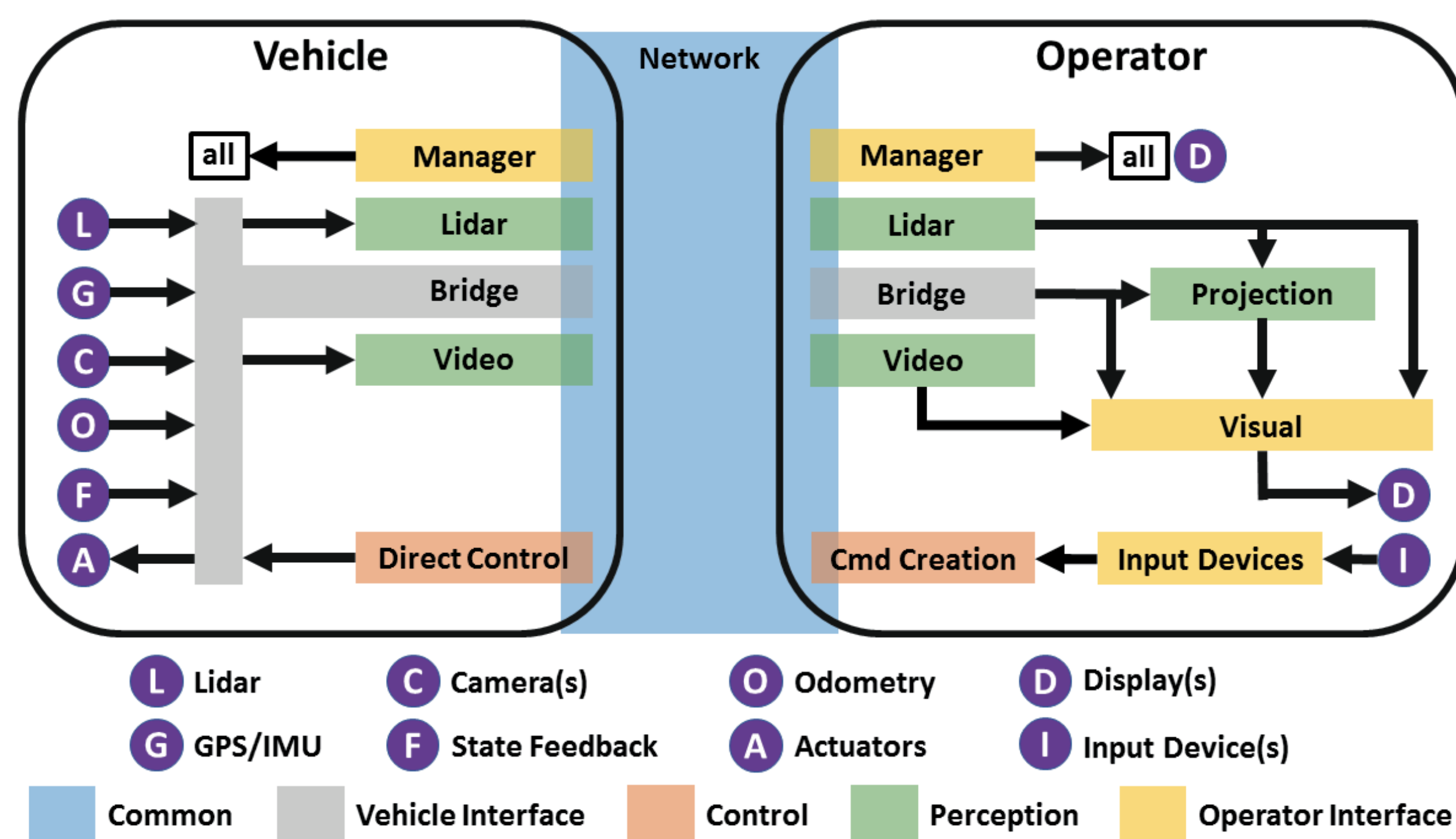


## Ability-Based System Awareness Protocol for Teleoperated Driving

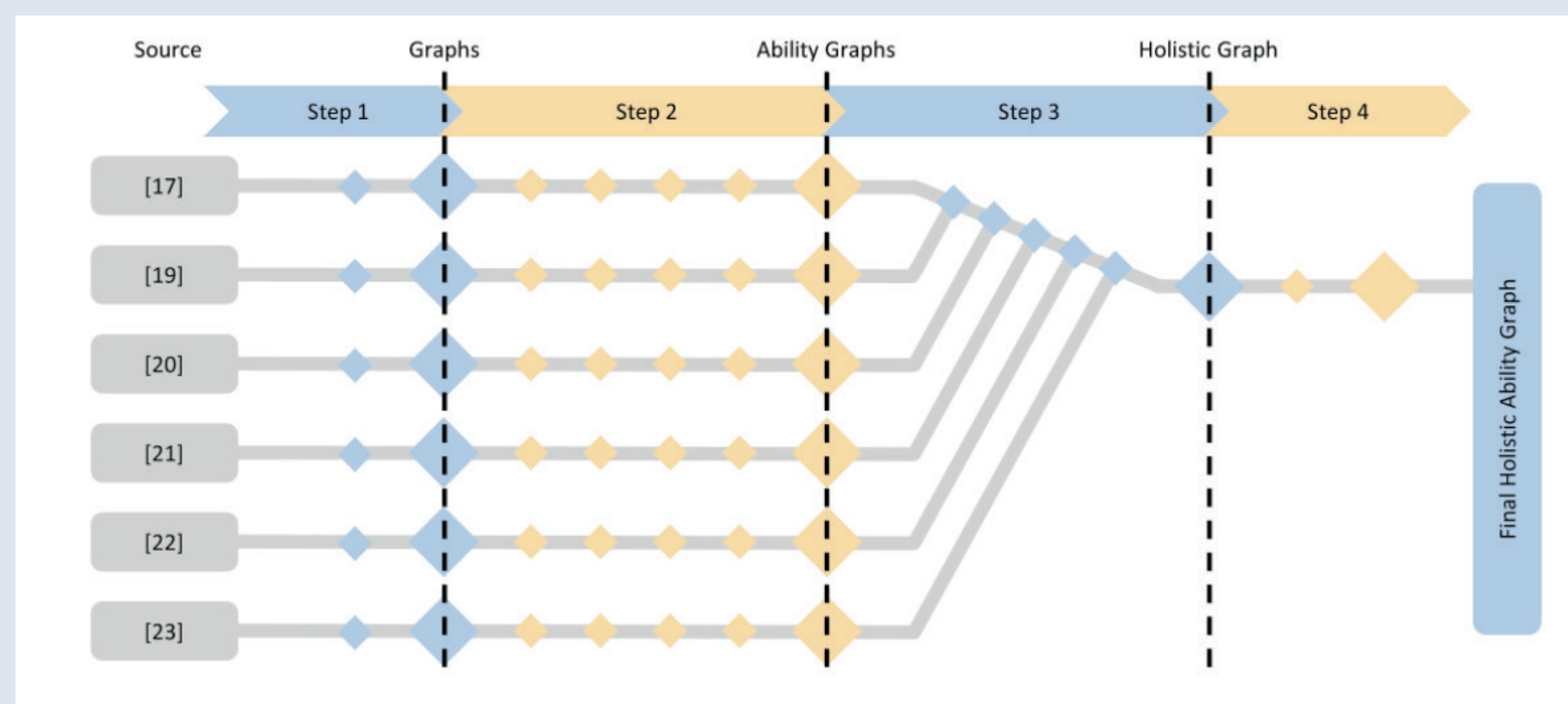
### Scope

To provide a fallback solution for disengagements of automated driving systems, the concept of teleoperation is recommended to support in such cases. For this, a human is brought back into the loop, who remotely connects to the vehicle via network communication and solves the disengagement.



