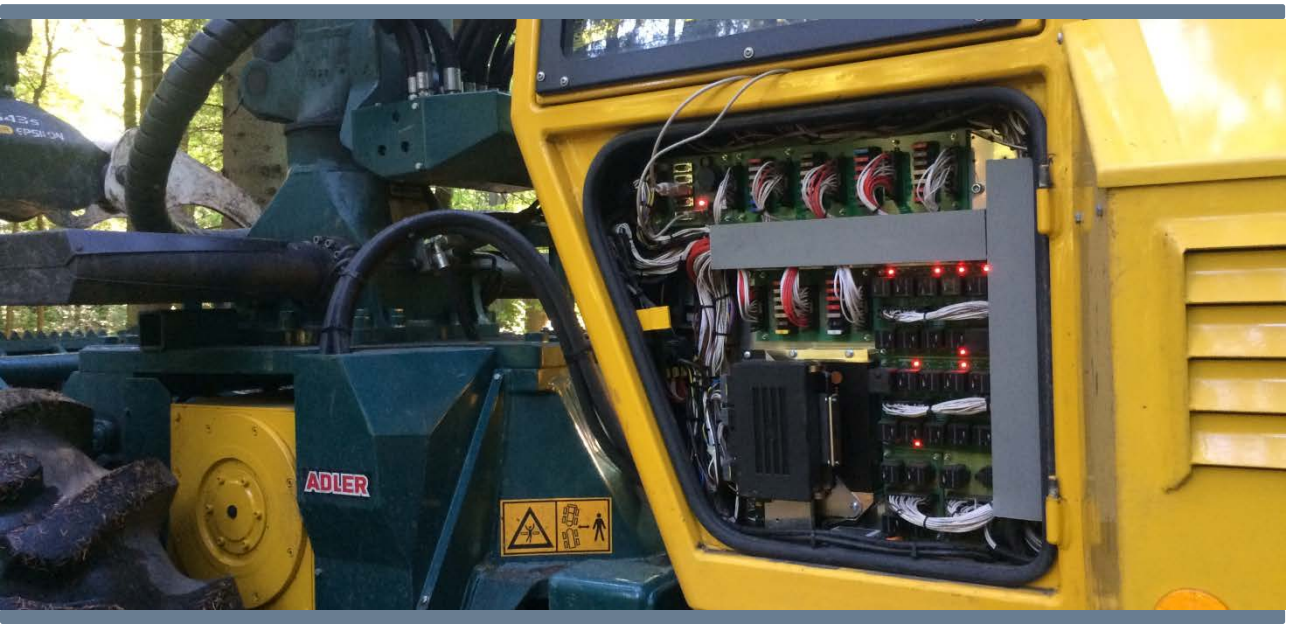
Berner
Fachhochschule



HSM Skidder 805 HD
Foto: B. Urbanke

Sensor-based, automated monitoring of fully mechanised harvesting processes – including options for automated process control

Martin Ziesak[1], Daniela Rommel[1], Stephan Ying[2], Patrick Preusch[3]

- Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften HAFL

Agenda

1. CAN bus data & iFOS
2. Monitoring of forest operations
3. Control aspects for forest operations
4. Conclusions

5. Questions

1. CAN bus & iFOS

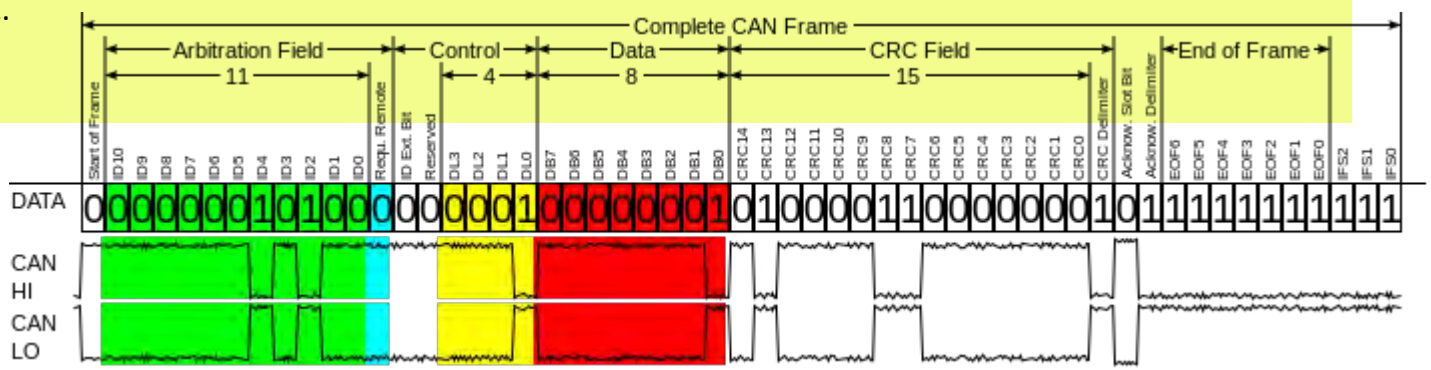
1.1. (Very short) background about the CAN bus

The **controller area network (CAN) bus** is used for sending communication messages on
- engine- and
- machine status, in any heavy duty machinery, also in forestry machines.

There is a widely accepted data standard, which is “SAE J1939”.

