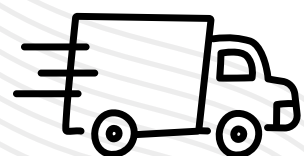


Timber transportation efficiency: challenges and solutions



Assoc.Prof. Nopparat Kaakkurivaara
Faculty of Forestry, Kasetsart University

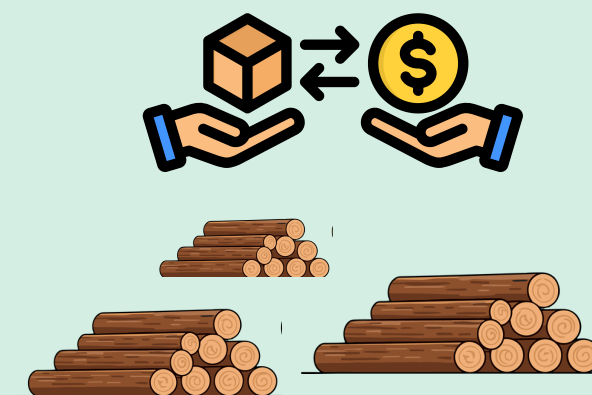
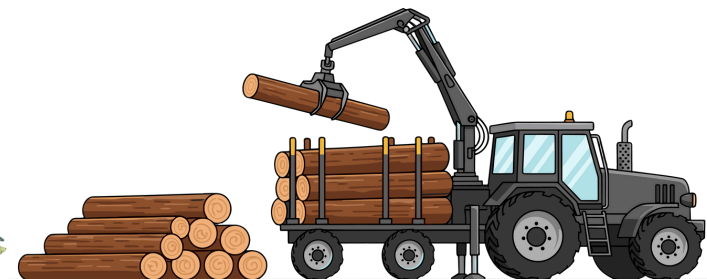


Timber Transportation

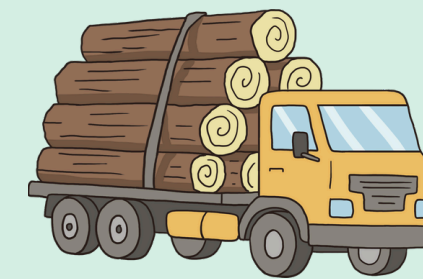
Primary transportation *(Short-distance)*



Plantation

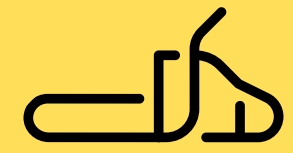


Forest gate



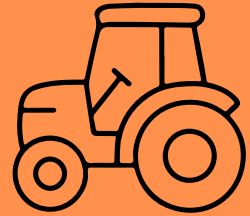
Utilization point

Timber harvesting cost breakdown



Felling and processing

15-25%



Extraction

25-35%



Transportation (Hauling)

30-50%





Photo: Nopparat K.



Photo: Rachen P.



Photo: Nopparat K.



Photo: Nopparat K.



Photo: Nopparat K.



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Photo: Nopparat K.



Photo: Nopparat K.



Photo by Nopparat Kaakkurivaara



FB: FM91 Trafficpro



Source: www.siameagle.com



Source: www.naewna.com

Key Challenges in Thailand



Operational challenges

- Small-scale plantations → inconsistent log sizes, higher loading/unloading time.
- Non-optimized routing: Rural roads → detours, seasonal road closures.
- Empty backhauls: Trucks return without cargo after delivering logs. *(in some cases)*



Infrastructure challenges

- Forest roads often unpaved; damage during rainy season delays transport.
- Limited rail integration (Thailand's rail freight: only ~2% of national freight).



Regulatory and economic challenges

- Weight restrictions vary by vehicle types; strict checkpoints cause delays.
- High fuel prices impact haulage costs.
- Transporters are mostly SMEs → limited access to tech investment.



Environmental challenges

- Trucks emit a large share of CO₂ in the timber value chain.
- Road expansion into forests increases ecological impact.

Impacts of Inefficiency

Higher cost per ton-km → mills and exporters lose margin.

Higher cost

Supply chain delays

Supply chain delays → production slowdowns

Higher emissions → hurts sustainability certification efforts (FSC, PEFC).

Higher emission

Reduced competitiveness

Reduced competitiveness against global suppliers.

Solutions



Operational improvement

- Cluster-based collection: Combine smallholders → larger loads → fewer trips.
- Digital weighing & load planning apps to optimize log stacking.
- Driver training to reduce fuel use and loading times.



Infrastructure solutions

- Upgrading plantation access roads (i.e. bearing capacity).
- Shared consolidation hubs to reduce short hauls.



Digitalization and technology

- GPS + telematics for real-time truck tracking.
- IoT sensors on log bundles to track moisture/weight.
- Systems to predict suitable routing.
- Predictive maintenance for trucks to avoid breakdowns in remote areas.



Sustainable transport options

- Long-term: adoption of electric or hybrid logging trucks (already piloted in Malaysia).
- May apply High-Capacity & Modular Trucks, however it requires regulatory alignment and proper roads

Example of solutions



Hybrid/ Electric vehicle

Loading / Unloading operations

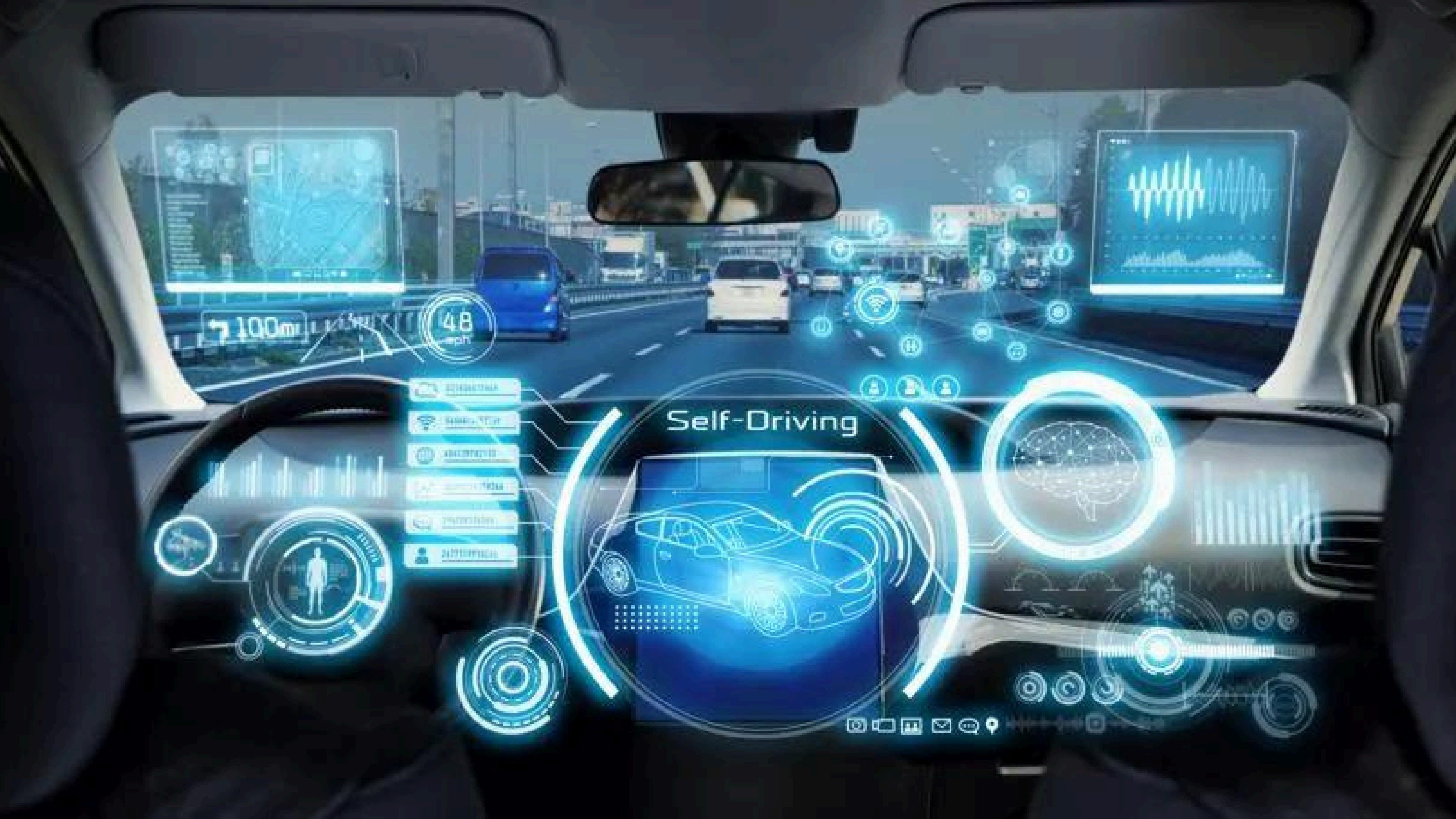
Virtual Reality (VR)

High-Capacity Transport (HCT)

Decision Support System (DSS)

Software





100mi

48
mph

Self-Driving



- SENSORS
- AI CORE
- ACTUATORS
- TELEMETRY
- PROCESORS
- ACTUATORS





Autonomous driving

Automatic parking

Energy saving

Biometrics

Augment reality

Driver monitoring

Traffic sign recognition

Enhance safety features

V2V Communication

The first electric timber trucks launched in 2022





Autonomous driving

Energy saving

Virtual reality

Sensing of trees, obstacles

Productivity monitoring

Enhance safety features

M2M Communication



Photo: Nopparat K.

