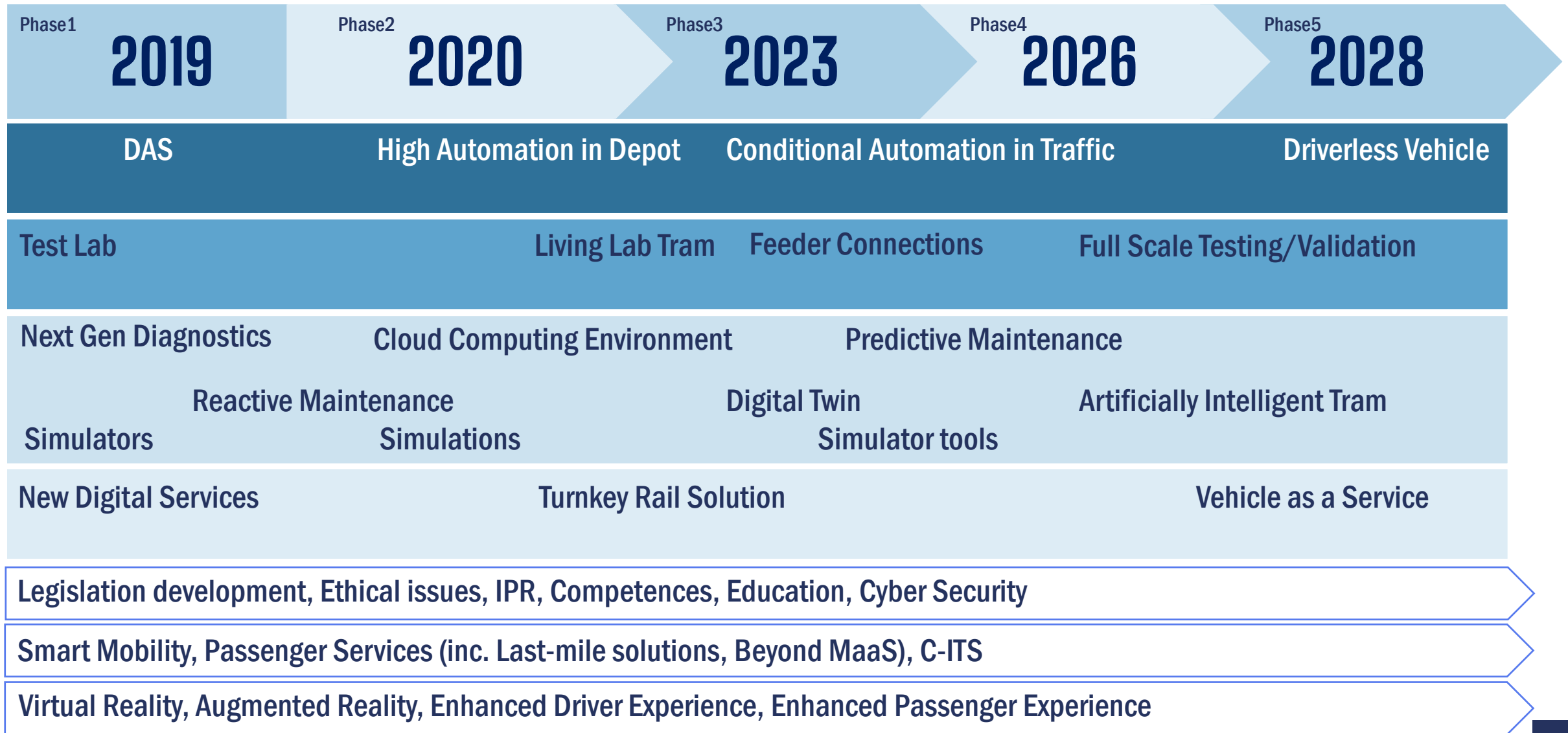


SmartRail-ecosystem

With Co-Innovations towards global markets.

SmartRail –ecosystem Technology roadmap



SmartRail –ecosystem Phases



SmartRail – Safe tram traffic through automation



GoA –levels generally

- GoA0 All Tram movements are managed by operational procedures
- GoA1 Tram driver is responsible for control the Tram movements
- GoA2 Tram driver control the doors and control the movements if necessary
- GoA3 No Driver, but Tram contains the attendant who takes the control if necessary
- GoA4 All Tram movements are managed by automation systems



