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Long/mid-term optimization module of the FIS

WP 5 – Forest information system development

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Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.





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Acronyms

SOA	Service Oriented Architecture
SOAP	Simple Object Access protocol
XML	eXtensible Markup Language
WSDL	Web Service Description Language
HTTP	HyperText Transfer Protocol
POST	POST is one of many request methods supported by the HTTP protocol used by the World Wide Web
GML	XML grammar defined by the Open Geospatial Consortium (OGC) to express geographical features
REST	Representational State Transfer
WUUDIS	Cloud service for forest data management
IPTIM	Integrated Planning and Timberland Management platform
SLOPE FIS	SLOPE forest inventory module
API	Application programming interface



1 Introduction

This document presents the main research and results within *task 5.5 “Mid-long term optimization; strategic and tactical planning”* of the SLOPE project. The objective is to develop a prototype of an optimization and planning module that can be easily integrated to the SLOPE FIS platform. Being the main deliverable of this task the development of a working prototype the main focus has been to configure and install an optimization/planning web service instance for the SLOPE purposes. Testing and experimenting Iptim web service API was also one goal of this task, with its integration planned for the work package 6. This document also acts like description of the Iptim web service interface. A working and integrated example of the module can be found at the following link:

<https://slopefis.mhgsystems.com/home>

Further details will be provided within deliverable D.6.02.2 “*System Integration Report II*”.





2 Iptim Software

This chapter describes Iptim application which is used in the Slope framework from generating harvesting plans. There are two options to use Iptim. One is to use a standalone desktop application with a user interface and second option is to use SOAP web service for customized SOA configurations.

2.1 Forest planning tool

IPTIM (Integrated Planning and Timberland Management) is a web-based forest planning system developed by Simosol. The system includes: tools for managing and analysing forest inventory data and stand databases; tools for modelling forest growth; user interfaces for modifying various growth model parameters as well as silvicultural and harvesting parameters; and most importantly, tools for generating forest management plans taking into account the user's objectives and constraints. IPTIM also supports the implementation of external forest simulators using the SIMO framework. IPTIM's optimization tools produce harvest schedules that are both optimal in terms of the decision maker's objectives, as well as in line with the constraints that affect forest management and operations. IPTIM includes an efficient LP solver called JLP (<http://mela2.metla.fi/mela/jjlp-en.htm>) as well as metaheuristics, such as a Tabu Search algorithm and a Genetic Algorithm implementation. IPTIM's graphical user interface allows the forest planner to define the objectives and constraints in a simple and efficient manner.

IPTIM consists of a lightweight desktop application that provides the graphical user interface, and a server side component that contains the databases, the simulation tools as well as the optimizers. IPTIM is a user-friendly tool that can handle complex large-scale plans efficiently and visualize the plans as easy-to-understand graphs, maps and tables. The forest management plans in IPTIM can be visualised through charts, maps and tables, as a way to highlight the differences between the plans being compared. Figure 1 shows user interface of Iptim desktop application.

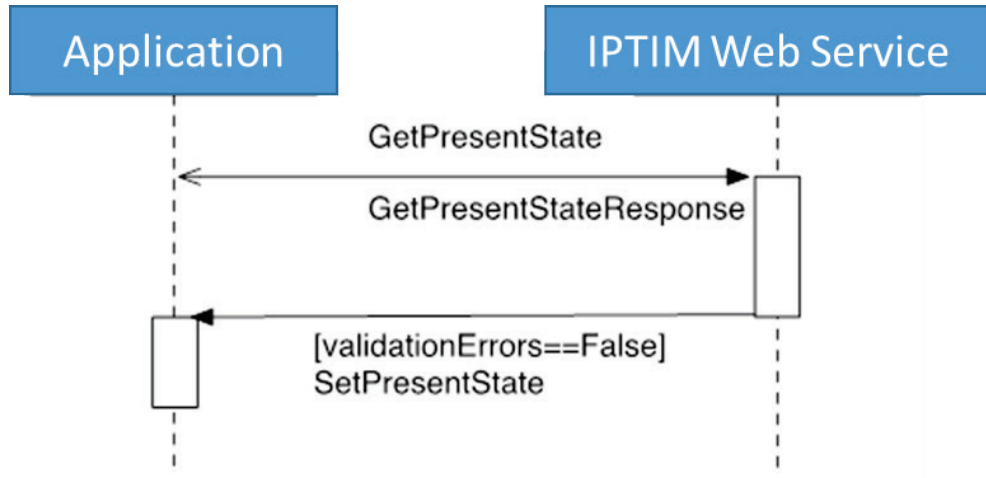


Figure 2: Iptim Web Service

The Iptim calculation service will generate a forest management plan for the real estate indicating how it should be managed in the future. Figure 3 shows a planned chain of operations imported to the Wuudis platform.