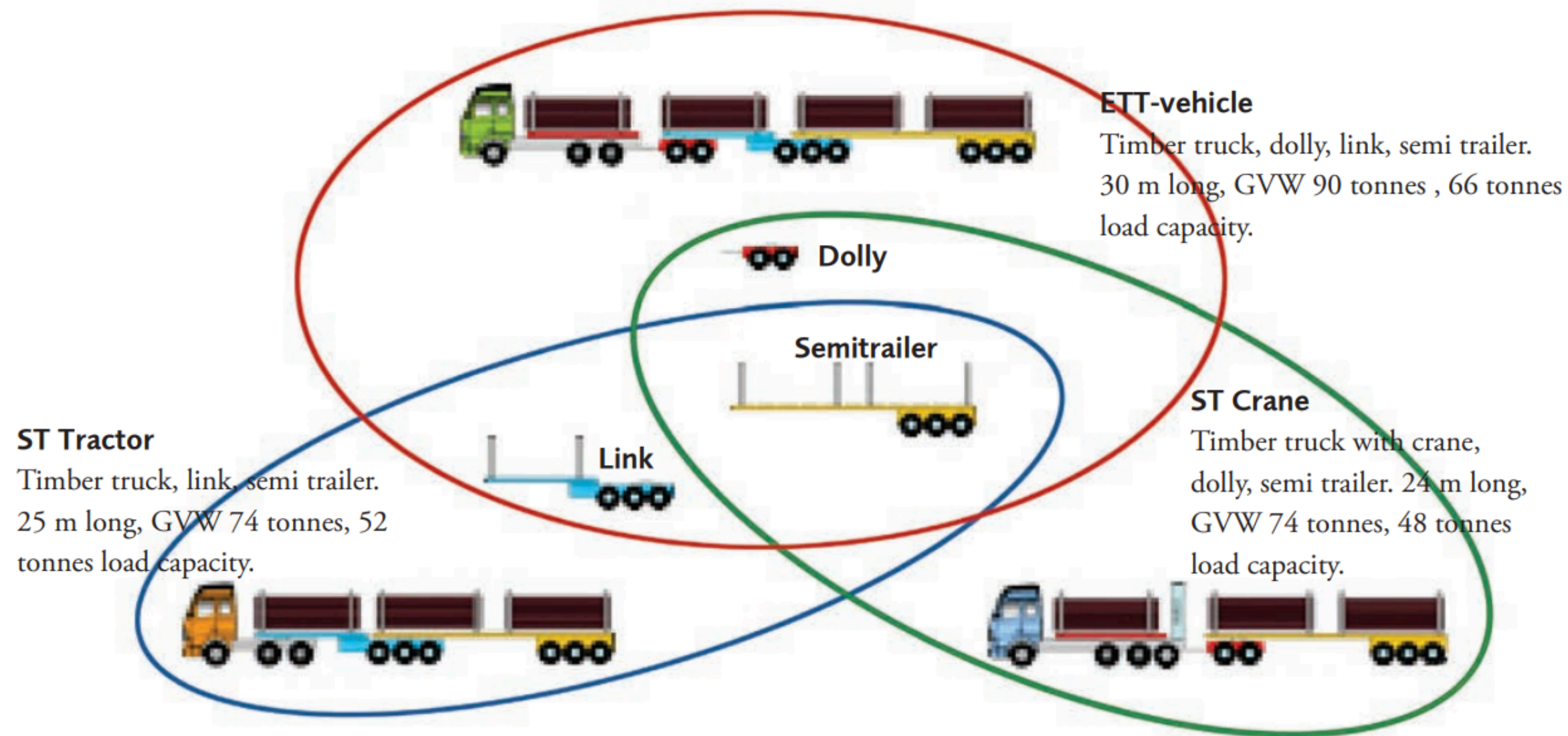
Logging Transportation
Photo by Nopparat Manavakun



Photo: Nopparat K.



European Module System (EMS)

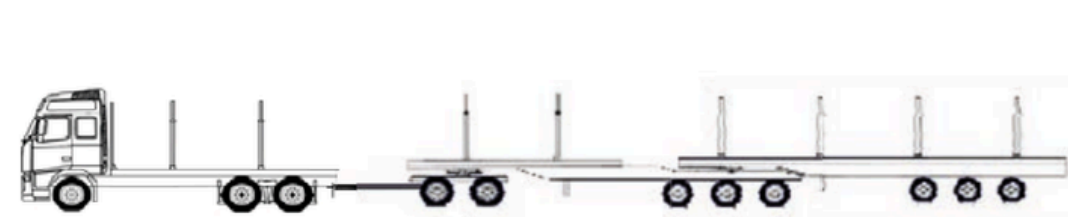


Purpose of EMS

- Increase transport efficiency (more cargo per trip)
- Reduce fuel consumption and CO₂ emissions per tonne-km
- Lower transport costs
- Reduce traffic volume (fewer trucks for same freight volume)

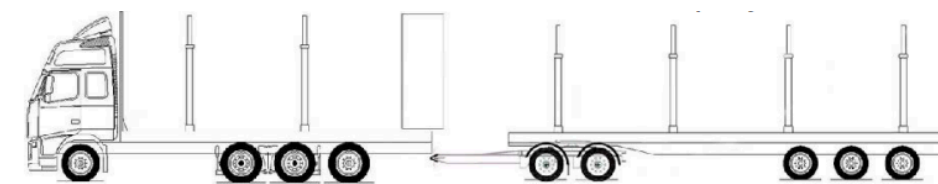
Source: Skogforsk.se

High-Capacity Transport (HCT)

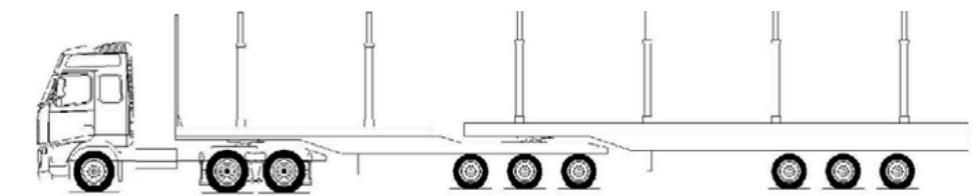


Truck Dolly Link Trailer

Gross vehicle length: 30 m
 Gross vehicle weight: 90 tonnes
 Net vehicle weight: 24 tonnes
Load capacity: 66 tonnes



Gross vehicle length: 24 m
 Gross vehicle weight: 74 tonnes
 Net vehicle weight: 26 tonnes
Load capacity: 48 tonnes



Gross vehicle length: 24 m
 Gross vehicle weight: 74 tonnes
 Net vehicle weight: 22 tonnes
Load capacity: 52 tonnes



06/08/2014
Source: Unknown



alibaba.com



medium.com



Source: Unknown



Photo: Nopparat K.



Source: Unknown



Photo: Tomi K.



Photo: Nopparat K.



Photo: Tomi K.



Photo: Nopparat K.