The list of variables / parameters available over the CAN bus is quite long, typical elements are

- Engine status (engine-stop, engine-start, engine-idling, working engine speed control, engine revolutions, …)
- Engine oil status (level, temperature, pressure, ...)
- Engine coolant (level, temperature, ...)
- Fuel indicators (consumption, engine trip fuel, temperature, ...)
- Ambient conditions (barometric pressure, cab temp., engine air inlet temp., ...)
- …

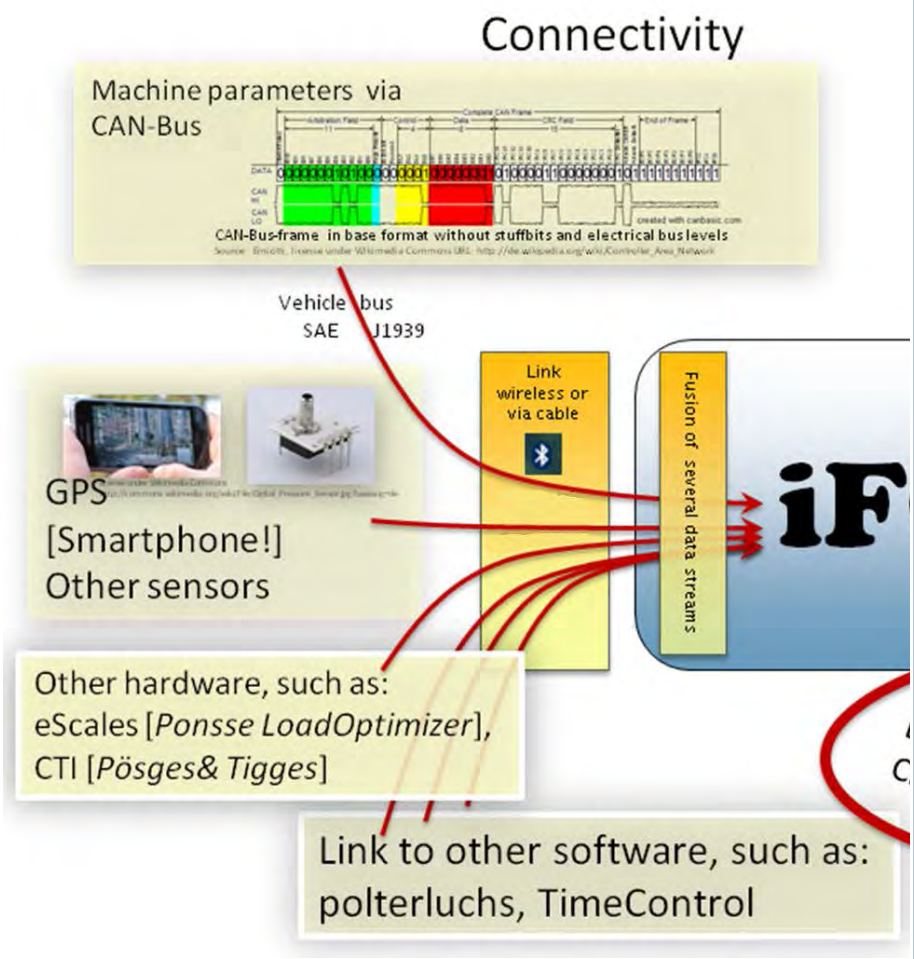


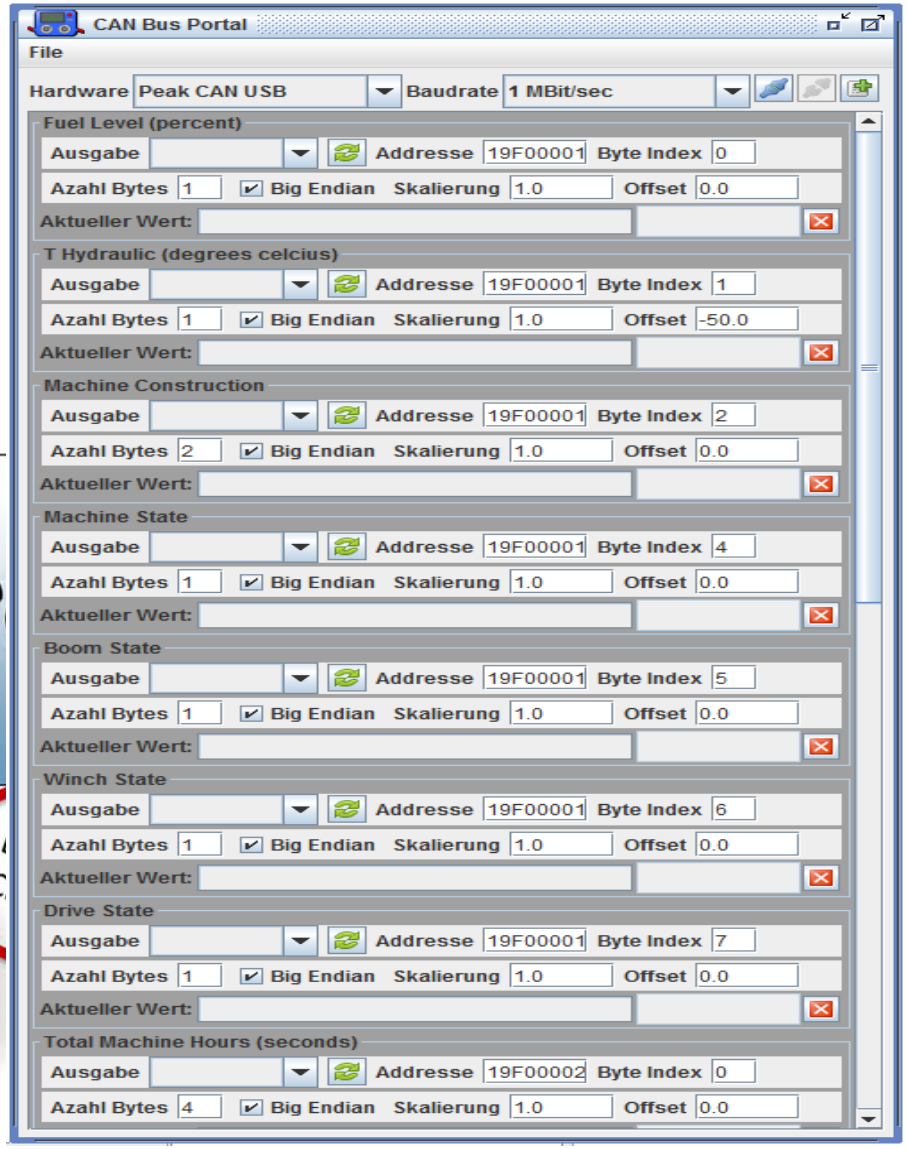
CAN-Frame in base format with electrical levels without stuffbits

https://en.wikipedia.org/wiki/CAN_bus

1. CAN bus & iFOS

1.2. *i*ntegrated *F*orestry *O*perations *S*oftware (iFOS)