Unfinished Completed operations
 Fellings **1** Carework **4**






Type	Operation	Stand	↑ Year
	Open felling	1	2017
	Mechanical cleaning	1	2017
	Prepare the soil in spot hummocks	1	2018
	Pine planting	1	2018
	Mechanical grass vegetation prevention	1	2019

Figure 3: Planned operations

The Iptim service is also able to calculate tree data to the present state by using earlier inventory data (provided as input) on the basis of growth models. Figure 4 for example, shows stand tree data on Wuudis, calculated by Iptim on the basis of input stand data.



14 Oct 2016 Calculation Activated

Tree species	Age	Basal area m ² /ha	Mean diameter cm	Mean height m
Spruce	82 yrs	8.4	31.0	26.7
Spruce	82 yrs	1.9	30.5	31.4
Spruce	82 yrs	138.0	28.8	28.4
Spruce	82 yrs	0.6	31.7	29.3

Figure 4: Tree data calculated by Iptim

The following chapter, describes more in details the Iptim API used for the project.



3 Iptim API description

The Iptim calculation server API *GetPresentState* request message includes *TaskId*, *ClientId* and *StandDataZip* elements. *TaskId* is the identifier for the calculation group while *ClientId* is the requester client identifier for authentication purposes. *StandDataZip* includes basic forestry data information packaged in zip binary format transferred in base64 format.

The WSDL document for the web service API can be found here: <https://t1.optiops.simosol.fi:7792/optiops?wsdl>

3.1 Request data description

The next table lists all the required information by the Iptim calculation server. Optional parameters can be sent for more accurate calculations. The Iptim needs some basic data about stands and stand tree data while operation data is optional. In calculation request this data is in base64 binary zip inside *StandDataZip* element. Data format inside zipped binary is Finnish forestry data standard xml.

Required - Stand	
Stand@id	Stand unique identifier
Stand@realEstateId	Real estate identifier
Stand/StandBasicData/PolygonGeometry/polygonProperty	Stand boundaries geometry in GML format. EPSG:3067 projection
Stand/StandBasicData/PolygonGeometry/pointProperty	Stand centre coordinates in GML format. EPSG:3067 projection
Stand/StandBasicData/StandNumber	Stand number
Stand/StandBasicData/StandNumberExtension	Stand number extension
Stand/StandBasicData/Area	Stand area (ha)



Stand/StandBasicData/StandBasicDataDate	Inventory date of stand tree data.
Stand/StandBasicData/MainGroup	<p>Main Group (1-8)</p> <ul style="list-style-type: none"> 1 Forest land 2 Stunted land 3 Wasteland 4 Other forest land 5 Building site 6 Agricultural land 7 Other land type 8 System of rivers and lakes
Stand/StandBasicData/SubGroup	<p>Sub group (1-5) if main group is 1 or 2.</p> <p>Correct values</p> <ul style="list-style-type: none"> 1 Heathy woodland 2 Wet peat-moor 3 Wet sphagnum moor 4 Bog 5 Fen



Stand/StandBasicData/FertilityClass	Fertility class (1-8) if main group is 1 or 2.
	<p data-bbox="821 387 1007 421">Correct values</p> <ul style="list-style-type: none"><li data-bbox="821 454 1139 488">1 Grass-herb forest<li data-bbox="821 521 1126 555">2 Grove like forest<li data-bbox="821 589 1134 622">3 Moist forest land<li data-bbox="821 656 1158 689">4 Semi dry woodland<li data-bbox="821 723 1187 757">5 Dry heathy woodland<li data-bbox="821 790 1043 824">6 Poor land<li data-bbox="821 857 1054 891">7 Rocky land<li data-bbox="821 925 1086 958">8 Hilltop forest