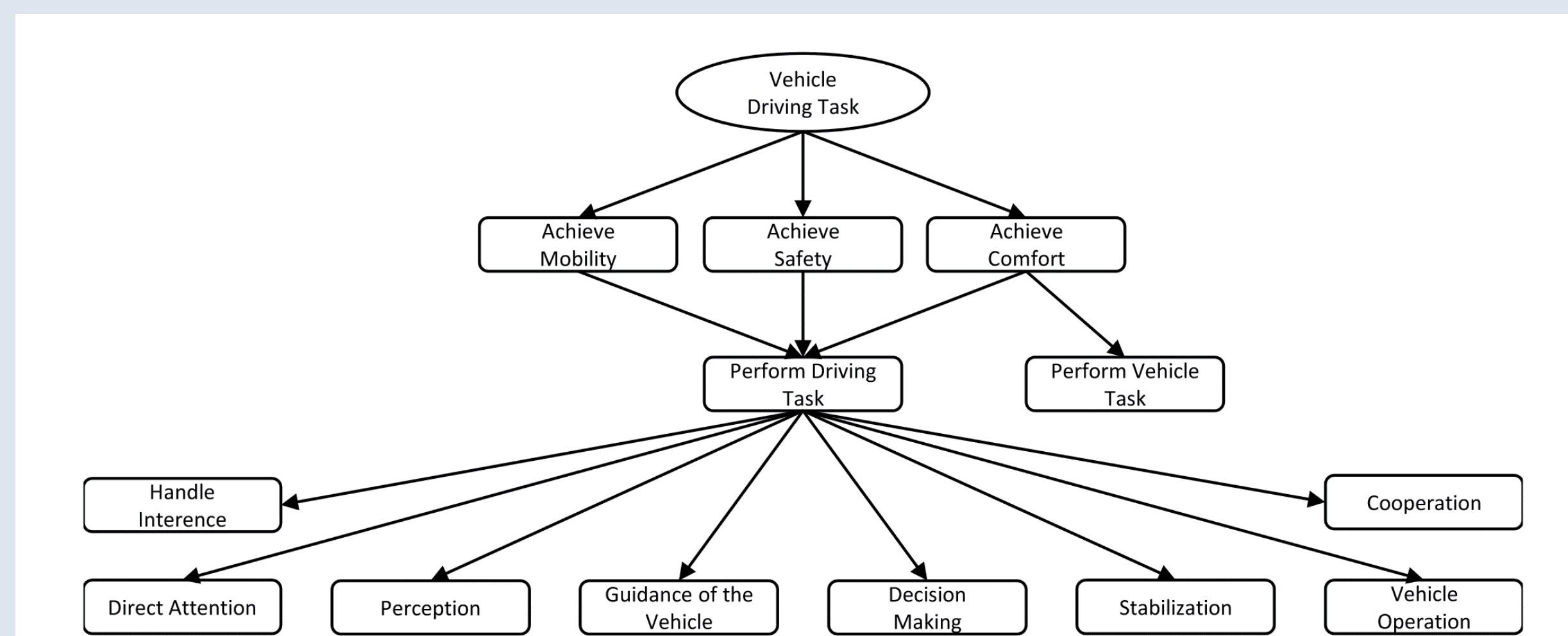
In ConnRAD an overall resilience concept for teleoperated driving systems is conceptualized and developed. One investigated concept is the usage of formalized descriptions of the required abilities of the teleoperated driving system. Those abilities are used to define a protocol to increase the system's awareness and thus the resilience of the system.

### Construction of a Holistic Ability Graph



This diagram represents the process of constructing a holistic graph from source. The source is depicted by various driving task descriptions. Those are conducted into a graph-based description and lastly combined into one holistic ability graph. Source: Pfab et al. How to Drive – An Ability-based Description of Autonomous, Remote and Human Driving 2024

### A Holistic Ability Graph



The holistic ability graph was derived from literature using different descriptions of the tasks for human and automated driving. Only the first four layers are depicted here. Source: Pfab et al. How to Drive – An Ability-based Description of Autonomous, Remote and Human Driving 2024

### System Awareness Protocol

The system awareness protocol comprises two steps:

1. Definition of the Operational Design Domain (ODD)
2. Negotiation of the available abilities between vehicle and operator

Within the first step, the vehicle suggests an ODD, which is either accepted or modified by the operator. Based on the agreed ODD, all available abilities on both the operator and vehicle side are determined. The vehicle's abilities are used to create an ability graph, which is sent to and checked by the operator. Extended by the operator's abilities the graph will be sent back to the vehicle. This process is repeated, as long as both parties accept the ability graph. As soon as the ability graph is negotiated and confirmed by vehicle and operator, the driving task can be performed according to the approved abilities.

