fRAme

Configurability

The ability of the system to be configured to perform a task or reconfigured to perform different tasks. This may range from the ability to re-program the system to be able to alter the physical structure of the system (e.g. by changing a tool).

Level	Response	Example
User run-time configuration	Has the ability	The user can update Alexa's parameters during a count down (e.g., the user can add further minutes to a timer).
Run-time self configuration	Has the ability	For instance, if Alexa is reproducing music and a notification arrives, it stops or lower down the music to alert the user about the incoming notification.
Autonomous configuration	Does not have the ability	Here we can report two examples to better understand why Alexa doesn't hold this ability. First, if the internet connection is lost, Alexa is able to inform the user and adjust its configuration accordingly. However, if its charger is broken, it does not notify the user; it simply stops functioning In the first example, the external factor (loss of internet) is unrelated to the system's internal components, and reporting the lack of connectivity is part of Alexa's normal autonomous operation. In contrast, the second example involves a failure of one of Alexa's internal components (the charger). According to the definition of the autonomous configuration ability level, Alexa doesn't hold it.

Dependability

The ability of the system to perform its given task(s) without systematic errors. Dependability specifies the level of trust that can be placed on the system to perform.

Level	Response	Example
Task dependability	Does not have the ability	For instance, when the user turns on the light, Alexa responds with 'Ok', but it cannot verify whether the light has actually turned on, meaning whether the command sent has been successfully executed.
Mission dependability	Does not have the ability	The same applies to the home lighting system.
Predictive dependability	Not applicable	Not applicable because it is not dependable (both for the task and the mission).
Prescriptive dependability	Not applicable	No, because it depends on the previous one.

Autonomy

The ability of the system to act autonomously. Nearly all systems have a degree of autonomy. It ranges from a simple autonomous task (e.g., when it reacts to sensor reading) to the ability to be self-sufficient in a complex environment.

Level	Response	Example
Basic action	Has the ability	The timer goes on
Basic decisional autonomy	Has the ability	For example, Alexa turns the lights on or off based on the time of day (artificial input), provided it has been instructed to do so (off during daylight, on at night).
Continuous basic decisional autonomy	Has the ability	For example, Alexa might stop replying during an interaction if there is a loss of connection
Simple autonomy without environment model	Has the ability	The system perceives the user's voice as input and executes commands accordingly, making real-time decisions to interact with the environment and fulfill predefined tasks.
Simple autonomy with environment model	Does not have the ability	The system does not rely on an internal model of the environment.
Task autonomy	Has the ability	Comando (perception of the env): "illumina esterno casa quando fa buio", implica monitora orario, accendi luci. ???
Constrained task autonomy	Not applicable	vedere rispetto a sopra (???)
Multiple task autonomy	Not applicable	
Dynamic autonomy	Not applicable	
Mission oriented autonomy	Not applicable	
Distributed autonomy	Not applicable	

Interaction

The ability of a system to interact physically, cognitively either with human or artificial agents or other systems around it. The ability to interact may be simple as the use of a communication protocol. The ability to interact is critical to many areas of application. Interaction depends on both the medium of interaction and the context and flow of the interaction. The ability to interact takes place in two distinct ways: physical or cognitive interaction.

Human-system interaction

The following set of levels relate to the interaction between human agents and the system.

Level	Response	Example
No interaction	Has the ability	The system can send notifications even without ongoing interaction (e.g., it activates independently to notify you of an email).
Direct control	Has the ability	Parental control allows the human agent to set parameters that guide the system's operation. These controls can translate, modify, or restrict the system's behavior within the boundaries defined.
Direct physical interaction	Has the ability	The contact point is the voice command "Alexa." Through this interaction, the system responds to the human agent, activating and remaining ready to receive further commands.
Task selection	Has the ability	Alexa can be assigned a sequence of commands to execute autonomously, even at a specified time. Once the sequence is completed, the human agent can provide further instructions to determine the next action.

Traded autonomy	Has the ability	Alexa performs tasks based on specific commands from the human agent. It operates autonomously during the execution of these tasks but relies on the human agent to provide subsequent instructions or intervene for further control. This creates an alternating pattern of autonomous operation and direct human control.
Task sequence control	Has the ability	Alexa can autonomously determine, based on a specific task assigned by the human agent, whether the preconditions for its execution are met.
Supervised autonomy	Has the ability	Alexa executes commands autonomously under most operating conditions. If the connection is lost or it encounters a situation where it cannot proceed, it notifies the user.
Task alternatives selection	Has the ability	When the user requests a recipe, Alexa can autonomously find it without additional input.
Mission goal setting	Has the ability	The user provides commands to Alexa, guiding the execution of its tasks toward achieving the user's overall goal.