Volume Differences of the same Weight Material by Different Product Types

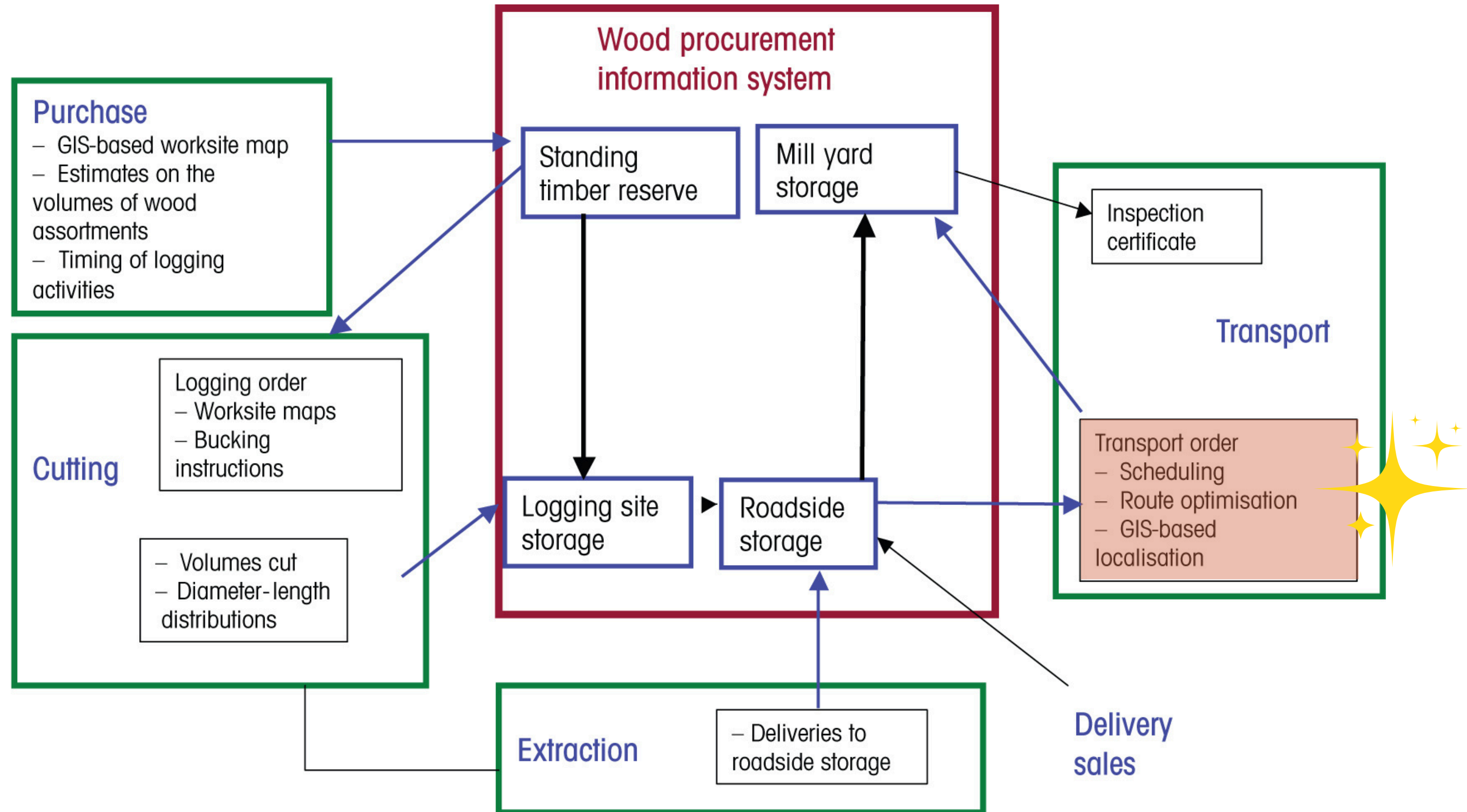


Source: USDA Forest Service Forest Product Laboratory

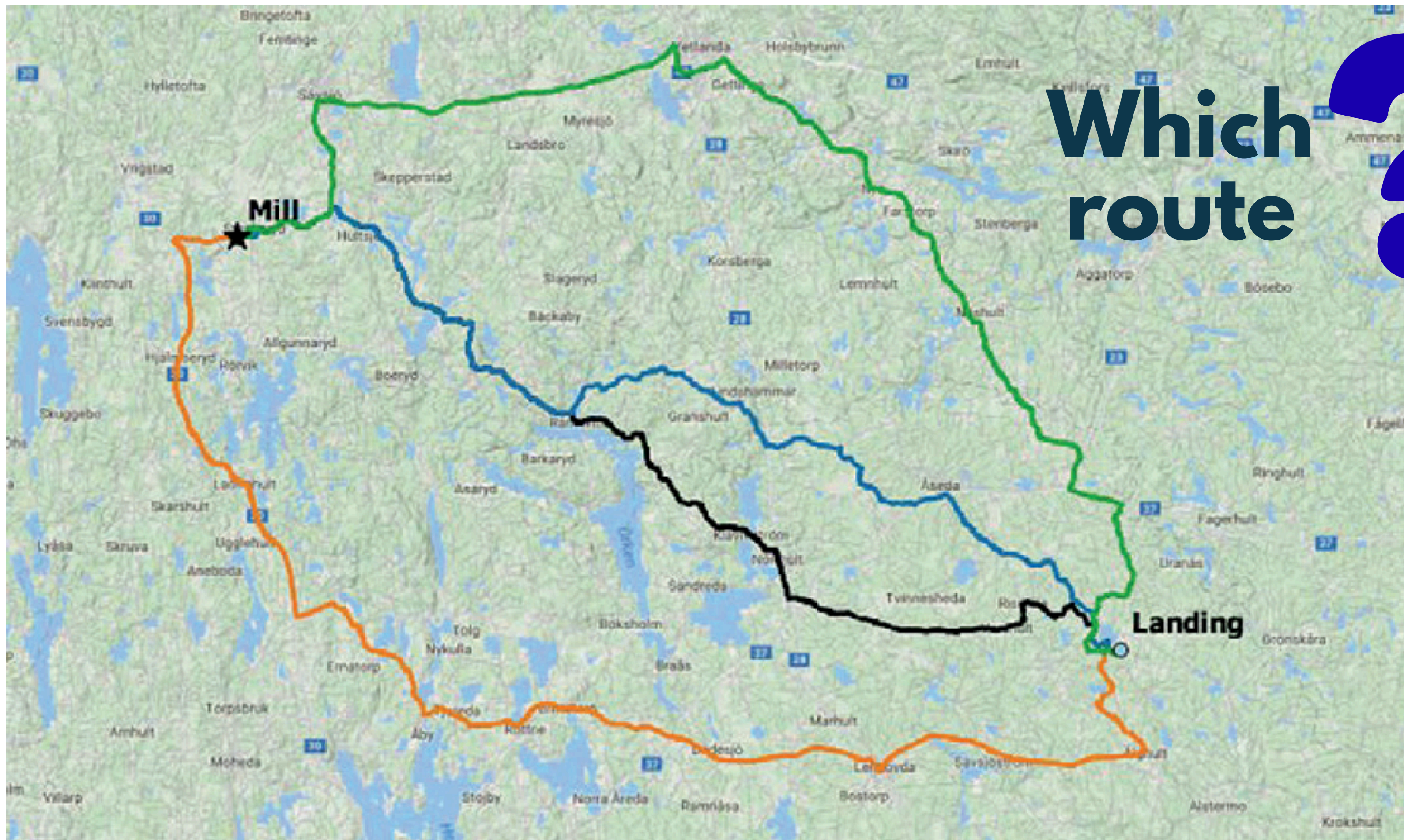
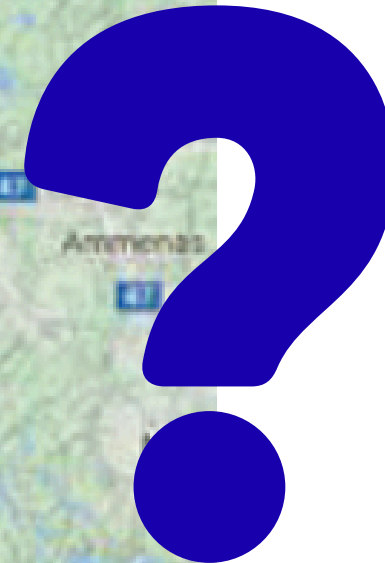
Wood chips transportation