1. CAN bus & iFOS

1.2. *i*ntegrated *F*orestry *O*perations *S*oftware (iFOS)

Machine, used for testing:
Skidder HSM 805 HD

Photo: Urbanke

Enriching CAN bus information by adding

1. Extra sensors (slope indicator, rear blade force indicator, …)
2. Including messages from driver: status messages
3. Including messages on machine level by CMC (central machine controller)

3. Report messages, as provided by skidder

Electric generator on	0x1
Water in filter	0x2
Parkbrake	0x4
Active brake	0x8
Hydraulic oil level low	0x10
Hydraulic oil too hot	0x20
Cooling water too hot	0x40
Hydraulic reservoir pressure low	0x80
Preheating	0x100
Water in filter	0x200
Allwheel drive on	0x400
Boom on	0x800

2.: Messages as provided by operator

Activity	ID
Transport	0x1
Work	0x2
Repair	0x4
Break	0x8
Service	…

2. Monitoring of forest operations

2.1. *i*ntegrated *F*orestry *O*perations *S*oftware (iFOS)

1. What to monitor?
   - Engine
   - Machine
   - External sensors (GPS)
   - Produced elements (assortments)

2. Make this monitoring information available independent of:
   - Position and
   - Time

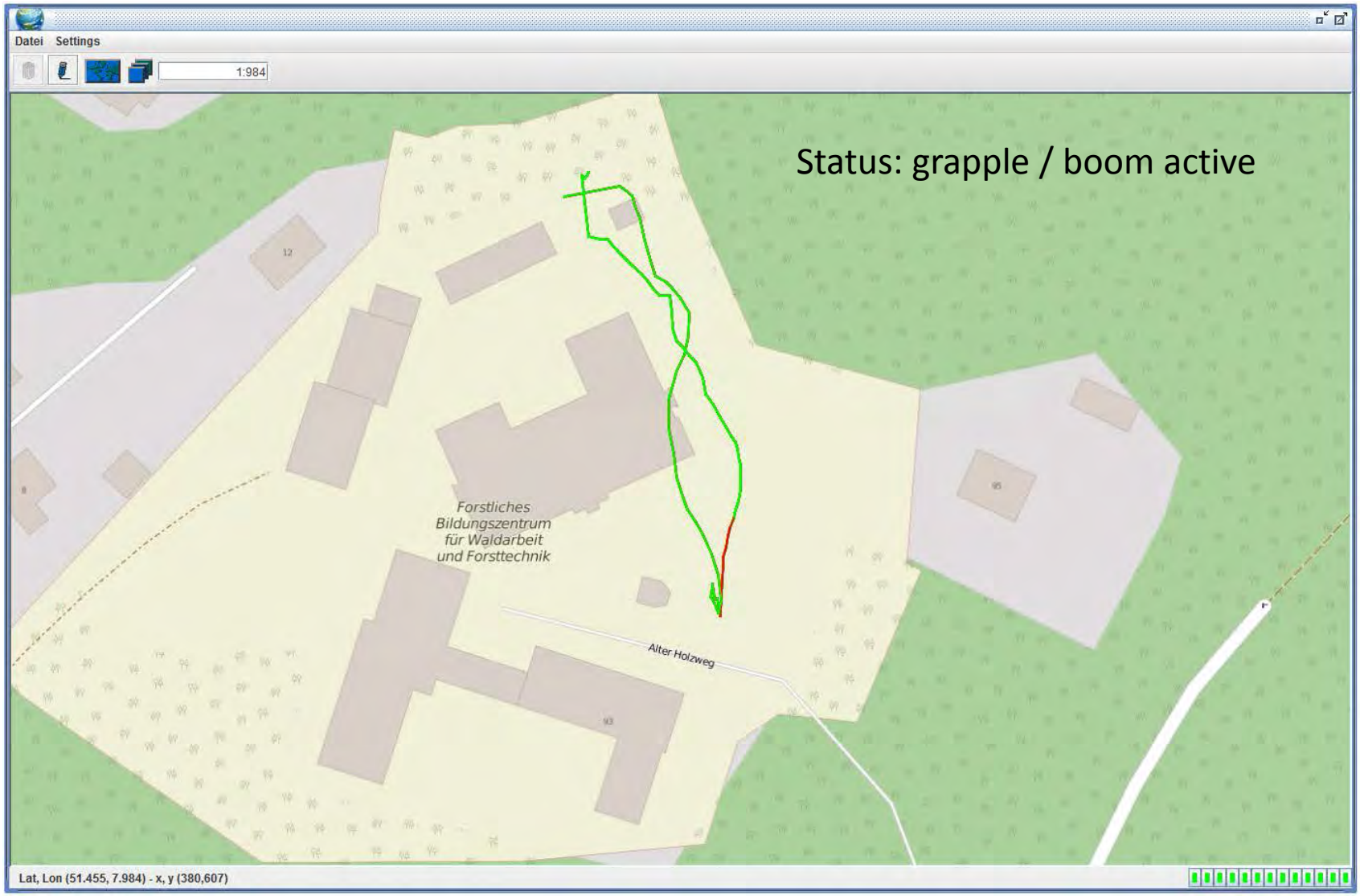
   by sending the describing data ***instantly*** to onto a GeoDatabase server

3. Thus a flexible data display is possible:
   - Values over time
   - Values pinned onto a map
   - …

   iFOS offers first, basic display options.

