Metsäteho

The potential and use principles of harvester production data as forest resource information

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Targets for extensive utilization of harvester data

- The objective in Finland is to utilize the existing information of harvesting and other forestry operations in keeping up the public forest resource information
  - Forest data provided by Finnish Forest Centre is open and free for everyone from March 1, 2018
    - laser-scanning based data (16 m x 16 m), will cover whole country by 2020
    - stand-based data from all over the country
  - Information about the cut areas can be achieved either from
    1. harvester production data: delineated stands and strip roads
    2. satellite images (Sentinel 2): interpretation of vegetation changes
  - Other potential data sources are the declarations of the performed operations and self-control systems of forest work
    - silviculture operations

- Estimation systems for stock properties of new harvesting sites
  - planning of wood supply operations in forest companies
  - electronic wood market
  - planning and simulation services of cross-cutting

- Wood value assessment
  - based on combining harvester data, measurement data of the sawmills (X-ray) and laser scanning data (ALS)

Basis and state-of-art of data production (1)

- Data is produced as a ”by-product” of harvesting operations so in principle it is free of cost
  - data ownership and rights to use the data has been agreed in Finland
- Quality of data is generally good enough
  - control and follow-up of wood measurement guarantees it
  - tree coordinates are integrated to production data on condition that advanced GNSS location systems are applied
    - still quite a lot of improvement actions need to be done
- New data production methods are being studied and developed for practical purposes
  - near mapping methods (TLS, MLS) for control of thinning density and mapping of standing trees after the cutting
  - self-control systems of harvesting work quality based on e.g. image analysis
- Stem-specific data offers possibilities to analyse tree and stock properties afterwards
  - wood quality at general level based on log cutting points
  - e.g. root rot infected areas

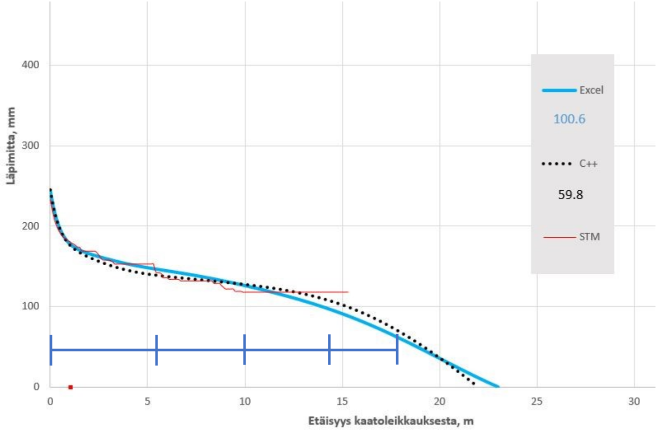
Basis and state-of-art of data production (2)

- StanForD 2010 is in implementation phase in the forest companies
  - production data will be more accurate due to stem and log-specific registering of measurement
  - both StanForD 2010 and StanForD Classic will be supported by machine manufacturers over the change period
  - WoodForce service will be taken in full use gradually by several forest companies
    - management of hpr files is done in the service

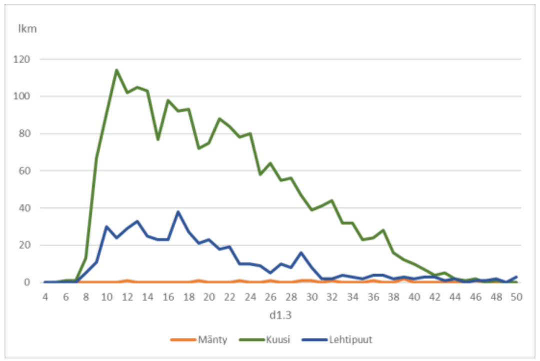
- Utilization concepts have been developed and promoted actively in the forest digitalization spear head projects funded by both Ministry of agriculture and forestry and forest industry
  - harvester data warehouses (stem banks) and supporting methods
  - methods to estimate stock properties of a harvesting object based on harvester big data
  - use of harvester data in updating of forest resources
    - data processing methods
  - Forest Data Platform in pilot phase
    - to combine different forest data sources