Mandatory functions		GoA0	GoA1	GoA2	GoA3	GoA4
Ensure safe movement of trains	Ensure safe route	x	Sys	Sys	Sys	Sys
	Ensure safe separation of trains	x	Sys	Sys	Sys	Sys
	Ensure safe speed	x	x (partly supervised by sys)	Sys	Sys	Sys
Drive Train	Control acceleration & braking	x	x	Sys	Sys	Sys
Supervise guideway	Prevent collision with obstacles	x	x	x	Sys	Sys
	Prevent collision with persons on track	x	x	x	Sys	Sys
Supervise passenger transfer	Control passenger doors	x	x	x	Sys	Sys
	Prevent injuries to persons between cars or between platform and trains	x	x	x	x	Sys
	Ensure safe starting conditions	x	x	x	x	Sys
Operate a train	Put in or take out of operation	x	x	x	x	Sys
	Supervise the status of the train	x	x	x	x	Sys
Ensure detection & mgmt of emergency situation	Detect fire/smoke & detect derailment, detect loss of train integrity, manage passenger requests (call/evacuation, supervision)	x	x	x	x	Sys and/or Staff in OCC

SmartRail – Safe tram traffic through automation

2023 GoA0

2025 GoA1

2028 GoA2

2030 GoA3

2035 GoA4

Challenges for Autonomous driving (lightrail, City environment)

- Complexity, Signalling, Positioning
- Safety, Acceptance criterias, Regulations
- Limited business area vs. high r&d costs
- Stopping distance longer than cars' have
- Door control at stops (Safety, Obstacle detection)
- North climate (snowfall->visibility)