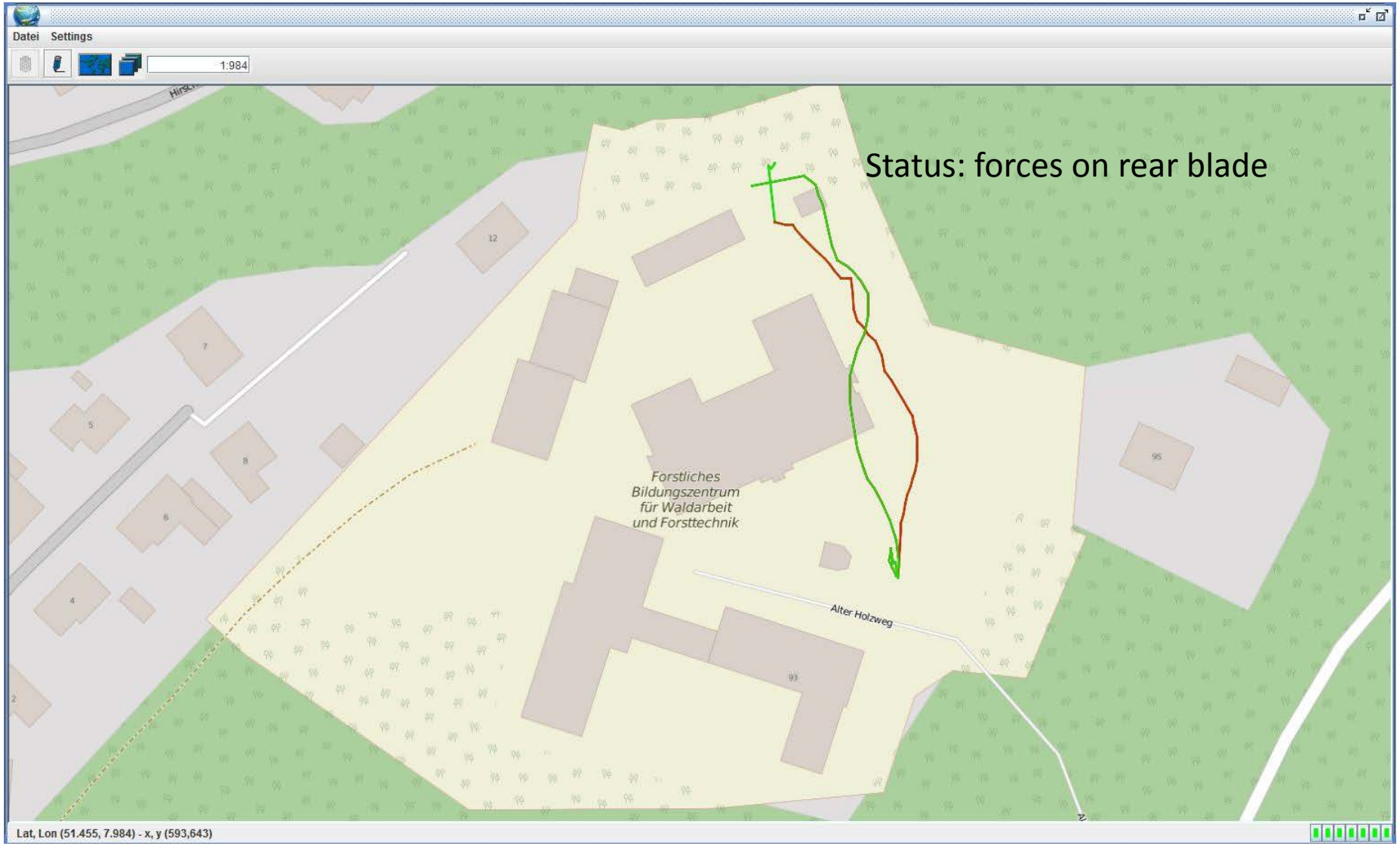
2. Monitoring of forest operations

2.2. Examples from iFOS (screen shots) 1/5



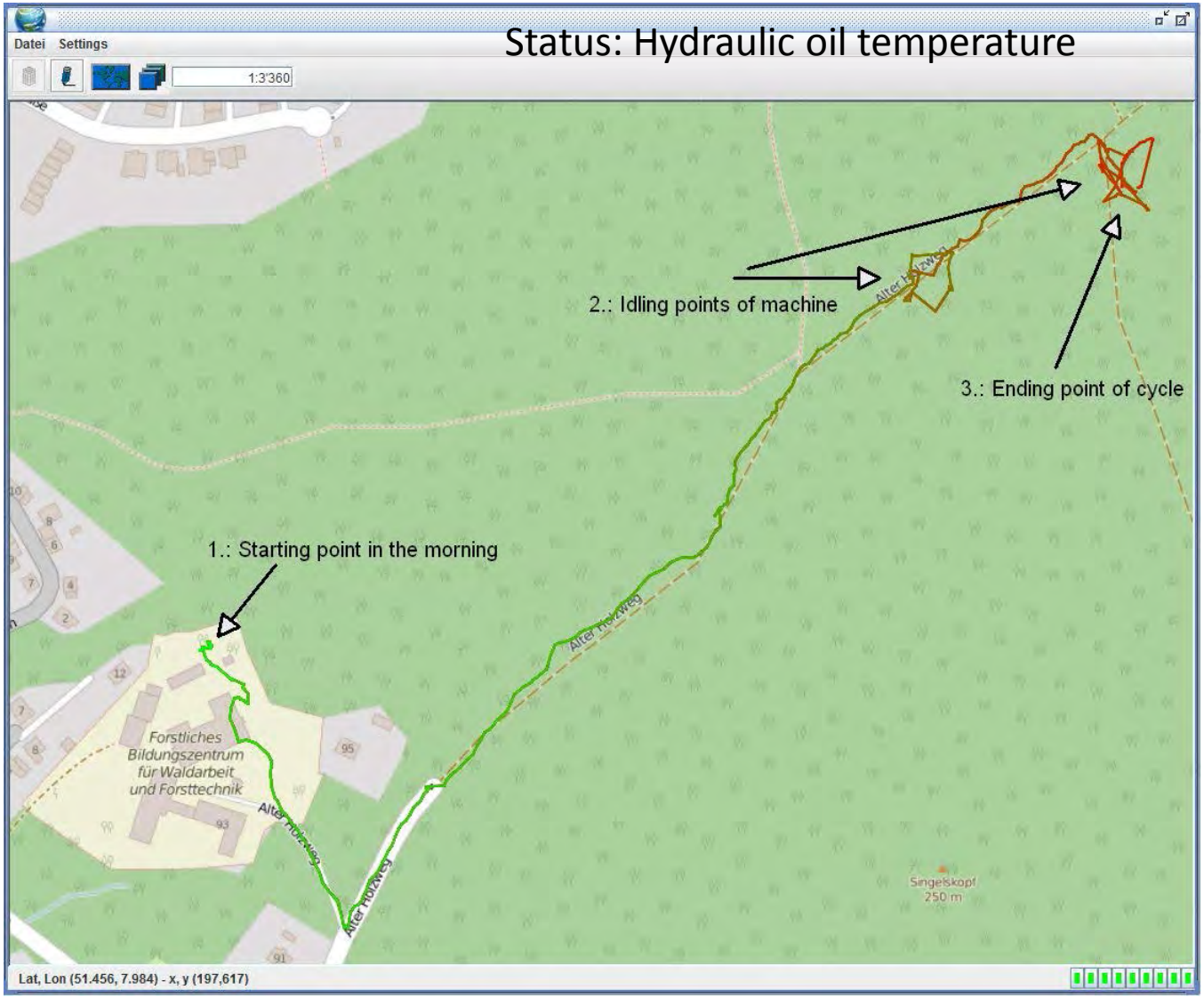
2. Monitoring of forest operations

2.2. Examples from iFOS (screen shots) 2/5



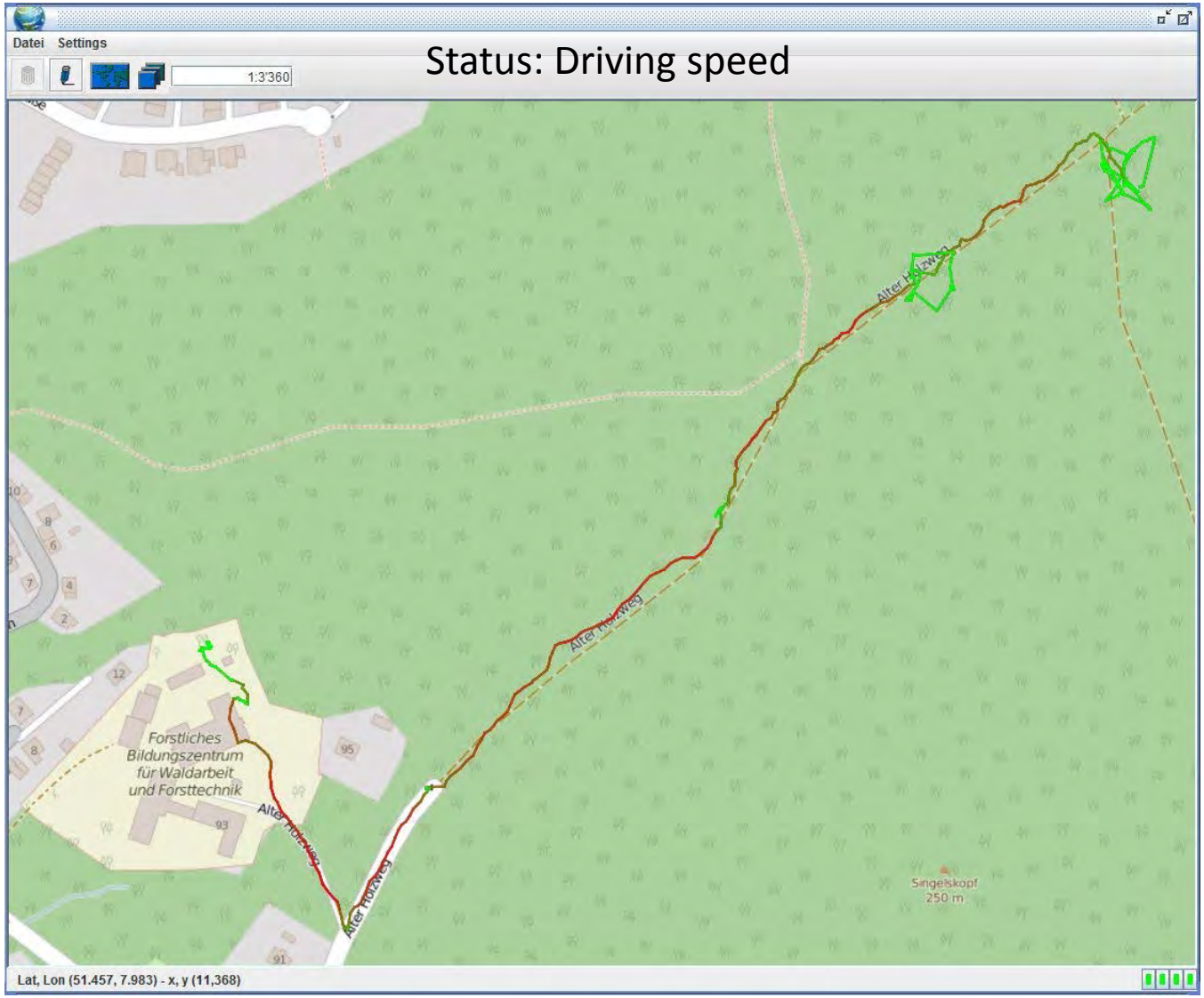
2. Monitoring of forest operations