Basic structure of a wood procurement information system



Which route



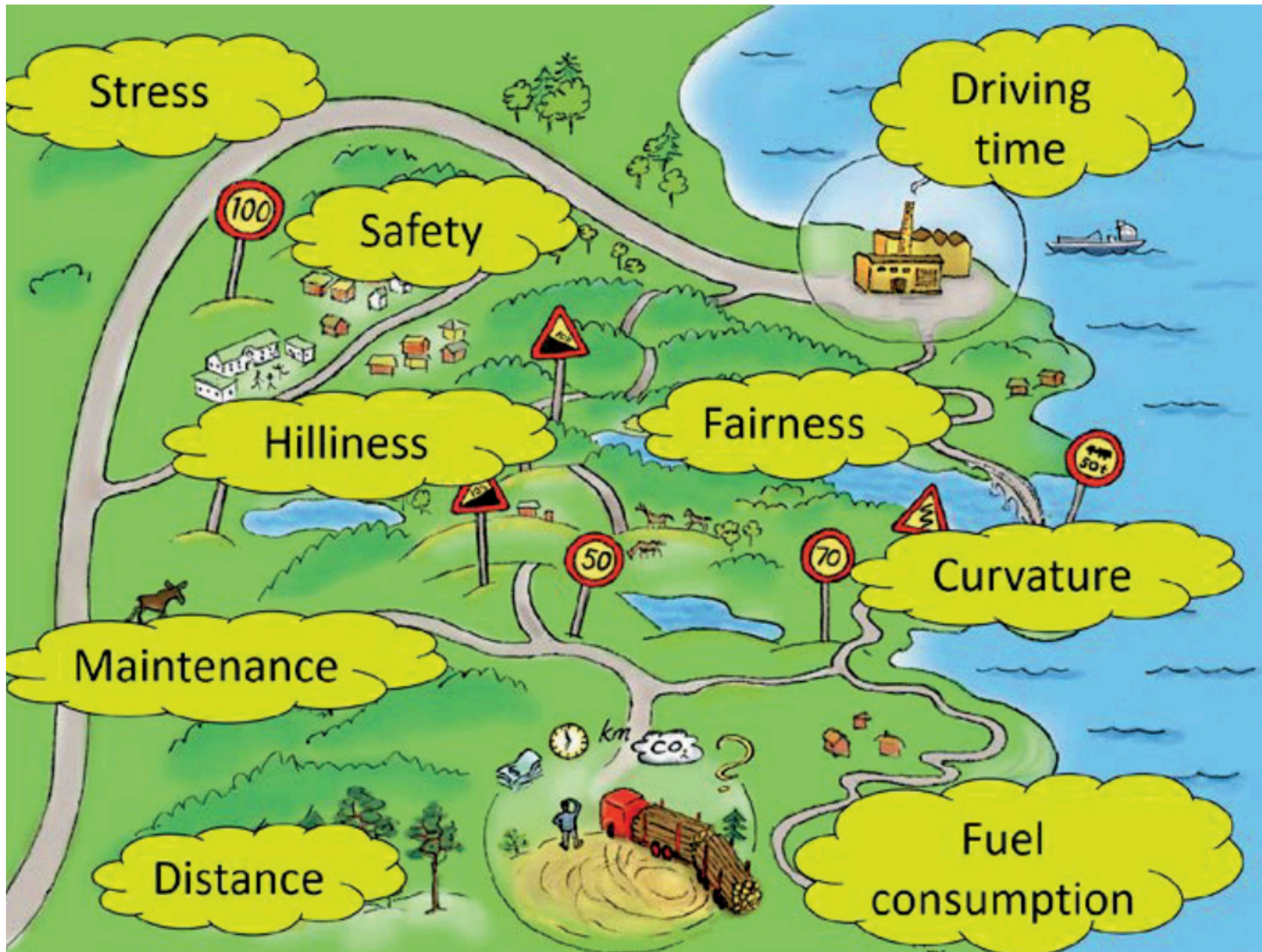


Illustration: Margareta Nilsson

Distance

- Shorter distance usually lowers fuel use and time.
- But a short route may be steep, unsafe, or poorly maintained.

Driving time

- Influenced by speed limits, curvature, hills, traffic, and road type.
- A longer route may be faster if roads are flatter and safer.

Fuel consumption

- Affected by distance, slope (hilliness), curvature, and stop-and-go driving.
- Steep or winding roads increase fuel use even if they are shorter.

Wear on the truck (maintenance)

- Rough roads, steep hills, and sharp curves increase mechanical wear.
- Higher maintenance costs can outweigh distance savings.

Road safety

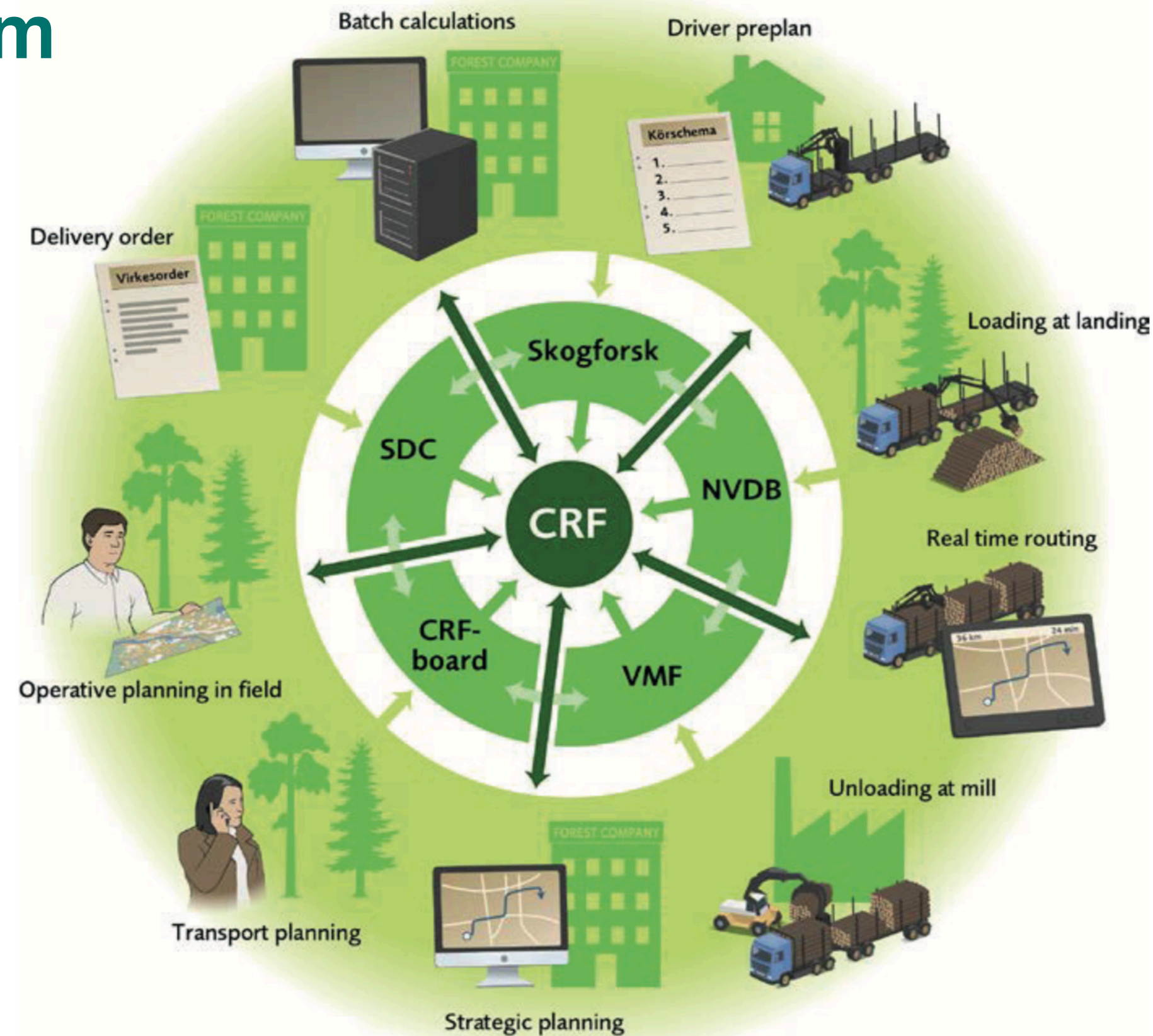
- Includes speed limits, curvature, road width, visibility, and accident risk.
- Safer routes reduce accidents, delays, and insurance costs.

Working environment (driver stress & fairness)

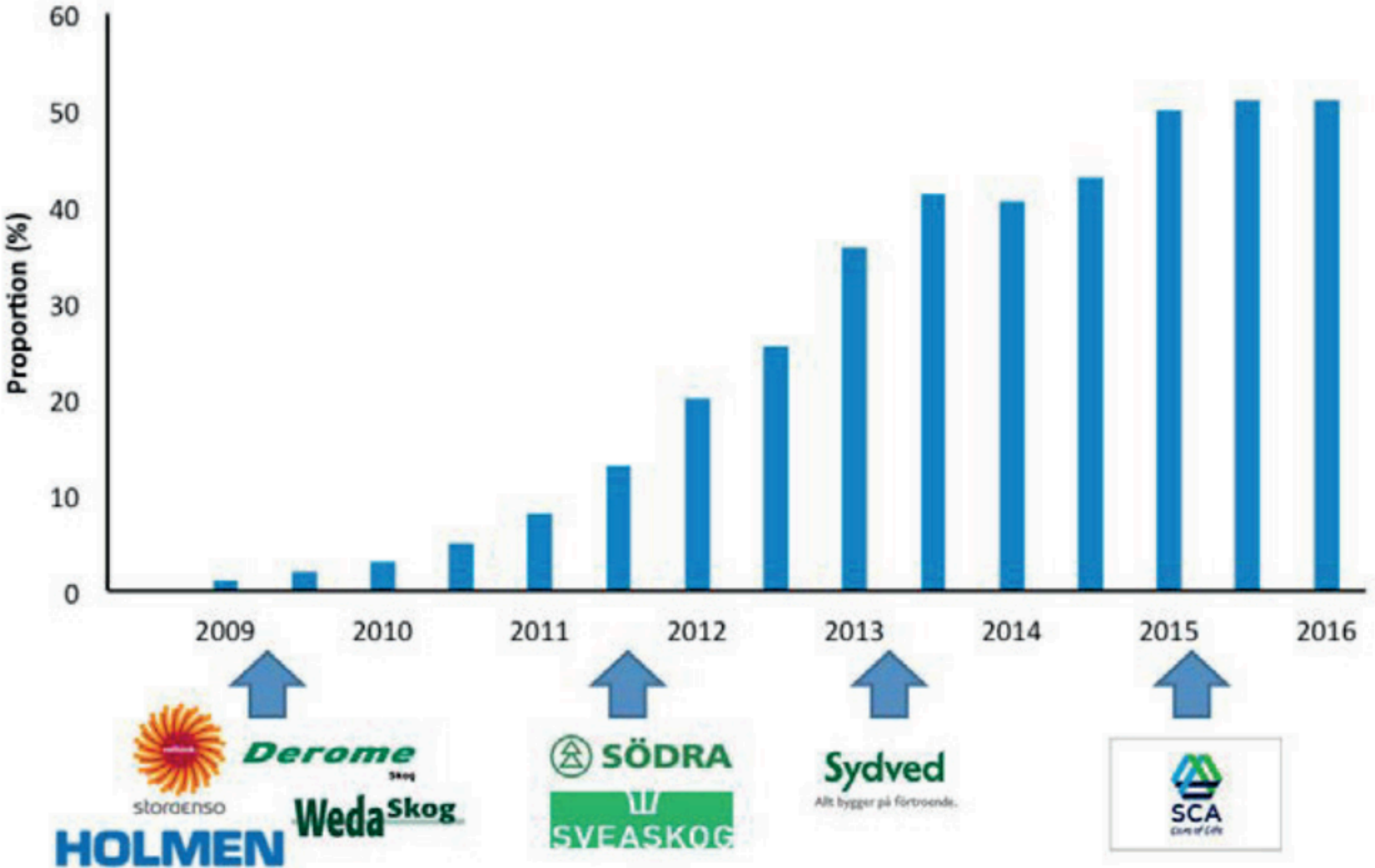
- Difficult roads increase driver stress and fatigue.
- Fair route planning distributes difficult and easy routes evenly among drivers.

