



# Need of AI in intelligent machines

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**FIMA**  
Forum for  
Intelligent  
Machines

# High end machines in automation and unmanned operations



Unmanned  
container  
handling



Autonomous ore  
transportation  
in mines

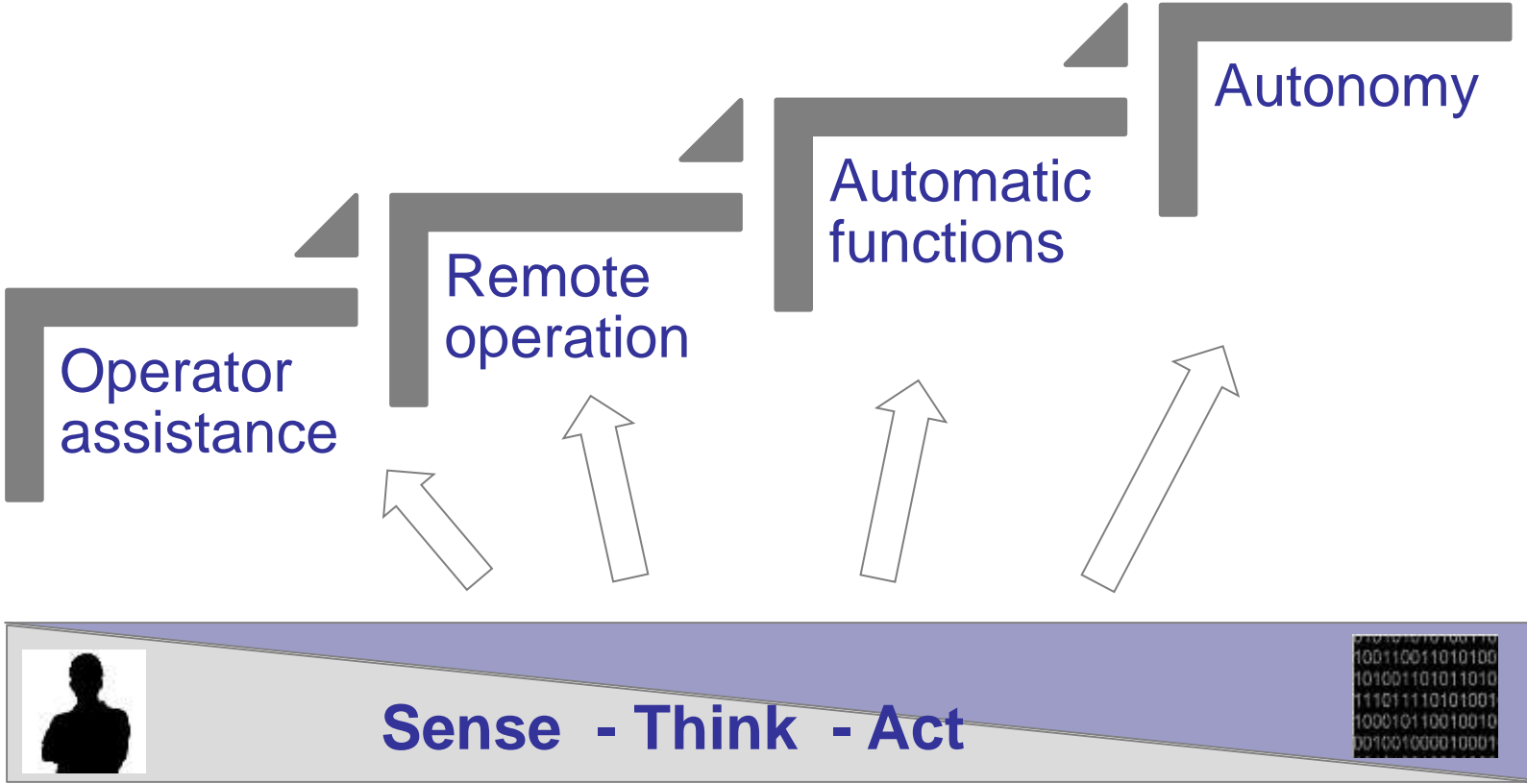


Forest  
machine  
automation



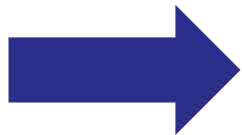
Advanced  
machine  
controllers

# Need for AI in intelligent work machine



## AI helps intelligent machines in

- abstract work task definitions
- decision making
- exception handling
- learning new skills
- utilizing sensor and control data (big data)
- predictive actions
- imitation from human behaviour
- co-operation with human workers and other machines