2.2. Examples from iFOS (screen shots) 3/5



2. Monitoring of forest operations

2.2. Examples from iFOS (screen shots) 4/5

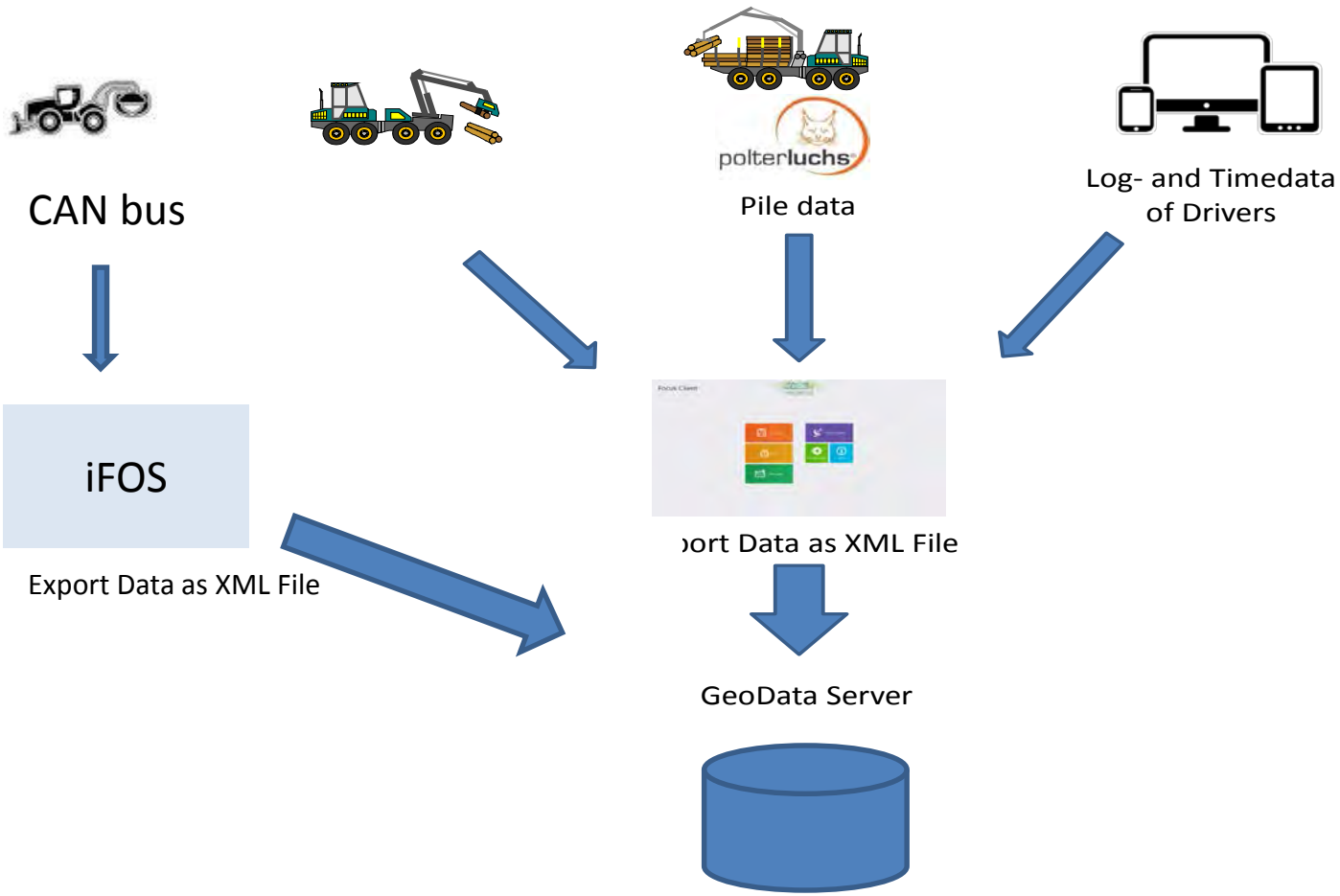


2. Monitoring of forest operations

2.2. Examples from iFOS (screen shots) 5/5

2. Monitoring of forest operations

2.3. Simplified data flow for blending engine- / machine- / operational data



3. Control aspects for forest operations

3.1. What are the variables to be controlled at the operational level?

Product quantities & characteristics:

more or less fixed and driven by other parameters

Resources, describing the technical production:

input of energy;

output of emissions (exhaust fumes, CO_2, …);