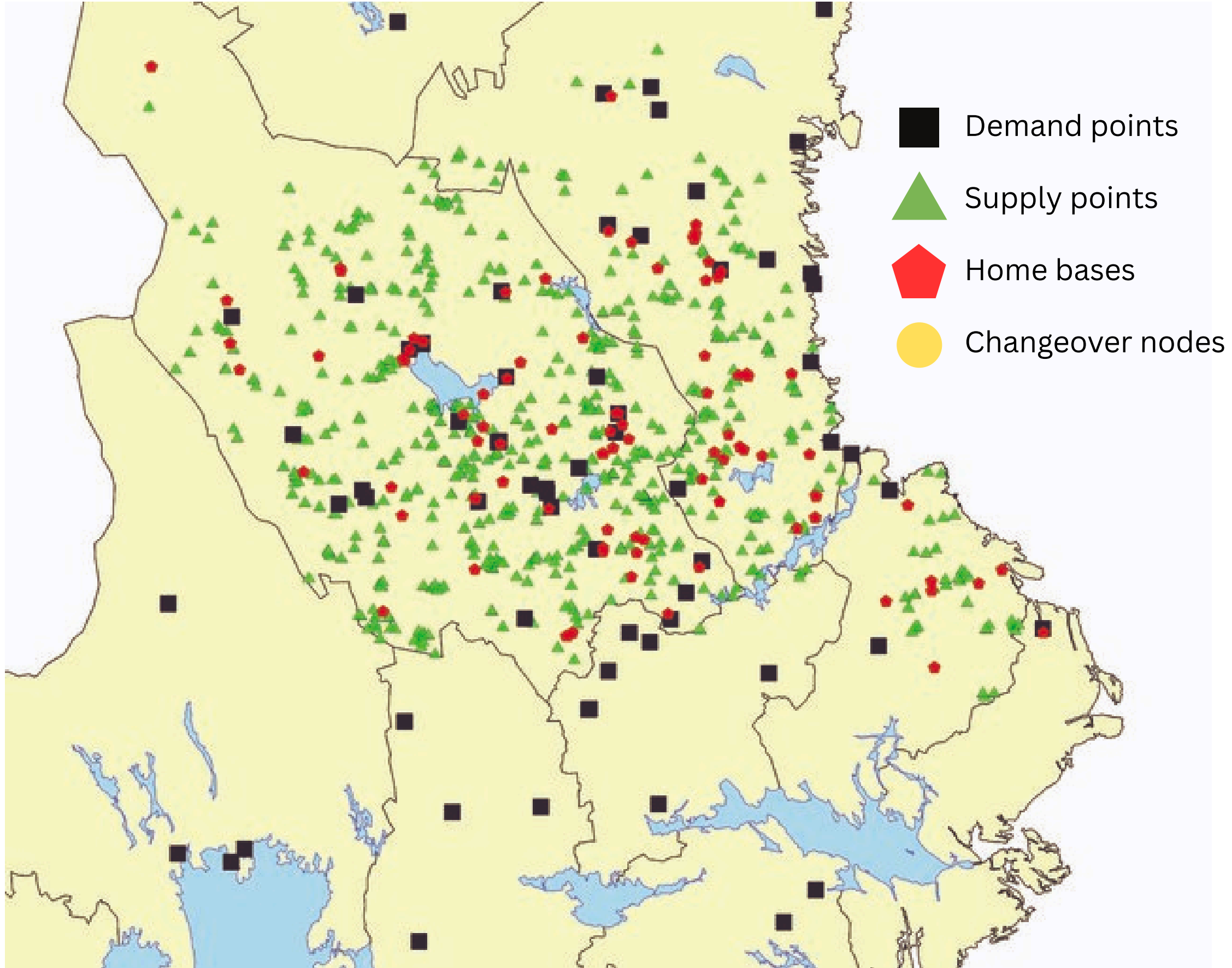
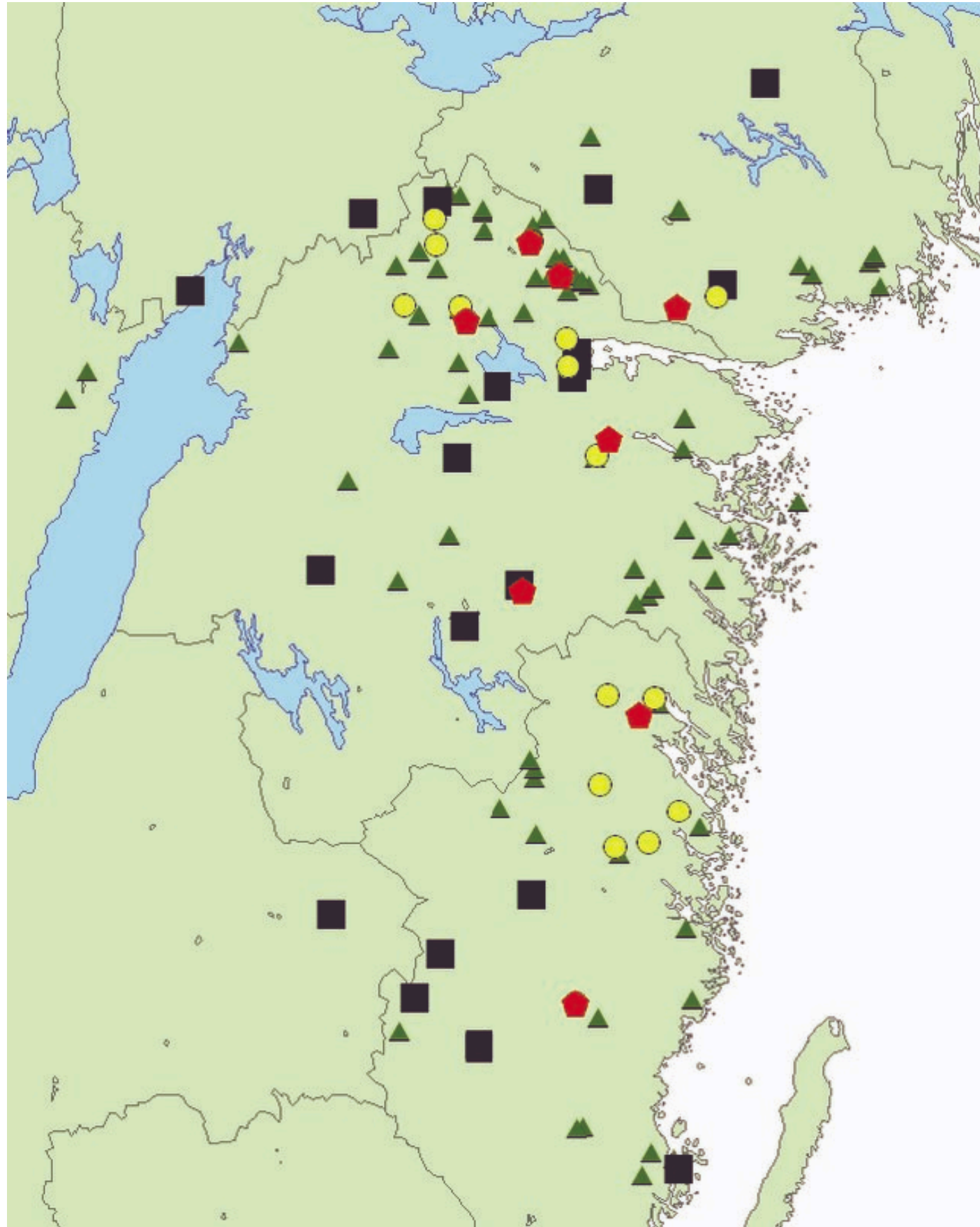
An overview of the CRF system

Forestry transport in Sweden is paid according to payload and distance travelled. The forestry sector has developed a system for distance measurement, **Calibrated Route Finder (CRF)**, which **balances quantitative factors**, such as *distance, functional road class and road width*, with **qualitative factors**, such as *stress and traffic safety*. An inverse optimization process is used to translate best-practice routes into a weighted objective that is used when new routes are generated.



The proportion of invoiced distances established by CRF since the launch of the system in 2009, and when different forest companies joined the system.