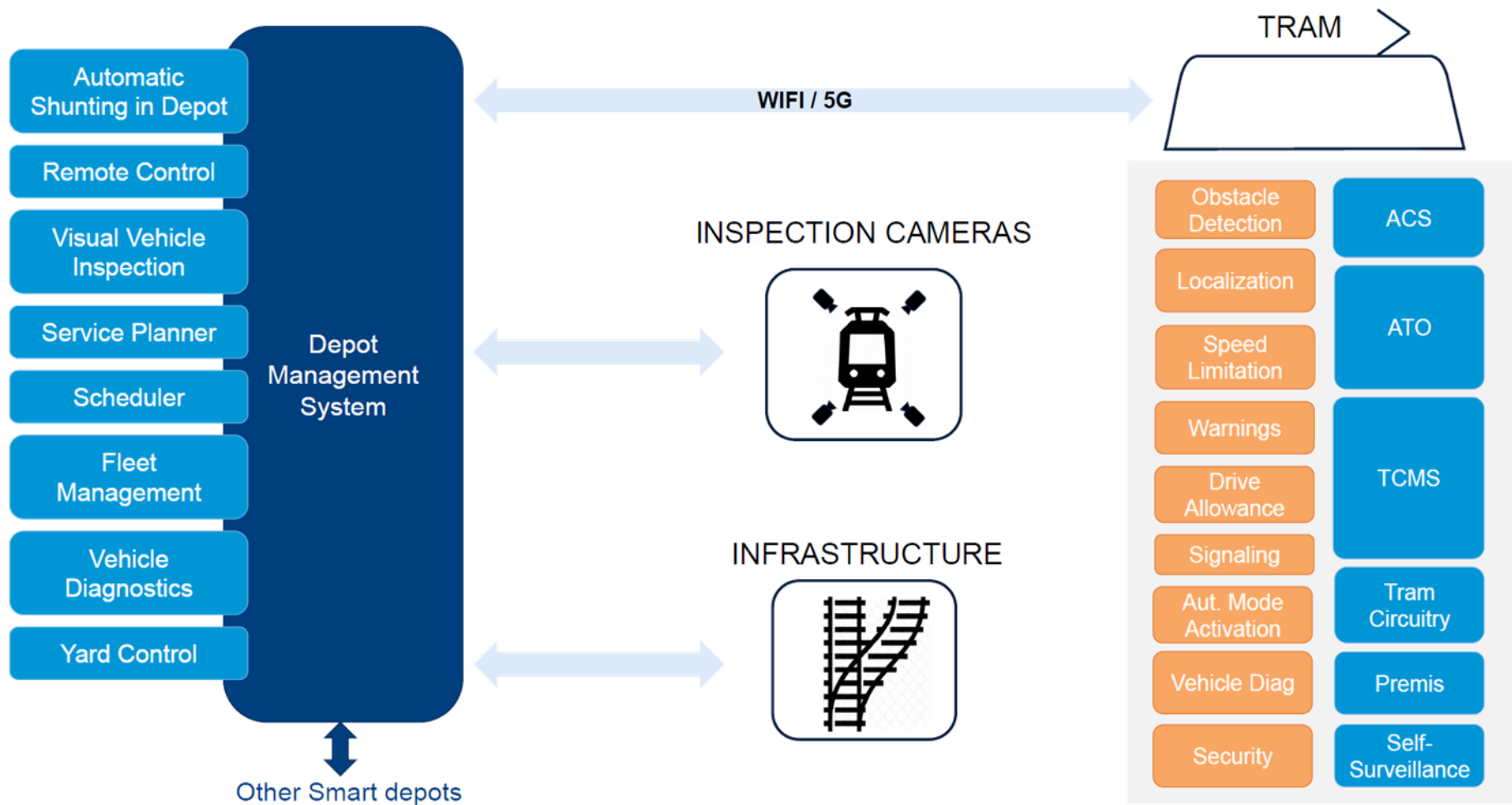


Opportunities with Autonomous driving (lightrail, City environment)

- Cost savings (maintenance, energy, fleet size, operational)
- Safety
- Flexibility (On demand service – feeder traffic)
- Accuracy
- New business models (e.g. Tram as a service)
- Driving routes are predefined and easily located with electronic map assistance system

SmartRail – Safe tram traffic through automation (Depot)

CONCEPT SMART DEPOT



SmartRail – Safe tram traffic through automation

FEATURES & USE-CASES



Helps drivers, operators and passengers



One system for all use cases



Great night performance



Easy vehicle integration
new railcars & retrofits



Rollingstock approved HW

- Alarm if somebody is around the vehicle
- Alarm if somebody is in contact with the vehicle
- Video recording triggered by alarms
- Incident localization and passing the information to the security service / fleet management
- "Safe Departure Assistant" checking that no one is in contact with tram when it starts moving (stop, depot)
- Custom vehicle reactions (i.e. lights on, horn, ...)

SmartRail – Safe tram traffic through automation

Comprehensive approach combining **Exterior** and **Interior** monitoring to achieve following features

Exterior Surveillance

- Vandalism monitoring (e.g. graffiti)
- Monitoring of movements around vehicle
- Safety (lights on if a person detected)
- Safe departure assistant



Behavioral Analysis

- Noise (call for help, screaming, shooting, breaking glass..)
- Fight (behavioral model - future)

Interior Surveillance

- Securing vehicle by motion detectors
- Driver monitoring

Interior Check in Depot

- Checks interior before and after the ride (forgotten luggage, vandalism, ..)

Passenger Monitoring System

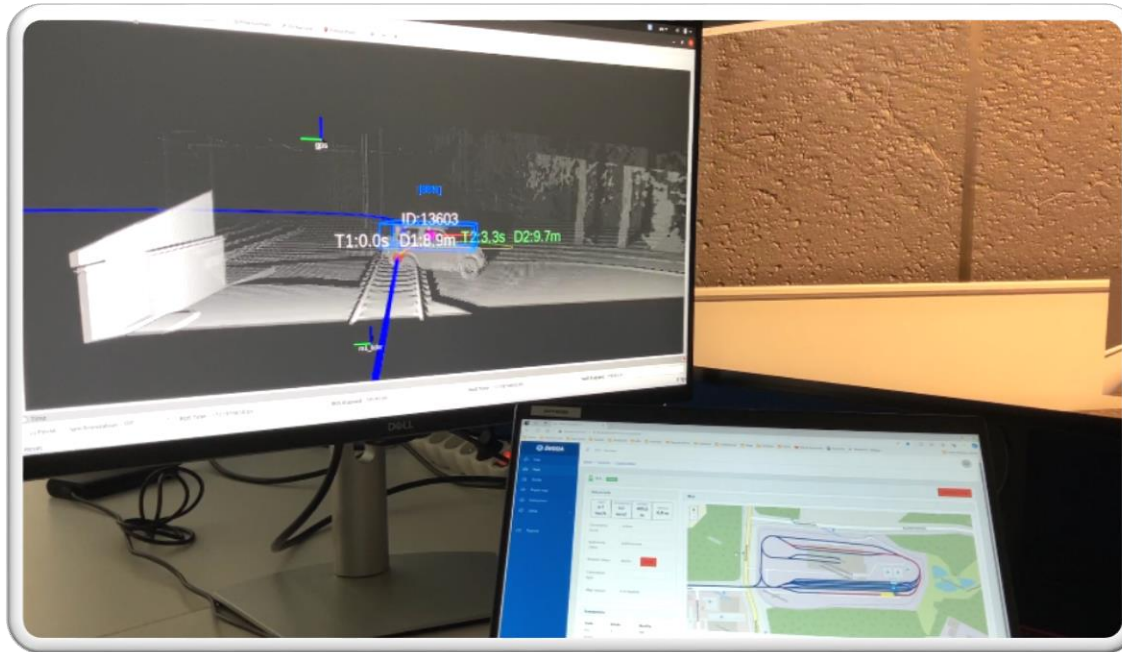
- Passenger Counting
- Object classification (trolley, wheelchair, unattended luggage)
- Face detection
- Anonymized video stream