Perception

The ability of the system to perceive its environment. It includes the ability to interpret information and make informed and accurate deductions about the environment based on sensory data.

General perception

The following levels refer to the generic ability of a system to perceive environmental state by sensor data.

Level	Response	Example
Multi-parameter perception	Not applicable	Alexa does not have a comprehensive model of the environment. As a result, the system's ability to alter its behavior based on environmental understanding is limited or nonexistent.
Feature-based perception	Not applicable	Alexa does not have a comprehensive model of the environment.
Grouped feature detection	Not applicable	Alexa does not have a comprehensive model of the environment.
Element identification	Not applicable	This is out of scope. The system cannot identify elements or coherent entities in the environment by grouping features or using these identifications to alter its behavior.
Property identification	Not applicable	vedere rispetto a parental control
Hidden state identification	Not applicable	

Cognitive

The ability to interpret the task and environment such that tasks can be effectively and efficiently executed even where there exists environmental and/or task uncertainty. The ability to interpret human commands delivered in natural language or gestures. The ability to interpret the function and

interrelationships between different elements in the environment and understand how to use or manipulate them. The ability to plan and execute tasks in response to high-level commands. The ability to work interactively with people as if like a person. Currently, different aspects and faculties of the Cognitive Ability as a whole have different degrees of maturity and pose different challenges.Attempting to combine these differences into a single rating or overarching target is likely to lead to invalid or misleading conclusions. The assessment of cognitive ability is therefore divided into several components or faculties. The assumption is that the cognitive ability of a system can be assembled and described more accurately by referring to a mixture of component abilities.

Action

It concerns the ability of the system to act purposefully within its environment and the degree to which it is able to carry out actions and plan those actions. These abilities build on perception and decisional autonomy abilities. Action ability also co-depends on the other cognitive abilities.

Level	Response	Example
Defined action	Has the ability	The user has the ability to set routines consisting of predefined actions. The system executes these actions as a sequence of sub-actions, which can repeat continuously until interrupted by an operator or triggered by a specific system event.
Decision based action	Has the ability	Yes, within the bounds of its limited decisional autonomy.
Sense driven action	Does not have the ability	???????
Optimized action	Has the ability	Limited. For example, I can instruct the system to raise its volume during an interaction if I am unable to hear it.
Knowledge driven action	Not applicable	
Plan-driven action	Not applicable	
Dynamic planning	Not applicable	
Task action suggestions	Has the ability	For example, the user states they want to book a vacation, and the system suggests checking flights on Skyscanner. The system can propose tasks that align with and contribute to achieving the objectives of a specific mission.
Mission proposals	Not applicable	

Acquired knowledge

Environments will always contain a number of unknowns. In many proposed application areas systems will encounter unknown situations as a normal part of task execution. The acquisition of knowledge about new situations is fundamental to the success of these new application areas.

Level	Response	Example
No acquired knowledge	Not applicable	

Sense data and property knowledge	Has the ability	The basic functionality of Alexa exemplifies this ability level.
Persistent sense data knowledge	Has the ability	Alexa is able to discriminate between voices of its users.
Deliberate acquisition	Has the ability	Alexa deliberately asks questions to better understand the environment around, specifically the user's needs.
Place knowledge	Does not have the ability	
Knowledge scaffolding	Does not have the ability	
Requested knowledge	Has the ability	Alexa demonstrates this capability by gathering the information needed to accomplish its task. For instance, it can check the current time online to determine if it should begin a task or ask the user additional questions during interaction. The system can recognize when it lacks sufficient knowledge about an element or context relevant to the task and formulate a query to obtain the necessary information, whether from a user or an external data source like the internet.
Distributed knowledge	Does not have the ability	Alexa does not receive feedback from other connected systems, even though it can send commands to them.
Interaction acquisition	Has the ability	Alexa demonstrates this ability by checking the time as part of a planned task and using that information to turn on the lights based on the time of day
Object function	Does not have the ability	Alexa does not observe the environment and, therefore, lacks this ability.
Human knowledge	Does not have the ability	See previous example.
Critical feedback	Does not have the ability	Alexa doesn't receive feedback from other systems with which it interacts.
Long-term observation	Does not have the ability	
Patterns of behaviour	Does not have the ability	
Observation learning	Does not have the ability	

Reasoning

The reasoning ability is the glue that holds the cognitive structures together. Perception, and knowledge acquisition all rely to a certain extent on the ability to reason from uncertain data. As application tasks become more complex the need to provide task and mission-level reasoning increases.