Human kind thinking

Computing power



# Examples of "next step" machine intelligence



Picking up logs from a undefined ground



Piling unbalanced pallets and loads



Moving boom tip to the target in all circumstances



Terrain and ground surface detection and characteristics

# Challenges in mobile work machine autonomy

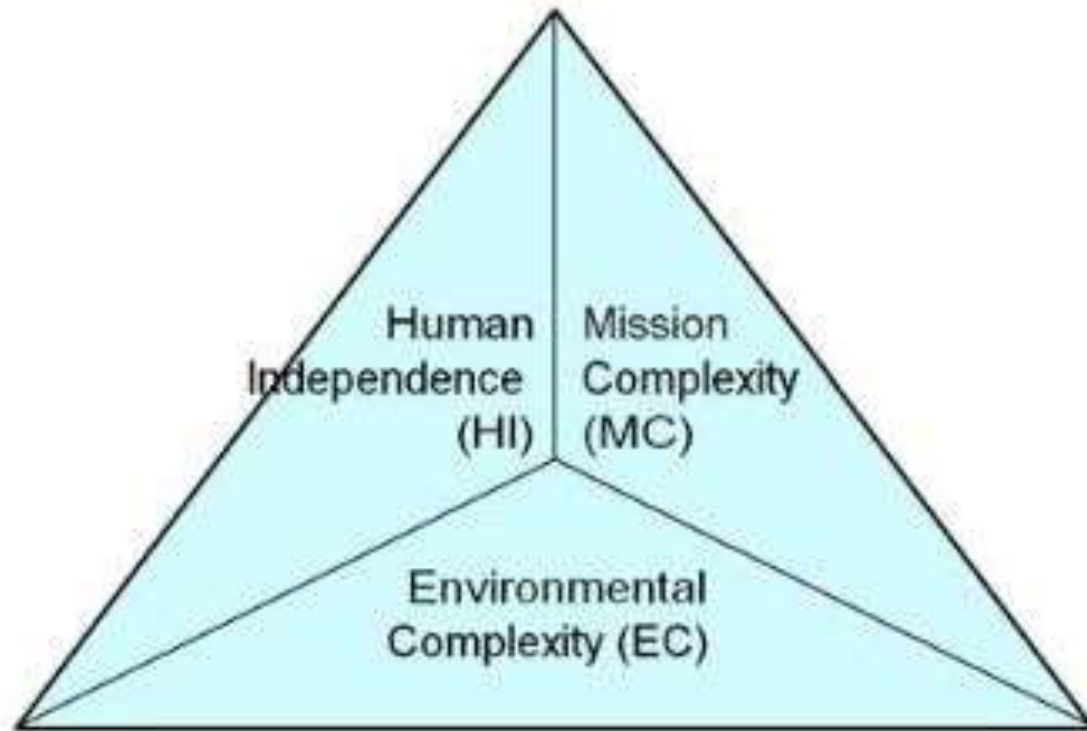
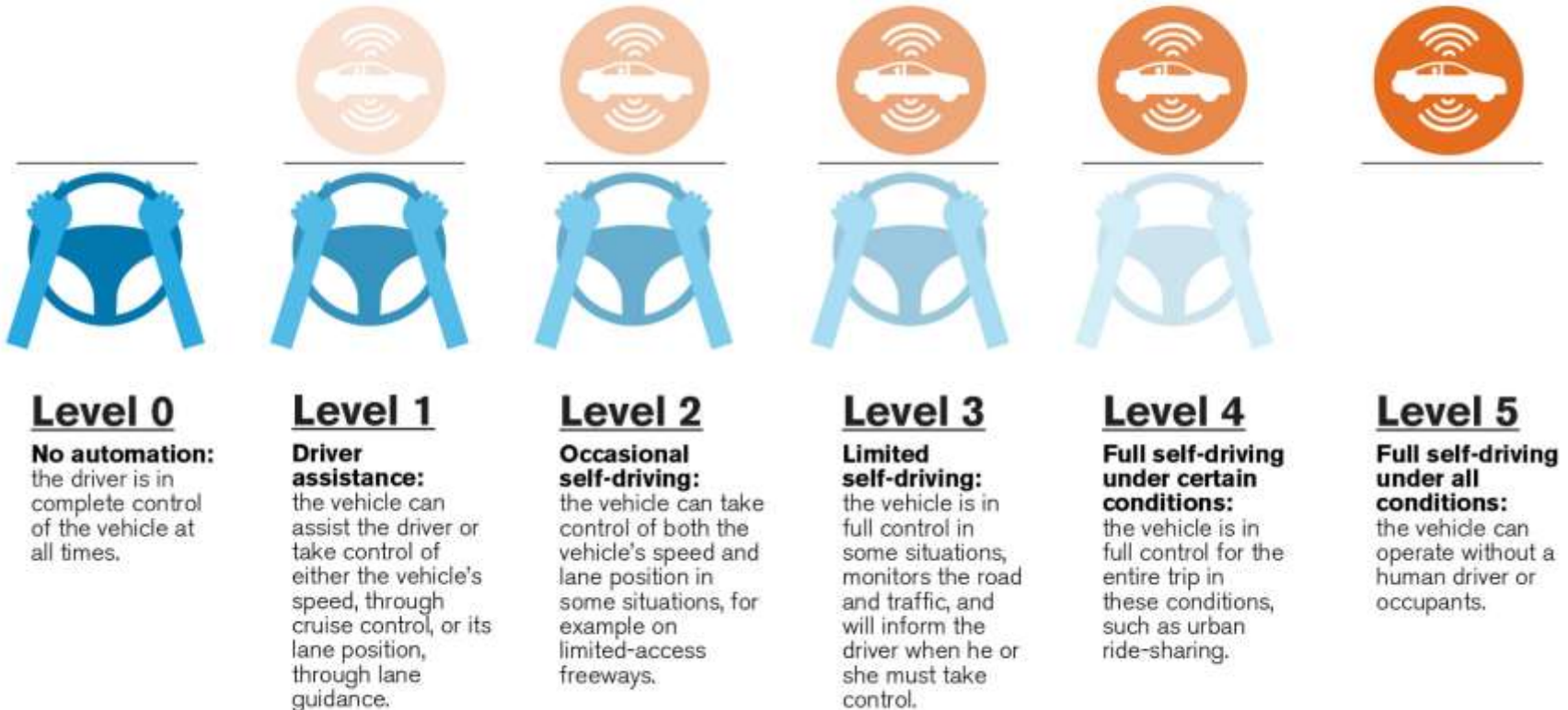