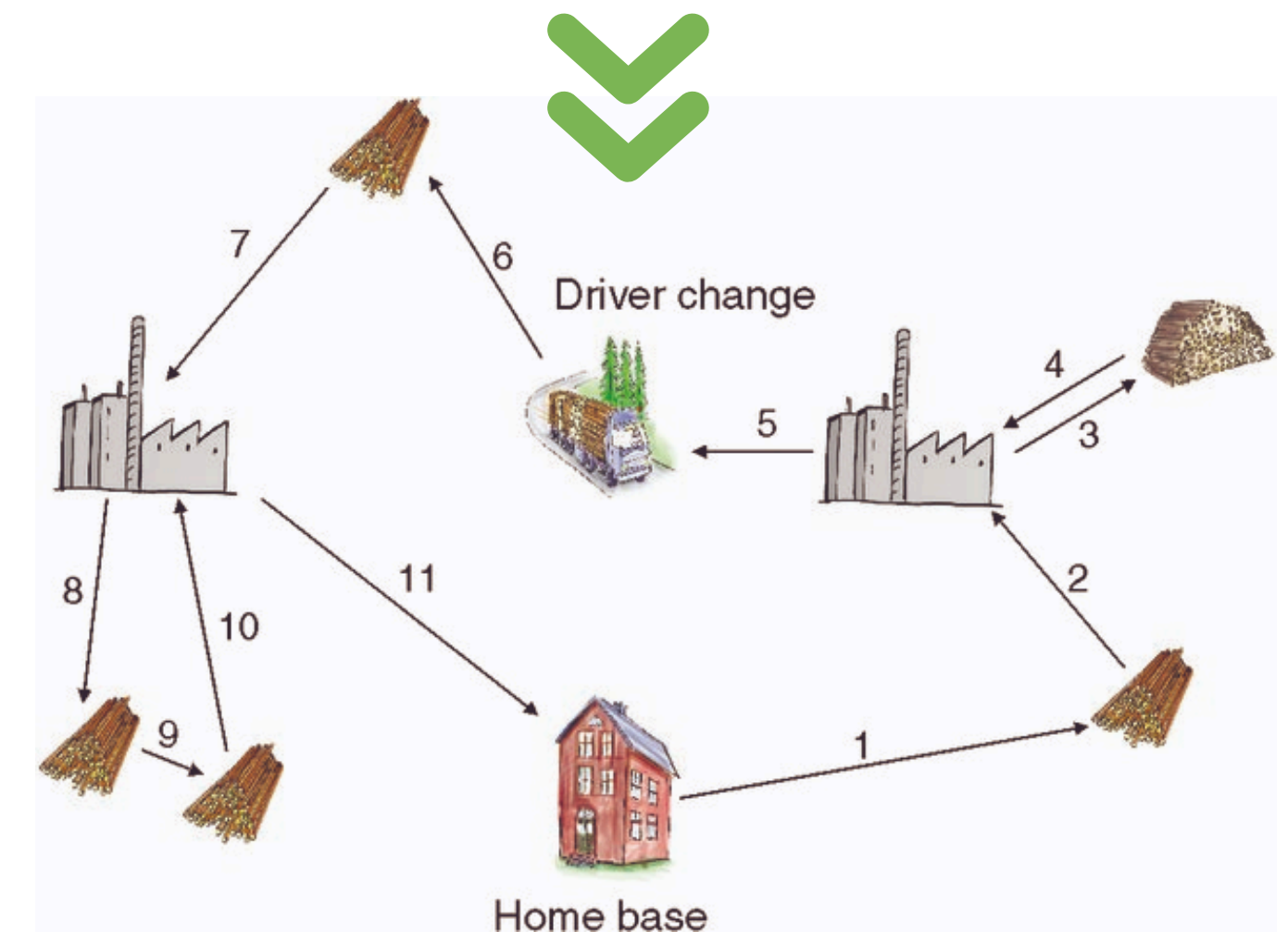
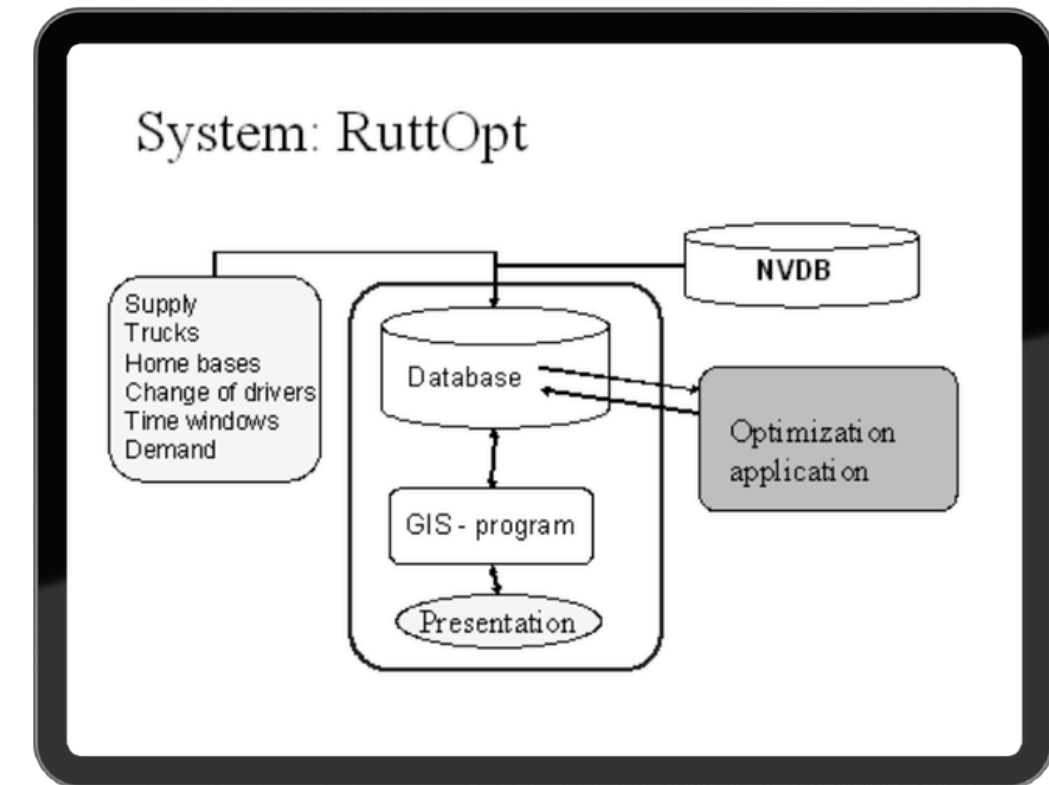


RuttOpt

The decision support system called **RuttOpt** is developed for scheduling logging trucks in the Swedish forest industry.

The system was developed for the forest industry in Sweden to help with the tactical planning of wood transportation. Key features of the RuttOpt system include:

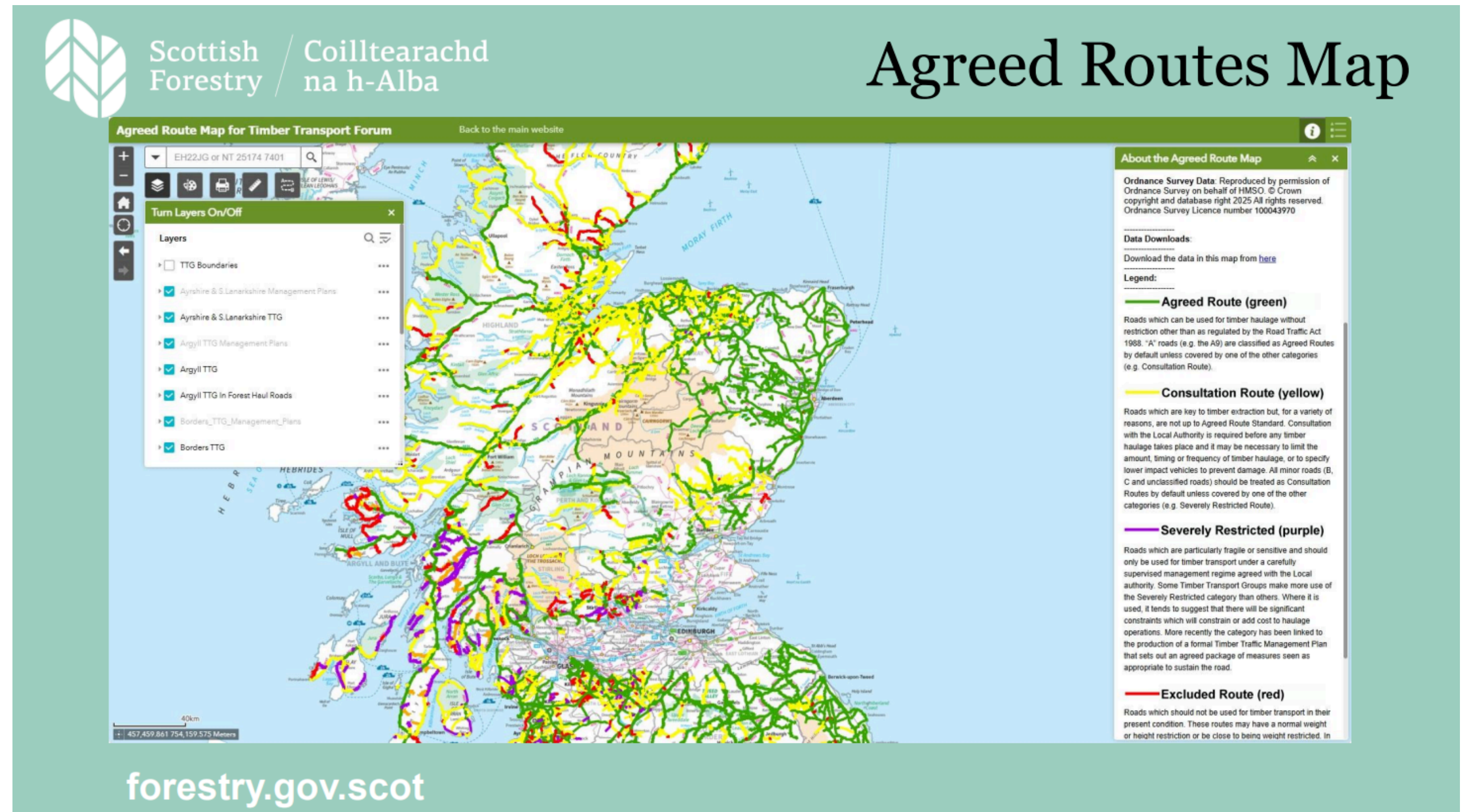
- **Optimization Routine:** It uses a two-phase algorithm combining linear programming and a tabu search method to find efficient schedules and routes for logging trucks.
- **Swedish Road Database (NVDB):** The system integrates with the national road database, which provides detailed road information and a tool to compute distances between locations.
- **User Interface:** A central user interface allows information and results to be viewed on maps and in Gantt schedules.