SmartRail – Safe tram traffic through automation

Phase3

2024

Simulator for speed up testing and development



SmartRail – Safe tram traffic through automation

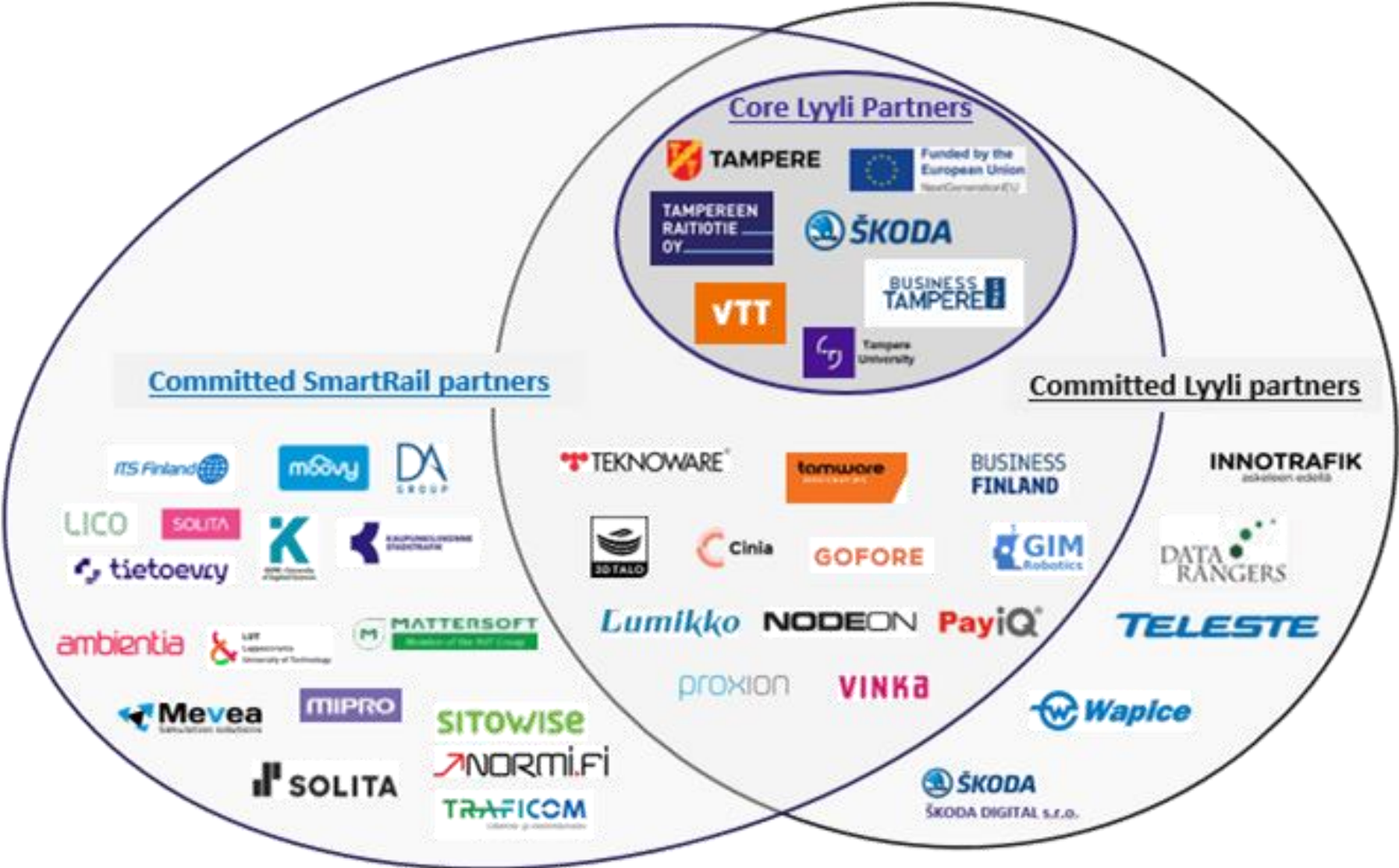
Phase3

2024

Piloting with Lyyli Tram



Committed Lyyli & SmartRail Partners





Thank You!

More about SmartRail Ecosystem

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