Potential use areas and applications of harvester data

Stem profiles and log information



Diameter and length distributions of the tree stock

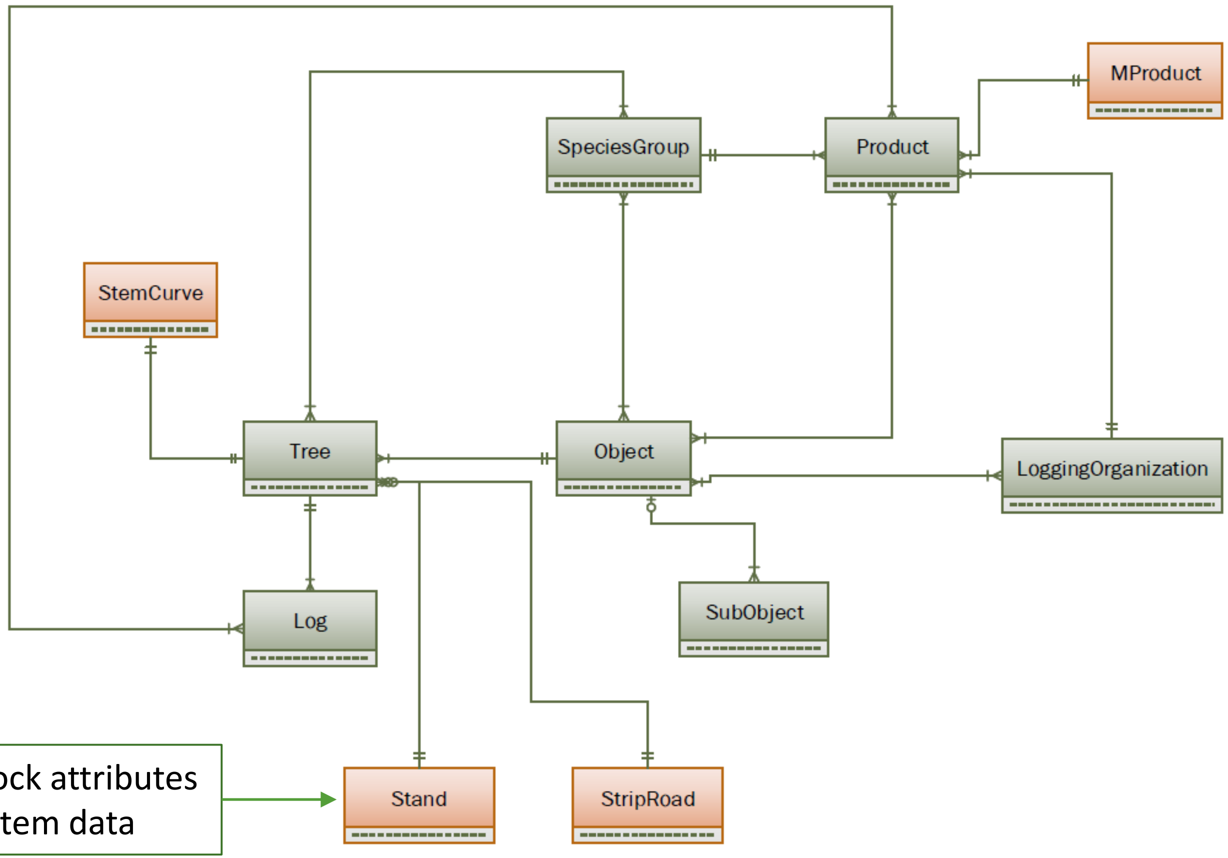


Location of trees

Stand delineation and striproad network

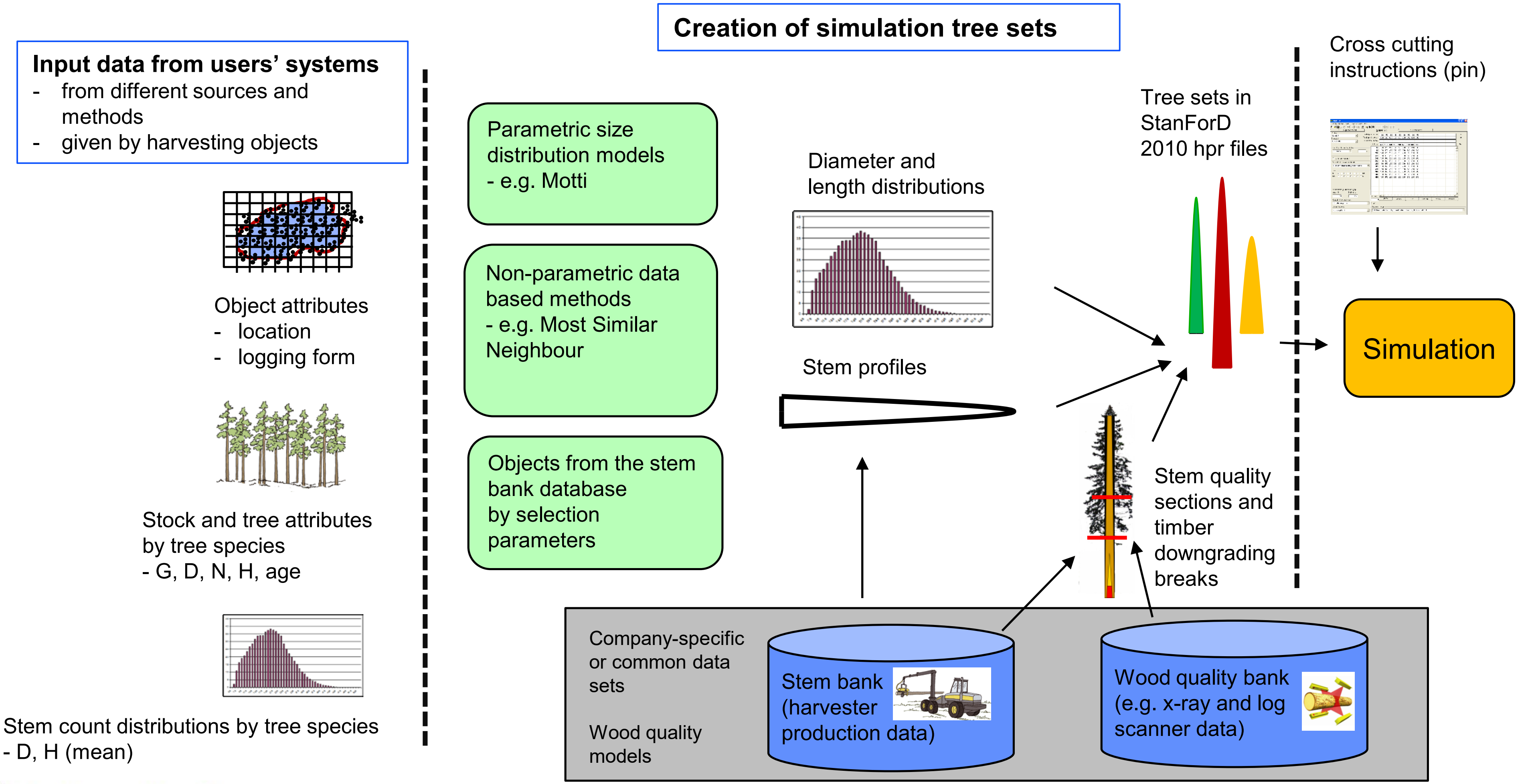
- Quality models
- Planning and control of bucking
- Wood purchase
- Harvesting site planning
- Field reference in forest inventories
- Site classi-fication
- Monitoring of operations
- Update of forest resources

Data model of the harvester database in Metsäteho



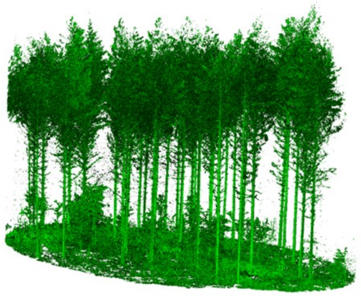
Aggregated stock attributes derived from stem data

Cross cutting simulation



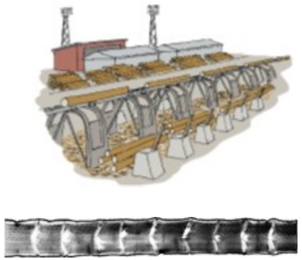
Sawmill X-ray measurement data in value based classification of harvesting objects

Stand data



Harvester measurement data

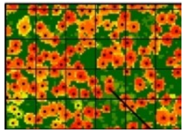
3D log scanner and X-ray data



Dependencies between stand properties and log quality attributes measured at millgate by X-ray utilizing Big Data methods