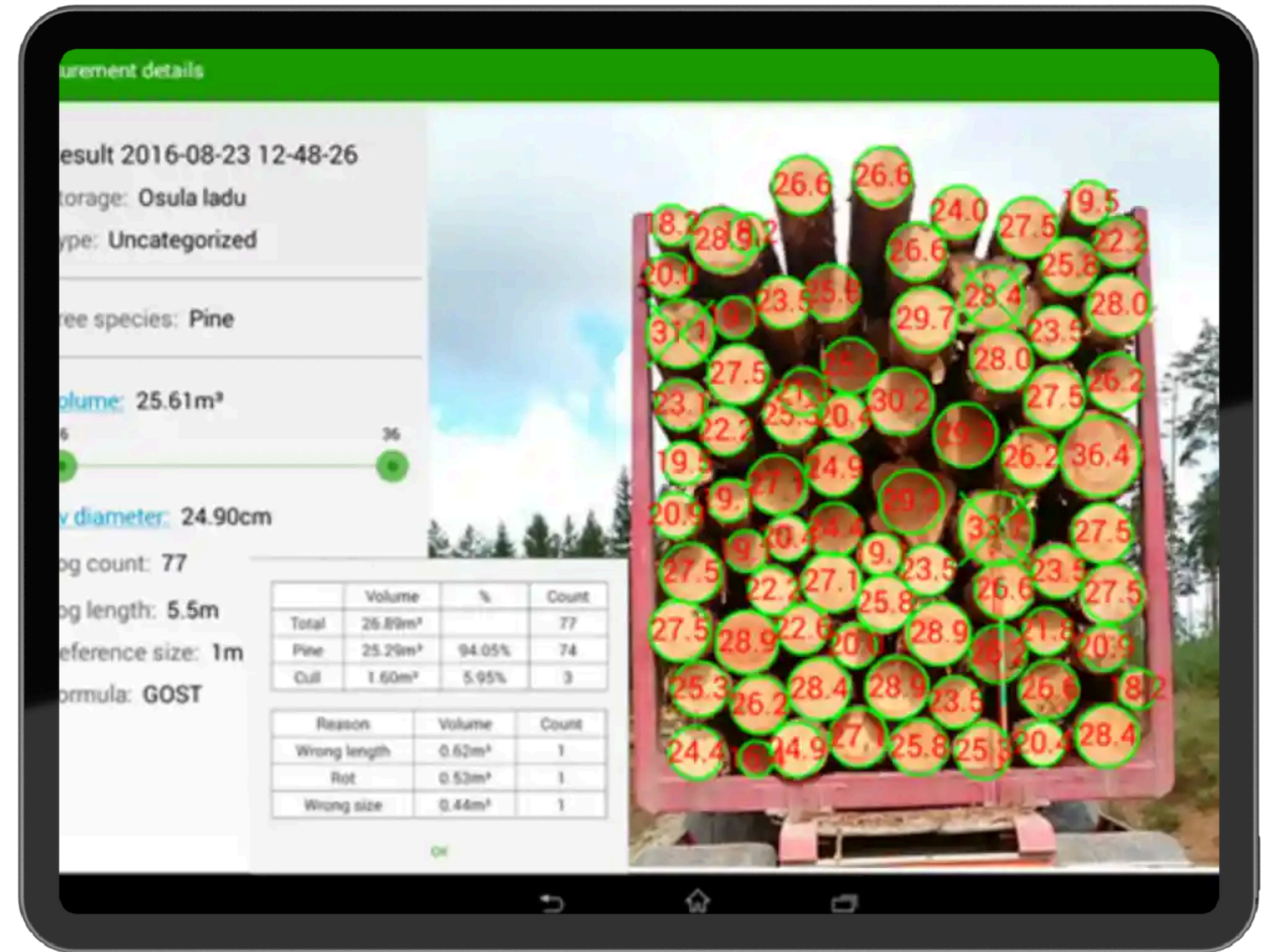
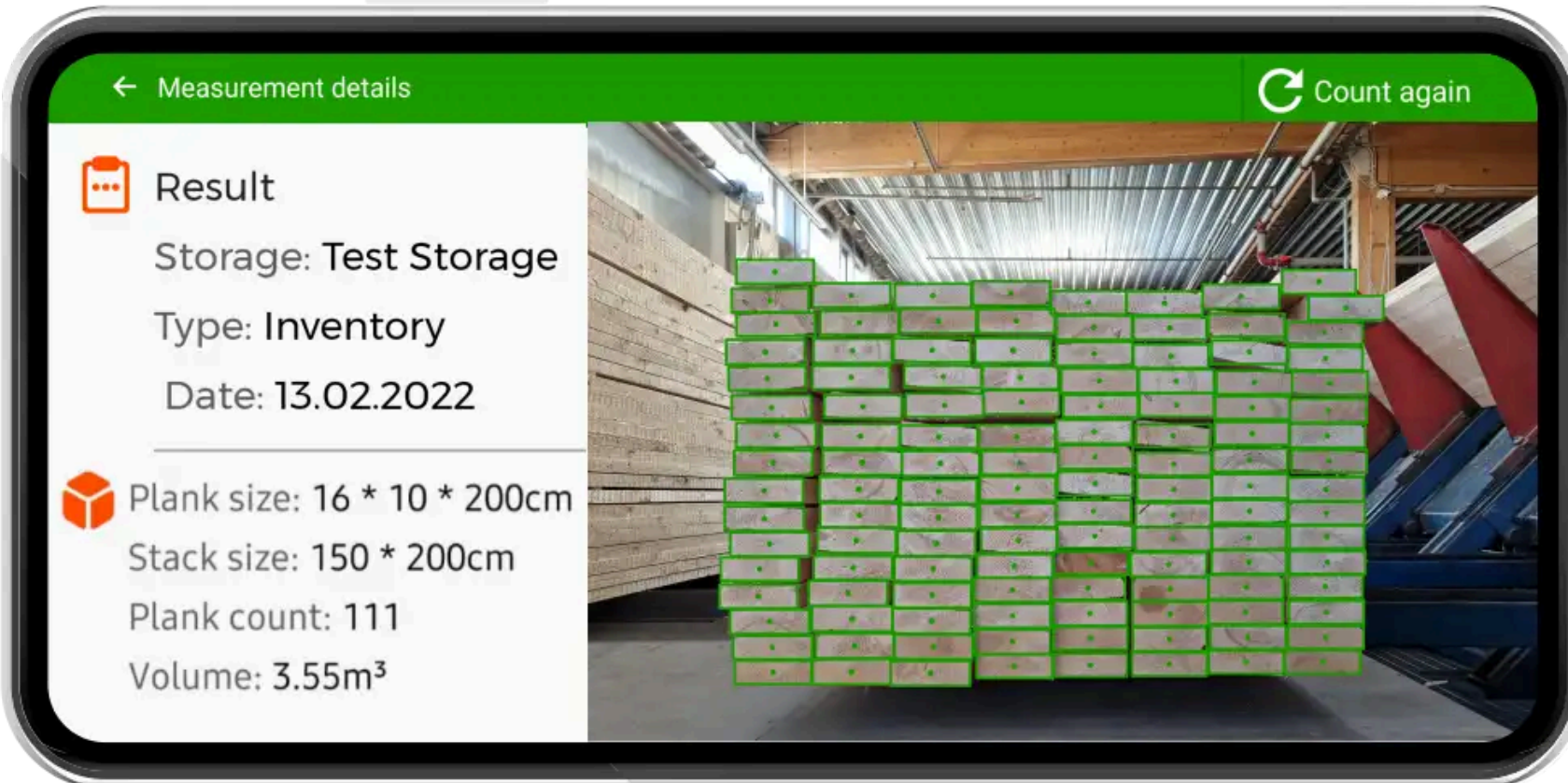
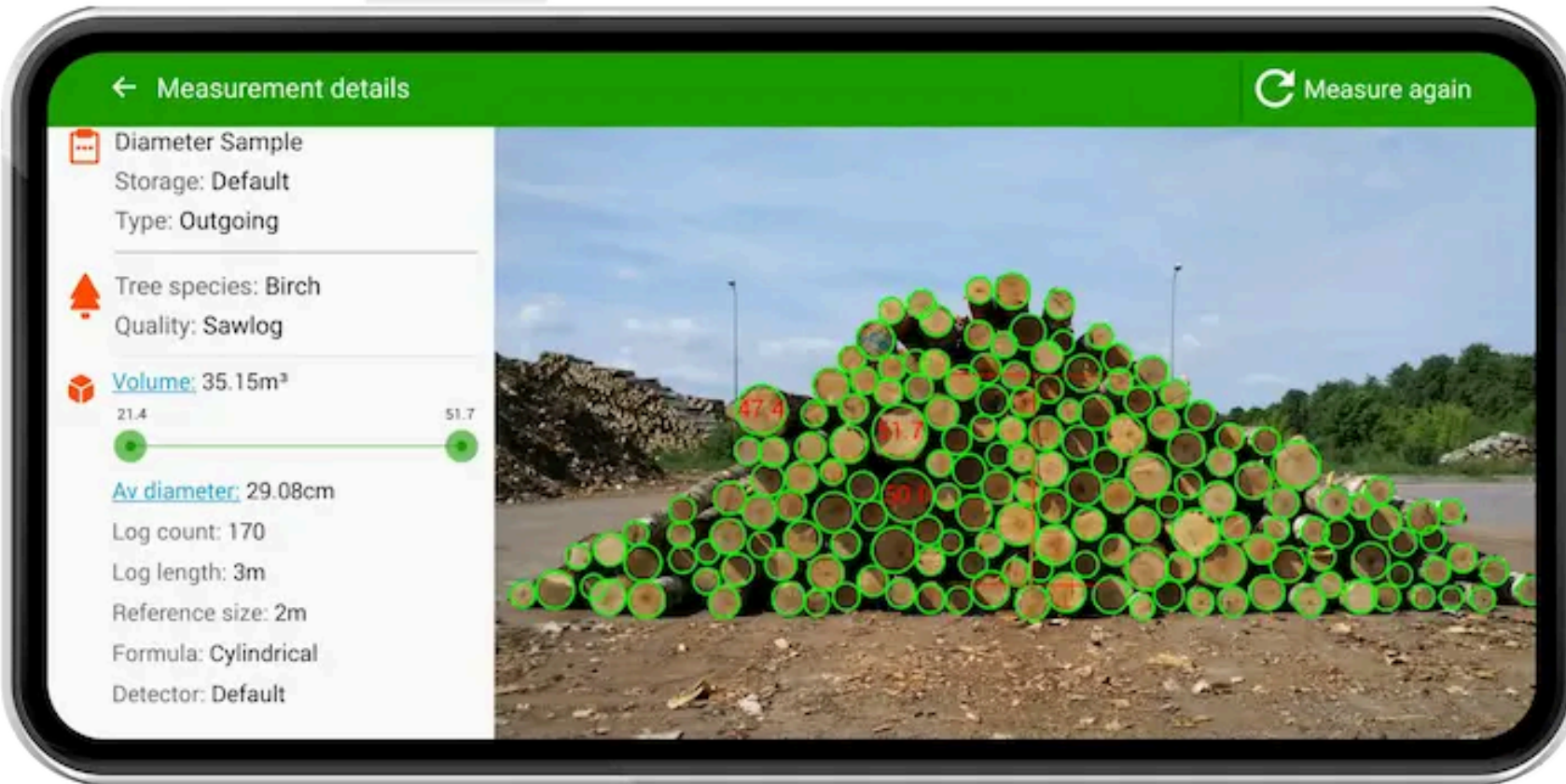