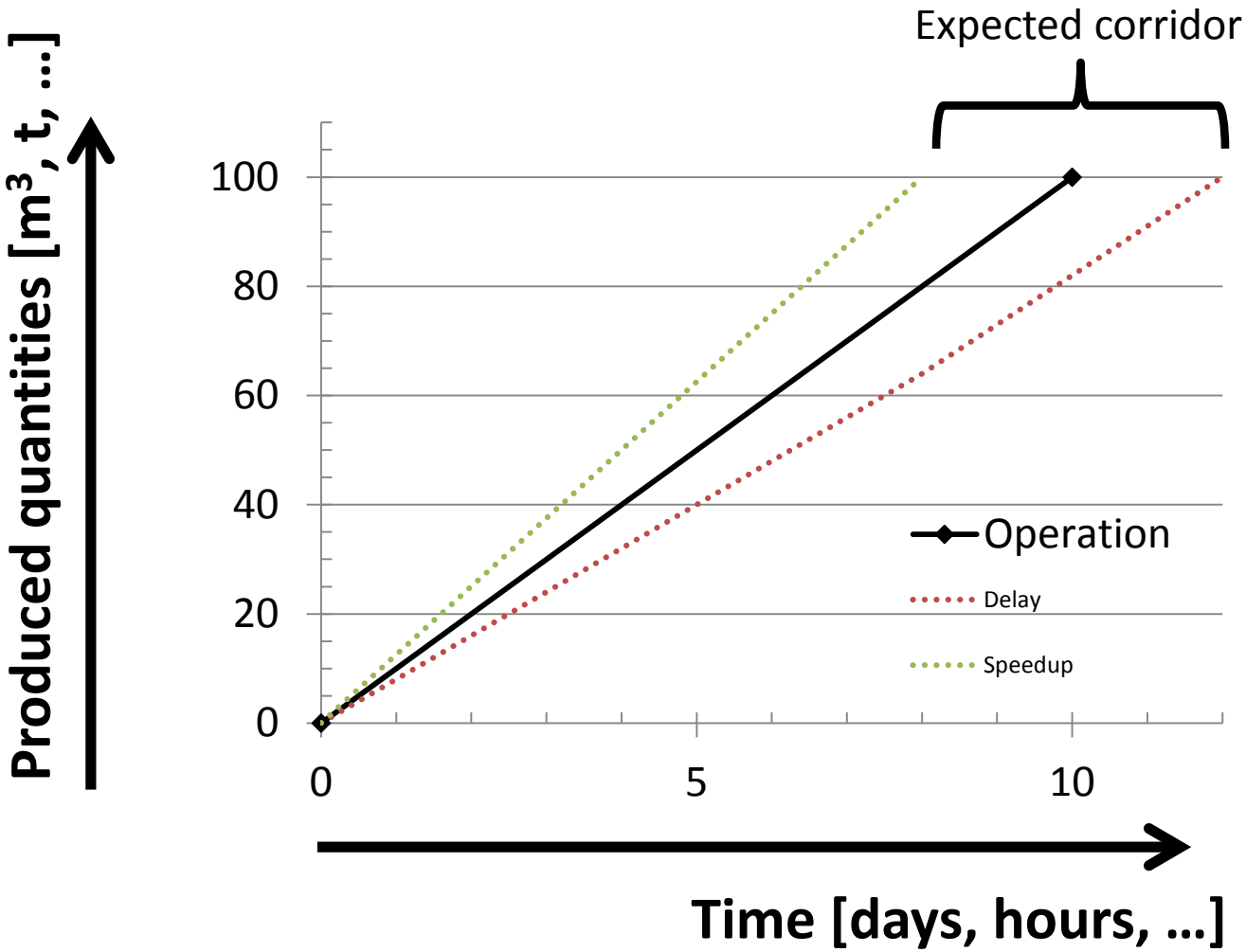
at this time no control feasible

Time:

important resource, steering actor for the sequence of actions

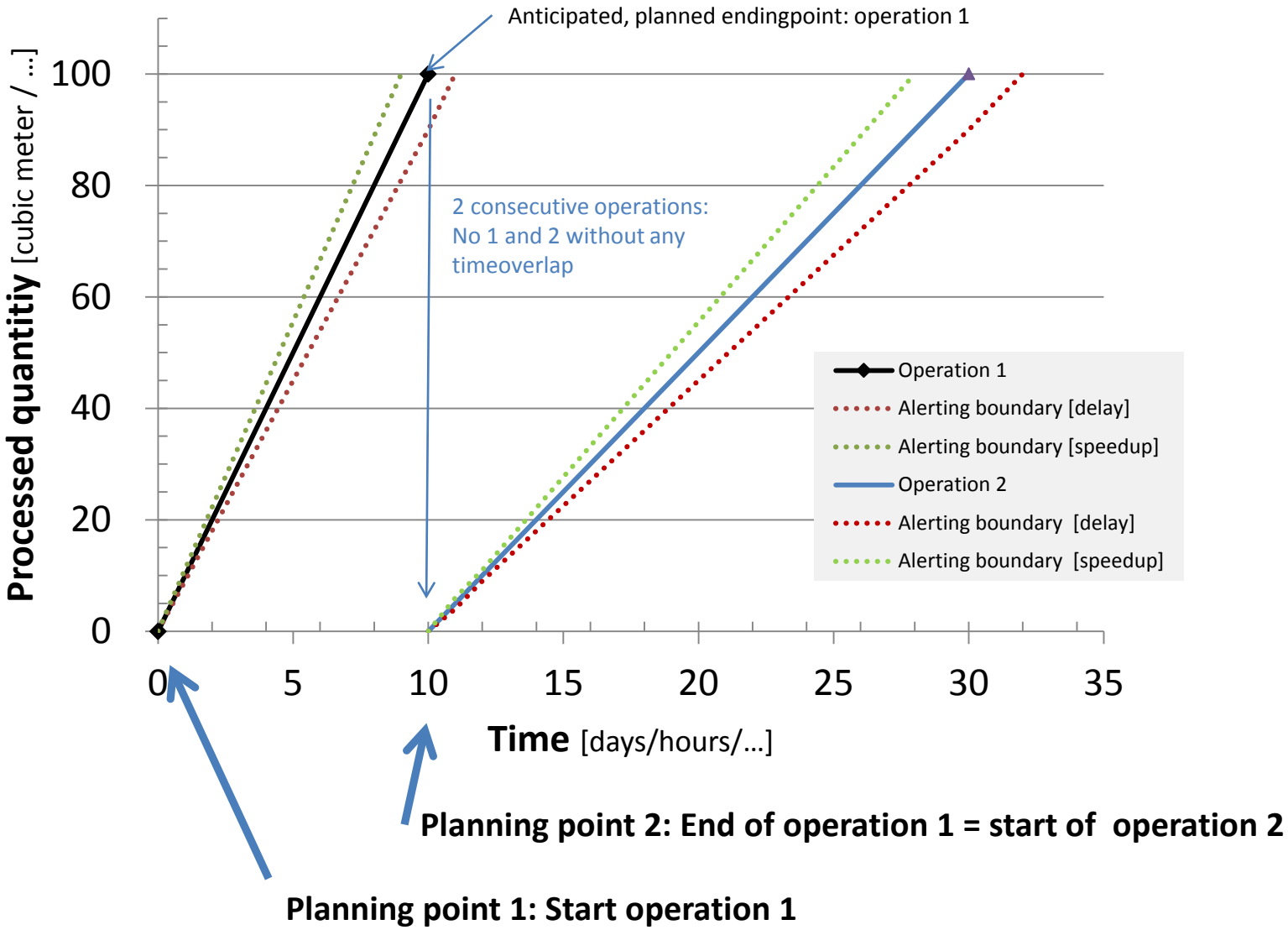
3. Control aspects for forest operations