Figure 1: The Three Aspects for ALFUS

# Five Levels of Vehicle Autonomy



Source: SAE & NHTSA

# Challenges in mobile work machine autonomy

## Functional Migration (5 levels)



**Autonomy (noun):** A condition free of external control or influence, an unmanned system's capability to perform in a self-determined, independent manner consistent with its capabilities and limitations.



	Sensing		Perception		Analyzing		Acting	Commun- -icating
	Level 0 Fusion	Level 1&2 Fusion	Level 3 Fusion	Planning	Decision-making	Acting		
<p><b>Level 5 (Autonomous)</b> The operational case with an unmanned system afforded the maximum degree of independence and self-determination within the context of the system's capabilities and limitations; the case of minimum human influence over unmanned performance; an unmanned system performing out of the direct observation of the human controller; requiring the unmanned system to sense its environment and report its state to the human; all perceiving and acting are done by the machine, most analyzing, planning and decision-making are conducted by the unmanned system; negotiation and collaboration may be performed by the human.</p>	All UMS	All UMS	Most UMS	Most UMS	Most UMS	All UMS	Most UMS	
<p><b>+5</b></p> <p><b>Level 4 (Human Aided)</b> The operational case with an unmanned system performing out of the direct observation of the human controller requiring the unmanned system to sense its environment and report its state to the human; analyzing, planning, and decision-making are shared between the human and the machine; most perceiving and acting is done by the unmanned system.</p>	All UMS	Most UMS	Shared	Shared	Shared	Most UMS	Most UMS	
<p><b>+6</b></p> <p><b>Level 3 (Human Directed)</b> The operational case with an unmanned system performing out of the direct observation of the human controller requiring the unmanned system to sense its environment and report its state to the human; most analyzing, planning, and decision-making are done by the human; perceiving and acting are shared between the human and the unmanned system.</p>	Most UMS	Shared	Most man	Most man	Most man	Shared	Most UMS	
<p><b>+6</b></p> <p><b>Level 2 (Tele-operation)</b> The operational case with an unmanned system performing out of the direct observation of the human controller requiring the unmanned system to sense its environment and report its state to the human; all analyzing, planning and decision-making are done by the human; most perceiving is done by the human; human directs all unmanned system actions from the machine's frame of reference.</p>	Shared	Most man	All man	All man	All man	Most man	Most UMS	
<p><b>+5</b></p> <p><b>Level 1 (Remote Control)</b> The operational case with an unmanned system afforded neither self determination nor independence. All sensing, perceiving, analyzing, planning, and decision-making are done by a human; human directs all unmanned system actions from the human's frame of reference; the case of maximum human influence over unmanned performance.</p>	All man	All man	All man	All man	All man	Most man	Most Man	