Stand/StandBasicData/SoilType	Soil type. Correct values are:
	<p data-bbox="815 387 1007 421">Correct values</p> <ul style="list-style-type: none"><li data-bbox="815 454 1203 488">10 Coarse firm forest land<li data-bbox="815 521 1166 555">11 Coarse moraine soil<li data-bbox="815 589 1142 622">12 Coarse sorted soil<li data-bbox="815 656 1273 689">20 Fine-grained firm forest land<li data-bbox="815 723 1187 757">21 Fine-grained moraine<li data-bbox="815 790 1219 824">22 Fine-grained graded soil<li data-bbox="815 857 1369 891">30 Stony middle-coarse firm forest land<li data-bbox="815 925 1190 958">31 Stony coarse moraine<li data-bbox="815 992 1190 1025">32 Stony coarse moraine<li data-bbox="815 1059 1342 1093">40 Stony fine-grained firm forest land<li data-bbox="815 1126 1059 1160">50 Rocky land<li data-bbox="815 1193 1034 1227">60 Peatland<li data-bbox="815 1261 1062 1294">61 Sedge peat<li data-bbox="815 1328 1118 1361">62 Sphagnum peat<li data-bbox="815 1395 1219 1429">63 Wood covered peatland<li data-bbox="815 1462 1270 1496">64 Erosion sensitive sedge peat<li data-bbox="815 1529 1326 1563">65 Erosion sensitive sphagnum peat<li data-bbox="815 1597 1209 1630">66 Unmoulded sedge peat<li data-bbox="815 1664 1267 1697">67 Unmoulded sphagnum peat<li data-bbox="815 1731 1082 1765">70 Moss-humus<li data-bbox="815 1798 1038 1832">80 Ooze soil



Stand/StandBasicData/DrainageState	Drainage state (1 or 3). If not provided, calculation will use the default value (3). 1 Ditched 3 Nonditched
Optional – Stand parameters	
Stand/StandBasicData/DevelopmentState	Development state of the stand. 02 Young tree stand 03 Mature stand 04 Regeneration stand 05 Shelter tree stand A0 Opening ER Different aged trees S0 Seed tree stand T1 Seedling stand below 1,3 m T2 Seedling stand over 1,3 m Y1 Seedling stand with hold-overs
Stand/StandBasicData/DitchingYear	Ditching year (for ex. 2010)
Stand/StandBasicData/ThinningYear	Thinning year (for ex. 2010)
Stand/StandBasicData/CuttingRestriction	Cutting restriction 0 No restrictions 5 No open felling 9 No cuttings
Stand/StandBasicData/CuttingRestrictionEnds	End date of the cutting restriction (for ex. 2016-01-01)



Stand/StandBasicData/SilvicultureRestriction	<p>Silviculture restriction</p> <p>0 No restriction</p> <p>3 No planting</p> <p>5 No soil treatment</p> <p>6 No ditching</p> <p>7 No soil taking</p> <p>9 No silvicultural works</p> <p>10 No stump lifting</p>
Stand/StandBasicData/SilvicultureRestrictionEnds	End date of the cutting restriction (for ex. 2016-01-01)
Stand/StandBasicData/Accessibility	<p>Accessibility of the stand (1-5)</p> <p>1 Also during thaw</p> <p>2 Also during non-frosty season, not during thaw</p> <p>3 Also during non-frosty season when dry</p> <p>4 Only when the soil is frozen</p> <p>5 Not defined</p>
Required - Tree data	
Stand/TreeStandData/TreeStandDataDate/TreeStrata/TreeStratum@id	Tree stratum identifier



Stand/TreeStandData/TreeStandDataDate/ TreeStrata/TreeStratum/TreeSpecies	Tree species
	1 Pine
	2 Spruce
	3 Silver birch
	4 White birch
	5 Aspen
	6 Grey alder
	7 Black alder
	8 Other conifer
	9 Pother softwood
	10 Douglas fir
	11 Juniper
	12 Lodgepole pine
	13 European white elm
	14 Larch
	15 Linden
	16 Black spruce
	17 Willow
	18 Rowan
	19 Siberian fir
	20 Sallow
	21 Ash
	22 Cembran pine
	23 Serbian spruce
	24 Oak
	25 Bird-cherry
	26 Maple
	27 Curly birch
	28 Wych elm
	29 Softwood
	30 Conifer





Stand/TreeStandData/TreeStandDataDate/ TreeStrata/TreeStratum/Storey	<p>Storey</p> <p>1 Prevailing section</p> <p>2 Lower section</p> <p>3 Upper section</p> <p>4 Preserve trees</p> <p>5 Remote sensing</p> <p>6 Removal trees</p>
Stand/TreeStandData/TreeStandDataDate/ TreeStrata/TreeStratum/Age	Age of the trees (years)
Stand/TreeStandData/TreeStandDataDate/ TreeStrata/TreeStratum/BasalArea	Basal area (m ² /ha)
Stand/TreeStandData/TreeStandDataDate/ TreeStrata/TreeStratum/StemCount	Stem count
Stand/TreeStandData/TreeStandDataDate/ TreeStrata/TreeStratum/MeanDiameter	Tree mean diameter (cm)
Stand/TreeStandData/TreeStandDataDate/ TreeStrata/TreeStratum/MeanHeight	Tree mean height (m)
Optional – Operations already done	
Stand/Operations/Operation/OperationType	Operation type code. See Annex 5.1 for codes.
Stand/Operations/Operation/CompletionData/ CompletionDate	Completion date of the operation (for ex. 2016-01-01).
Optional – Planned operations	
Stand/PlannedOperationChains/PlannedOperationChain/ Operations/Operation@id	Planned operation identifier
Stand/PlannedOperationChains/PlannedOperationChain/ Operations/Operation/OperationType	Planned operation type code. See Annex 5.1 for codes.