=> Grounds for value based precise control of wood flow and use of raw material

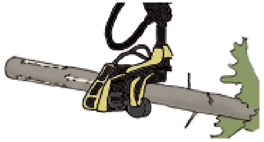
Wood quality data repositories



Grid level remote sensing data (laser scanning)
- features
- tree properties

MODELS

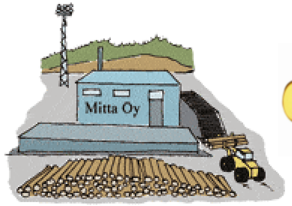
Harvesting object
- base information
- object borders (GIS)



Harvester’s stm/hpr –files (StanForD)
- aggregated stock attributes per harvesting object and tree species
- e.g. saw log percent

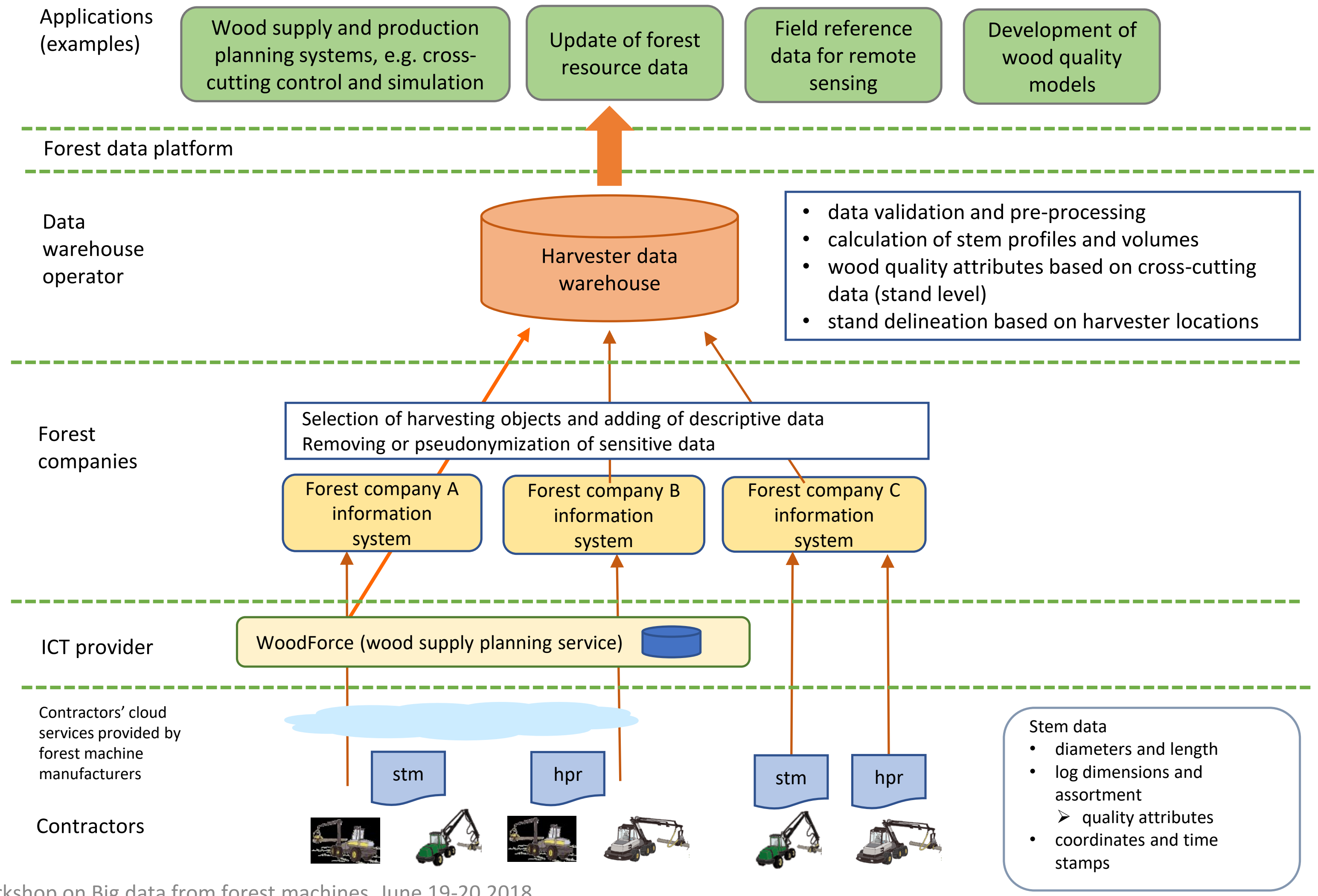
WOOD QUALITY DATA REPOSITORY

Transport information
- truck load information
- loads can be combined from different roadside storages (different harvesting objects)



