart Phones, Tablets	App to Securely Provide Profile Information	Recognition of Passenger	Access to Baseline Info. on Disabilities	Portrayal to Assure Recognition
Emergencies	Controls to Stop Vehicle & Move to Safe Space	Recognition & Prediction of Situation	Surrounding Vehicles, People & Built Environ.	External Services -- Police, Fire, Health	Portrayal of Vehicle Situation
Adaptation to Passengers	Adjusting Entry, Egress, Seating	Learning Passenger Preferences	Sensing Reactions to Adaptations	Access to Baseline Info. on Adaptations	Portrayal to Enable Change Confirmations
Easy & Safe Entry & Egress	Sufficient Space to Maneuver	Capturing Data on Space Conflicts	Surrounding Vehicles, People & Built Environ.	Networked Access to, e.g., Bldg. Directions	Portrayal of Surrounding Objects
Trip Monitoring & Progress	Speedometer, GPS, Maps	Predictions of Progress, Points of Interest	Surrounding Vehicles, People & Built Environ.	Access to Traffic Information, e.g., Accidents	Portrayal of Trip & Progress
Onboard Safety	Securement of Wheelchairs & Occupants	Capturing Data on Securement Conflicts	Sensing & Recording Safety Risks	Access to Best Practices on Safety Risks	Portrayal of Securement Status



## Investors' Attributes of Interest

- **Competitive Advantage (CA):** To what extent will the investment of interest enable value-added pricing, reduce production costs, reduce operating costs, and leverage existing capacities?
- **Strategic Fit (SF):** To what extent will the investment of interest leverage technology competencies, exploit current delivery architectures, complement existing value propositions, exploit current partnerships and infrastructure, and provide other opportunities for exploitation?
- **Return on Investment (ROI):** What capital expenditures, technology acquisition costs, and labor expenses will be needed? What revenue and profits will likely result?

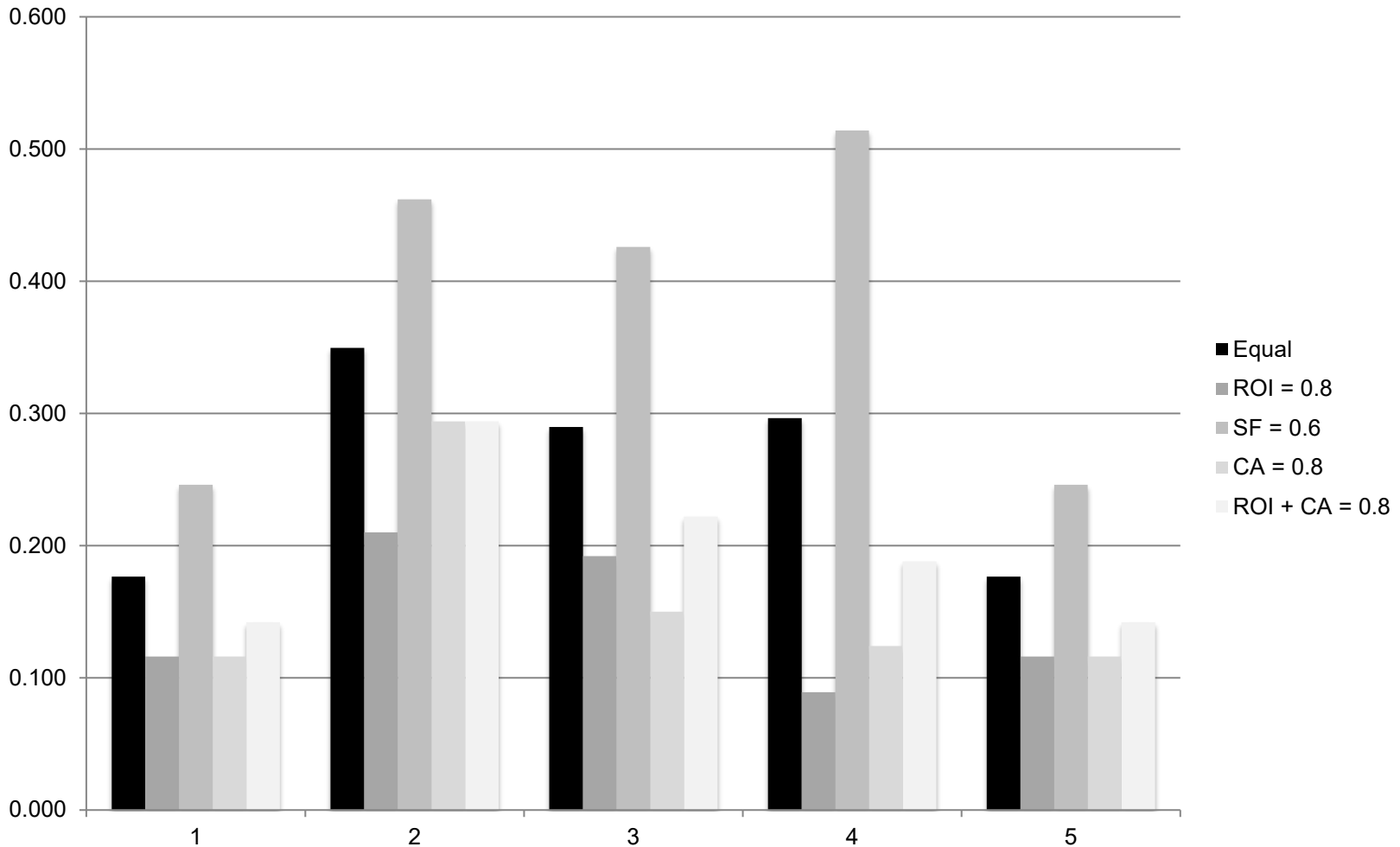


# Alternative Investment Scenarios

Scenario	Examples	Uncertainties	Confidence in Requirements	Ability to Respond
Provide total vehicle package	OEM itself or acquisition of autonomous vehicle player	Can OEM really compete against the tech companies?	Hardware is high; software has some unknowns	Strength in integration; easier when OEM controls
Provide vehicle platform to host intelligent software	Alliance with Amazon, Apple, Google, Microsoft or Uber	Why will intelligent platform players source OEM's vehicles?	Basic vehicle platform design is known, but can OEM do this at lowest cost?	Time to integrate software, which will evolve faster than hardware
Provide vehicle platform to host user-centered HMI	Alliance with advocacy groups for disabled & older adults	Why will user-centered HMI players source OEM's vehicles?	How will HMI requirements impact vehicle design?	Time to integrate software, which will evolve faster than hardware
Provide vehicle platform without alliance	OEM will manufacture desired platforms	Why will major players source OEM's vehicles?	Basic vehicle platform design is known; can OEM do this at the lowest cost?	Time to integrate software; design in modularity
Provide integrated mobility services	OEM will provide total mobility experiences	Can OEM competitively manage an end-to-end service?	Auto OEMs do not really understand business model, but does anyone?	Longer time to build out entire ecosystem



# Expected Utilities of Scenarios







# Overall Investment Strategy

- Substantial investment in Scenario 2 – a hedge against market and technology risks
- Moderate investment in Scenario 3 – a hedge against Scenario 2 not resulting in a partner
- Baseline investment in Scenario 4 – acceptance of a traditional role in the automotive marketplace



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