3.1. Produced quantities over time



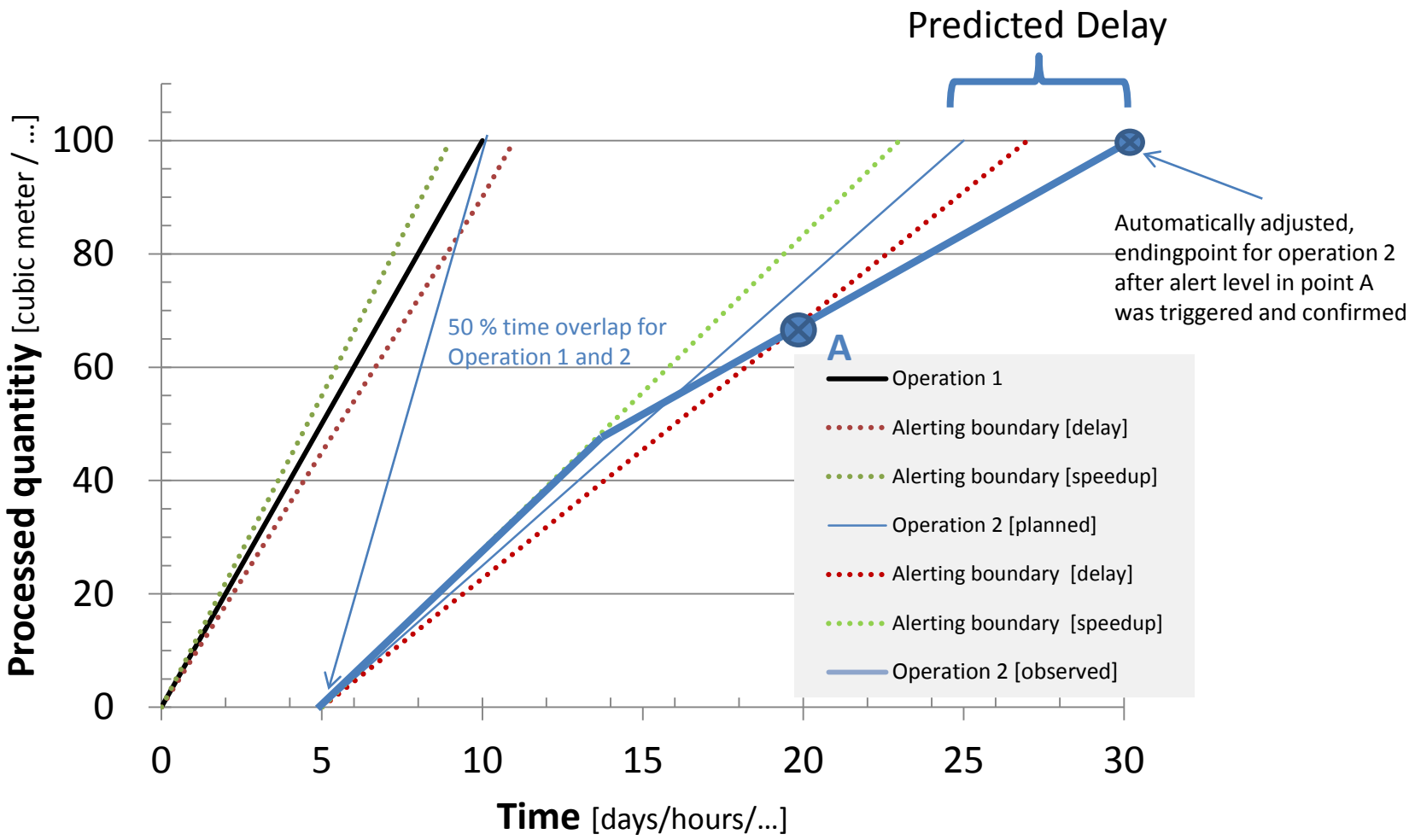
3. Control aspects for forest operations

3.1. Produced quantities over time



3. Control aspects for forest operations

3.1. Produced quantities over time



4. Conclusions

4.1. The CAN bus offers valuable information for describing the engine / machine status, thus production.

4.2. In particular, by merging and enriching, the CAN bus data by further information elements, a detailed, automatic description of production is possible.

4.3. By sending such production data instantly to a database server, a space independent life monitoring of forest operations is possible.

4.1. Even an automatic, time oriented process control is possible.

Photo: Urbanke