Measurement data at sawmills
- log scanner and X-ray

Collecting harvester data into a common or company-specific data warehouse



The positioning accuracy of trees based on measured harvester location and crane position

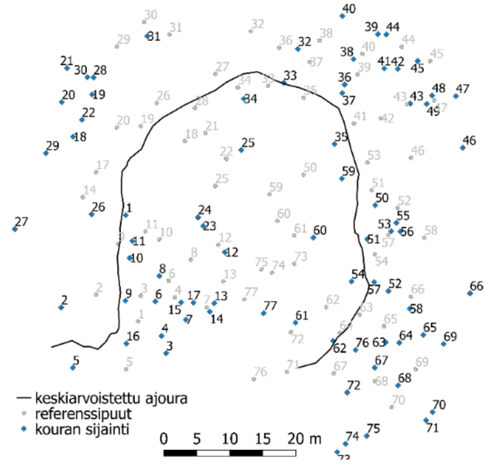
- The objective was to examine and improve the tree-wise positioning accuracy from harvester measurements.
- The data was collected from eight sampling plots from Evo research site, Finland, in co-operation with uni. Helsinki (A. Saukkola master thesis), HAMK polytechnic school, Komatsu Forest Ltd, Metsäteho and its shareholders.
  - Field measurements of individual tree locations with high-accuracy GPS (N = 633)
  - Harvester measurements
- The harvester was Komatsu 931.1, MaxiExplorer operating system
- Data included parameters from HPR file:
  - raw location and bearing of harvester, harvester head (cabin) direction w.r.t. the machine and length of the boom.
- Using raw harvester data:
  - average distance of harvester – tree: ~ 7.9m
  - average distance of harvester head – tree: ~ 6.6m → **only ~ 1.2m** improvement and still poor level of accuracy

→ Metsäteho developed a computational algorithm to improve the position of the harvester head w.r.t. the measured tree locations

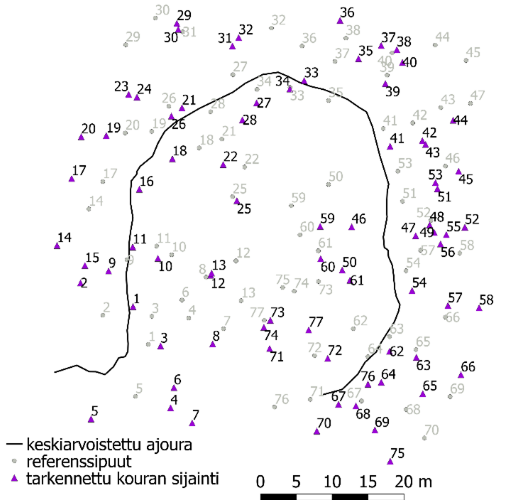
  - the algorithm averages the harvester locations and filters the bearings of harvester.

The positioning accuracy using algorithm

Mid-strip road observations	Positioning accuracy, m			Improvement, m		
	Harvester – reference (A)	Harvester head - reference (B)	Algorithm – reference (C)	Boom position (A-B)	Algorithm (B-C)	Improved position (A-C)
Boom extension used (n_plots = 6)	8,24	6,41	5,04	1,83	1,37	3,19
Boom extension not used (n_plots = 2)	7,13	6,80	4,15	0,33	2,65	2,98



Boom position



Improved position

- The algorithm improves the positioning accuracy of Komatsu Forest's harvester head by over 1,7m
- The best achieved level of positioning accuracy within sampling plots was 3.6m.
- The average level of accuracy within the whole dataset was 4.9m. (raw data 7.9m)
- The sampling plots were rather small in size when compared to typical harvested stands
  - relatively more beginnings and endings of the strip roads → lower positioning accuracy.

Thank You !