Level	Response	Example
Reasoning from sense data	Has the ability	Alexa is able to discriminate among voices.
Pre-defined reasoning	Has the ability	See example before.
Basic environment reasoning	Does not have the ability	
Reasoning under uncertainty	Does not have the ability	
Dynamic reasoning	Does not have the ability	
Safety reasoning	Does not have the ability	
Task reasoning	Does not have the ability	
Mission reasoning	Does not have the ability	

Cognitive human interaction

The following levels relate to different levels of human interaction with a system that has a cognitive element. They specifically relate to the interaction between a human and a single system. Where multiple systems are involved a corresponding set of levels applies.

Level	Response	Example
No cognitive human interaction	Not applicable	Alexa is centered on the interaction with the human.
Fixed interaction	Has the ability	The interaction follows a fixed pattern with the user activating it by saying "Alexa". Indeed, the user interface of Alexa is the user voice and the connection between the human and the system is always a wireless link.
Task context interaction	Has the ability	Alexa interprets users commands in a given context and is able to transmit tasks status to the user (e.g., the timer is over).
Element interaction	Has the ability	The classic example is when the user asks Alexa to turn on the light.
System-triggered interaction	Does not have the ability	Alexa can send notification to users but this is limited to a notification without starting a conversation that is always started by the user.
Social interaction	Does not have the ability	Alexa replies to user's questions but it cannot establish a dialogue.
Complex social interaction	Does not have the ability	
Intuitive interaction	Does not have the ability	

Levels

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Configurability

○ ○ ●

Dependability

● ● ◍ ◍

Autonomy

○ ○ ○ ○ ● ○ ◍ ◍ ◍ ◍ ◍

Interaction

Human-system interaction ○ ○ ○ ○ ○ ○ ○ ○
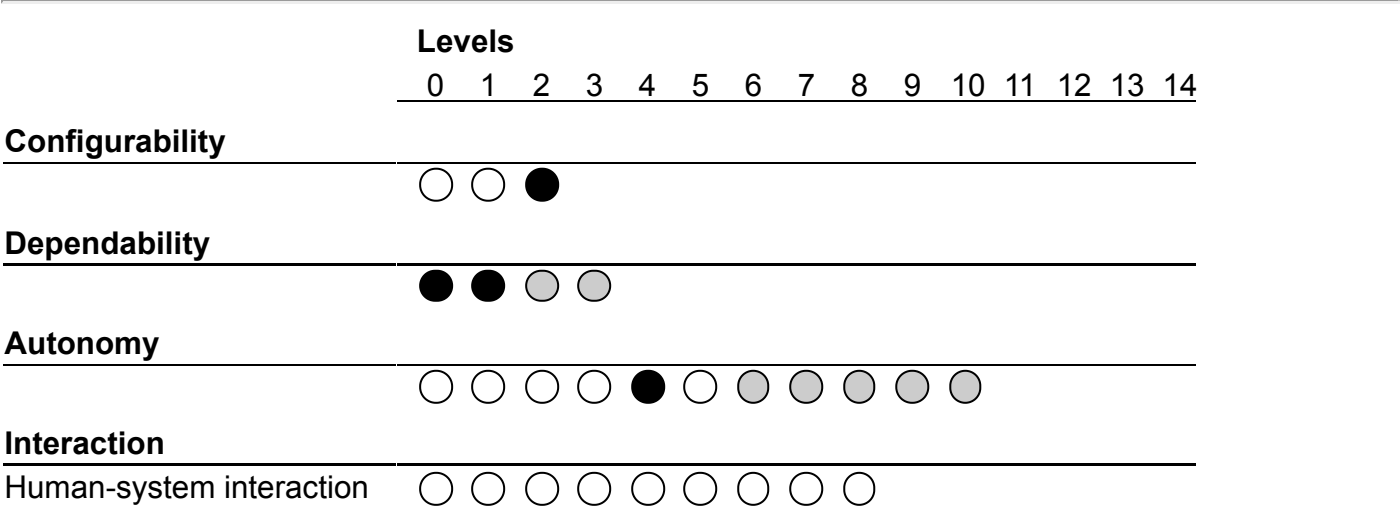
Levels

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Perception

General perception	◍	◍	◍	◍	◍	◍									

Cognitive

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Action	○	○	●	○	◍	◍	◍	○	◍						
Acquired knowledge	◍	○	○	○	●	●	○	●	○	●	●	●	●	●	●
Reasoning	○	○	●	●	●	●	●	●							
Cognitive human interaction	◍	○	○	○	●	●	●	●							