Stand/PlannedOperationChains/PlannedOperationChain/ Operations/ProposalData/ProposalType	Type of the proposal 0 Simulated 1 Field proposal
Stand/PlannedOperationChains/PlannedOperationChain/ Operations/ProposalData/ProposalYear	Year when operation is proposed to be done (for ex. 2017)

3.2 Iptim data response

The Iptim web service is an asynchronous service. It does not return calculated harvesting plan at the same time when the request is sent but it puts the calculation request to the queue and sends data back when the calculations are ready. Response URL, where the Iptim will send simulated data, is defined to the *ClientId* specific configuration. The Iptim sends response SOAP message (*GetPresentStateResponse*) via standard HTTP (POST) request. Message can be received by implementing SOAP interface or with standard REST style interface which listens to HTTP POST method.

GetPresentStateResponse message includes *dataXmlZip* element that includes ZIP compressed XML document in base64 binary data format. Inside the XML document there is a root element called *ComputedStands* and inside the root element there is a harvesting plan that includes computed stands, tree data and proposed operations in Finnish forestry standard XML format.

If there are any problems with *GetPresentState* request message data validations, Iptim will send back a *ValidationErrors* XML message which includes all possible validation errors specified.



4 Conclusions

This document describes the deliverable prototype of the task 5.05 - Mid-long term optimization; strategic and tactical planning. The main deliverable in the task is the application module for generation harvesting plans from the SLOPE FIS input data. Main goal was to have in place a module that can be integrated easily to the SLOPE FIS service oriented architecture. In this work one important subtask was to investigate and understand Finnish forestry standard because it is the data transfer format for the Iptim optimization web service. All the goals have been achieved successfully in this deliverable and Iptim optimization web service is successfully deployed and tested for Slope purposes.

This document works also as a description of the Iptim web service interface. In this task, all integrations to the SLOPE FIS data store were excluded and the main focus was to deploy and test the Iptim web service interface data communication. This task provides a good starting point for the integrations of work package 6.





5 ANNEX

5.1 Finnish forestry standard operation types

Operation types listed with Finnish forestry standard codes.

- | | |
|-----|--|
| 1 | Cutting of hold-overs |
| 2 | First thinning |
| 3 | Thinning |
| 4 | Strip felling |
| 5 | Open felling |
| 6 | Fodder wood cutting |
| 7 | Shelter wood cutting |
| 8 | Seed tree felling |
| 9 | Specific felling |
| 11 | Thinning from above |
| 12 | Accretion cutting |
| 13 | Repairing cutting |
| 20 | Energy wood thinning |
| 90 | Specific cutting resulting in change of land utilization class |
| 91 | Specific cutting according to forest law |
| 92 | Other felling or activity |
| 93 | Clear cut in forest damage area |
| 94 | Improvement cutting in forest damage area |
| 100 | Natural reforestation |





- 101 Natural reforestation for pine
- 102 Natural reforestation for spruce
- 103 Natural reforestation for silver birch
- 104 Natural reforestation for white birch
- 105 Natural reforestation for aspen
- 106 Natural reforestation for grey alder
- 107 Natural reforestation for black alder
- 108 Other natural reforestation for conifers
- 109 Other natural reforestation for softwood
- 110 Natural reforestation for douglas fir
- 111 Natural reforestation for juniper
- 112 Natural reforestation for lodgepole pine
- 113 Natural reforestation for European white elm
- 114 Natural reforestation for larch
- 115 Natural reforestation for linden
- 116 Natural reforestation for black spruce
- 117 Natural reforestation for willow
- 118 Natural reforestation for rowan
- 119 Natural reforestation for siberian fir
- 120 Natural reforestation for sallow
- 121 Natural reforestation for ash
- 122 Natural reforestation for cembran pine
- 123 Natural reforestation for serbian spruce
- 124 Natural reforestation for oak
- 125 Natural reforestation for bird-cherry
- 126 Natural reforestation for maple