Timber Transport Forum (TTF)

Aim of TTF to minimise the impact of timber transport on the public road network, on local communities and on the environment. The Forum promotes voluntary measures to improve the sustainability of timber transport:

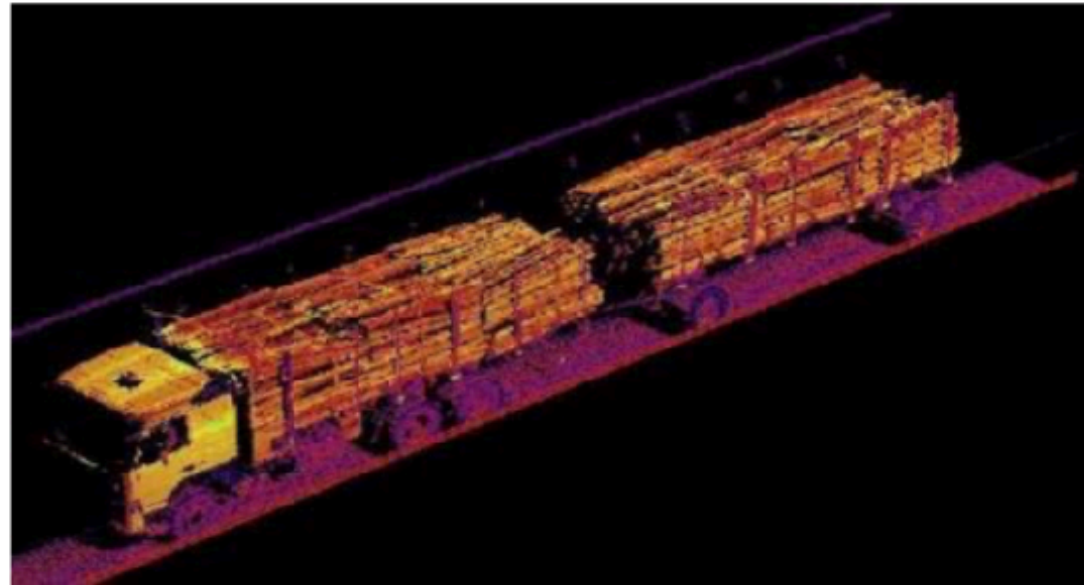
- Managing timber traffic to sustain the road network and minimise disruption
- Maintaining and improving minor roads used for timber haulage
- Moving timber by other modes of transport where possible





Solid volume measurement

Laser scanning



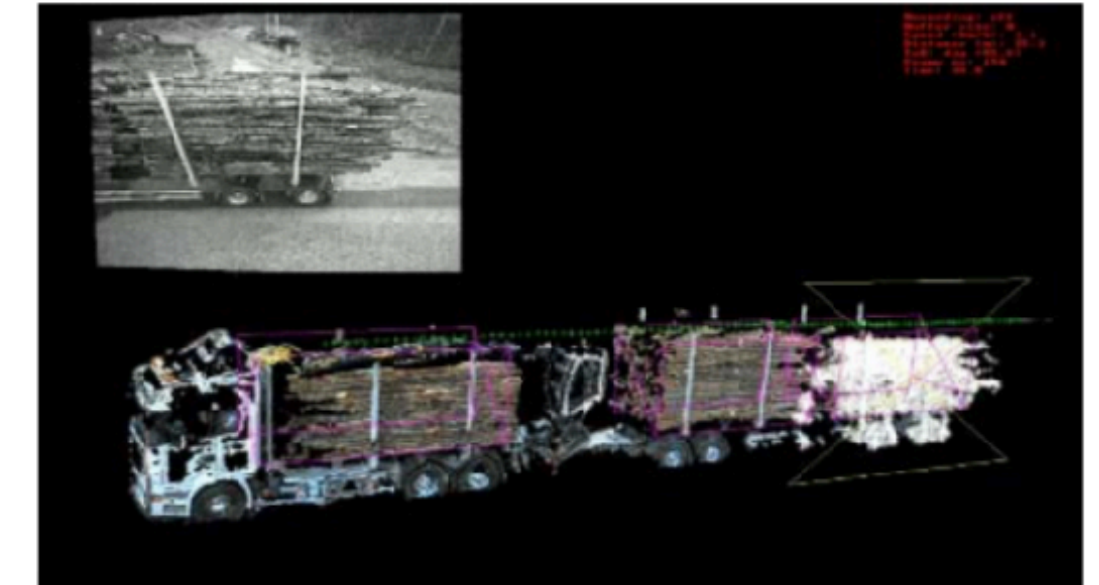
Source: Woodtech

Laser scanning



Source: Mabema

Stereoscopic cameras



Source: Saab/Microtech

Solutions
are context dependent.



**The future of transport is
smart, sustainable and built to**

waste

cost

harm

LESS

”