- 127 Natural reforestation for curly birch
- 128 Natural reforestation for wych elm
- 200 Sowing
- 201 Pine sowing
- 202 Spruce sowing
- 203 Silver birch sowing
- 204 White birch sowing
- 205 Aspen sowing
- 206 Grey alder sowing
- 207 Black alder sowing
- 208 Other conifer sowing
- 209 Other softwood sowing
- 210 Douglas fir sowing
- 211 Juniper fir sowing
- 212 Lodgepole pine sowing
- 213 European white elm sowing
- 214 Larch sowing
- 215 Linden sowing
- 216 Black spruce sowing
- 217 Willow sowing
- 218 Rowan sowing
- 219 Black spruce sowing
- 220 Sallow sowing
- 221 Ash sowing
- 222 Cembran pine sowing
- 223 Cembran spruce sowing





- 224 Oak sowing
- 225 Bird-cherry sowing
- 226 Maple sowing
- 227 Curly birch sowing
- 228 Wych elm sowing
- 300 Planting
- 301 Pine planting
- 302 Spruce planting
- 303 Silver birch planting
- 304 White birch planting
- 305 Aspen planting
- 306 Grey alder planting
- 307 Black alder planting
- 308 Other conifer planting
- 309 Other softwood planting
- 310 Douglas fir planting
- 311 Juniper planting
- 312 Lodgepole pine planting
- 313 European white elm planting
- 314 Larch planting
- 315 Linden planting
- 316 Black spruce planting
- 317 Willow planting
- 318 Rowan tree planting
- 319 Siberian fir planting
- 320 Goat willow planting





- 321 Ash planting
- 322 Cembran pine planting
- 323 Serbian spruce planting
- 324 Oak planting
- 325 Bird-cherry planting
- 326 Maple planting
- 327 Curly birch planting
- 328 Wych elm planting
- 401 Cleaning
- 410 Mechanical cleaning
- 420 Mechanical-chemical cleaning
- 440 Pre-prevention for growing aspen sprouts
- 450 Pre-cleaning
- 501 Soil treatment
- 510 Prepare the soil in spots
- 511 Prepare the soil in spots by excavator
- 520 Prepare the soil in hummocks
- 521 Prepare the soil in hummocks upside down
- 522 Prepare the soil in hummocks with slight ditches
- 523 Prepare the soil in spot hummocks
- 530 Harrowing
- 531 Harrowing crosswise
- 540 Plowing
- 550 Ditching in hummocks
- 560 Field soil treatment
- 601 Pine supplementary planting





- 602 Spruce supplementary planting
- 603 Silver birch supplementary planting
- 604 White birch supplementary planting
- 605 Aspen supplementary planting
- 606 Grey alder supplementary planting
- 607 Black alder supplementary planting
- 608 Other conifer supplementary planting
- 609 Other softwood supplementary planting
- 610 Douglas fir supplementary planting
- 611 Juniper supplementary planting
- 612 Lodgepole pine supplementary planting
- 613 European white elm supplementary planting
- 614 Larch supplementary planting
- 615 Linden supplementary planting
- 616 Black spruce supplementary planting
- 617 Willow supplementary planting
- 618 Rowan supplementary planting
- 619 Siberian fir supplementary planting
- 620 Sallow supplementary planting
- 621 Ash supplementary planting
- 622 Cembran pine supplementary planting
- 623 Serbian spruce supplementary planting
- 624 Oak supplementary planting
- 625 Bird-cherry supplementary planting
- 626 Maple supplementary planting
- 627 Curly birch supplementary planting





- 628 European white elm supplementary planting
- 630 Supplementary sowing
- 640 Mechanical grass vegetation prevention
- 650 Chemical grass vegetation prevention
- 660 Mechanical cleaning
- 670 Chemical cleaning
- 680 Mechanical-chemical cleaning
- 690 Cleaning in rounds
- 701 Tending of seedling stand
- 730 Cleaning of seedlings in groups after sowing
- 740 Tending of seedling stand
- 750 Tending of young stand
- 760 Tending of small trees
- 840 Mechanical prevention of grass vegetation
- 850 Chemical prevention of grass vegetation
- 860 Mechanical cleaning
- 870 Chemical cleaning
- 880 Mechanical-chemical cleaning
- 890 Tending of seedling stand
- 911 Improvement fertilizing
- 912 Specific fertilizing with micronutrients
- 940 Repairing ditching
- 950 Haulage of tops and branches
- 951 Lifting up stumps
- 960 Burning over
- 970 Branch pruning





- 980 Treatment with elk repellent
- 990 Prevention of root-rot
- 999 Blocking of ditches

