Optimization Challenges in Communal Sector

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Outline

- Communal sector requirements
- Some case study results
- Future trends
- Commercial solver features
- Parallelization approach
- Challenges in the software development

Street maintenance

- Many different types of operation
- Contract areas
- Time windows
- Priorities
- Bumpers
- Vehicle fleet optimization
- Equipment selection
- Compatibility (vs. e.g. weather and street types)
- Rush hours and locations
- Turning restrictions
- Joint operations
- Real-time planning
- Balanced work division
- Work regulations, driver properties
- Depot selection and location
- Best practice

Home care and home health care

- Teams, geographical areas and dedicated nurses
- Time windows
- Periodic and real-time planning
- Uncertainty
- Rostering
- Customer specific service times
- Priorities
- Different vehicle types
- Competence and equipment
- Equal work division
- Service level and costs

School transportation

- Operating hours of schools
- Duration and waiting time minimization
- Vehicle compatibility
- Vehicle types and availability
- Public transport
- Safety
- Maximum walking
- Combined transportations
- Leveling of transportations

Workforce management

- Communal services
- Health care services
  - Cost
  - Skills
  - Regulations
  - Balance
  - Vacations
  - Multiple objective
  - Uncertainty
  - Long-term & real-time

Other applications

- Logistic operations
  - Materials
  - Internal mail
- Waste collection
- Sustainable development
- Transportation of elderly
- Personnel transportation

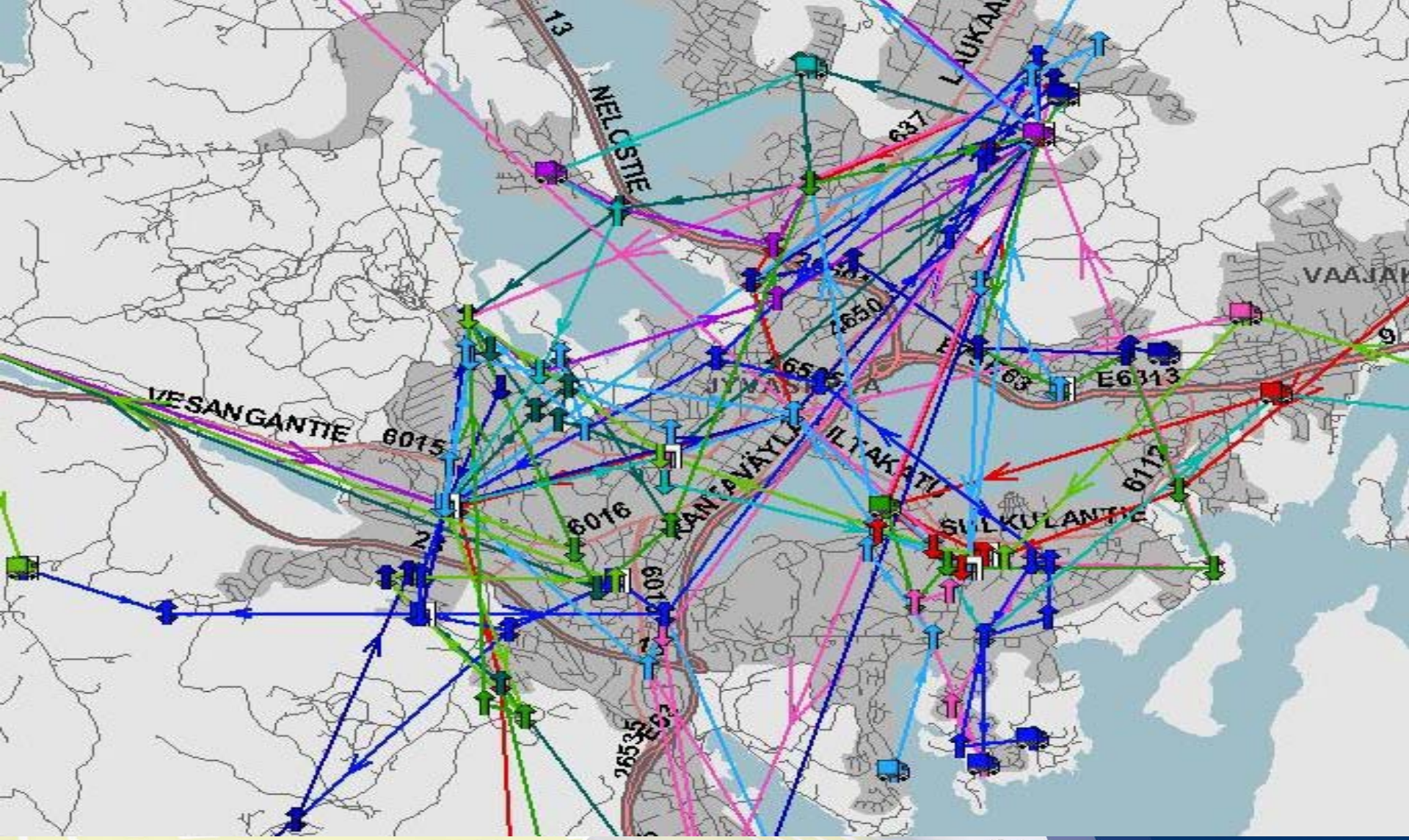
Home health care savings

	Current	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Travel distance/km	–	277.2	238.8	123.6	60.3
Shifts per day	76	48	32	23	22
Savings in number of shifts	–	36.8%	57.9%	69.7%	71.1%

Home meal delivery

Scenario	TSP/ VRP	Open/ closed	Maximum tour duration (h)	Time windows	Number tours	Simultaneous loading
1	TSP	Closed	–	10–13.30	1–2	No
2	VRP	Closed	2	10–13.30	2	No
3	VRP	Closed	3.5	10–13.30	1	No
4	VRP	Closed	2.5	10–13.30	2	No
5	VRP	Closed	3.5	10–13.30	1	Yes
6	VRP	Closed	5	8.30–13.30	1	No
7	VRP	Open	3.5	10–13.30	1	No

Savings	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)
Distance	22.68	12.41	33.35	20.50	33.52	36.67	51.24
Vehicles	0	26.98	30.16	26.98	34.92	50.79	30.16



Future trends

- The company size is increasing
- The role of joint planning and collaboration will be more important
- Customer-specific services
- Multi-purpose vehicles
- Real-time planning of large entities
- The amount of information and transparency will increase
- The environmental and security issues become more important
- Human technology
- E-commerce
- Integrated systems
- Map data
- Lower costs
- Automatic planning

Procomp solver features

- Capacities, time windows (hard & soft, multiple)
- Compartments, combatibilities
- Precedence
- Different vehicle types, properties and equipment
- Workforce management
- Periodic and multi-day planning
- Priorities, optional deliveries
- Multi-depot, facility location
- Transshipment, multimodality
- Time dependent variables (rush hours)
- Design of areas/zones
- Real-time and stochastic information
- Address correction, aggregation
- Automatic parameter tuning
- Integration with databases etc.

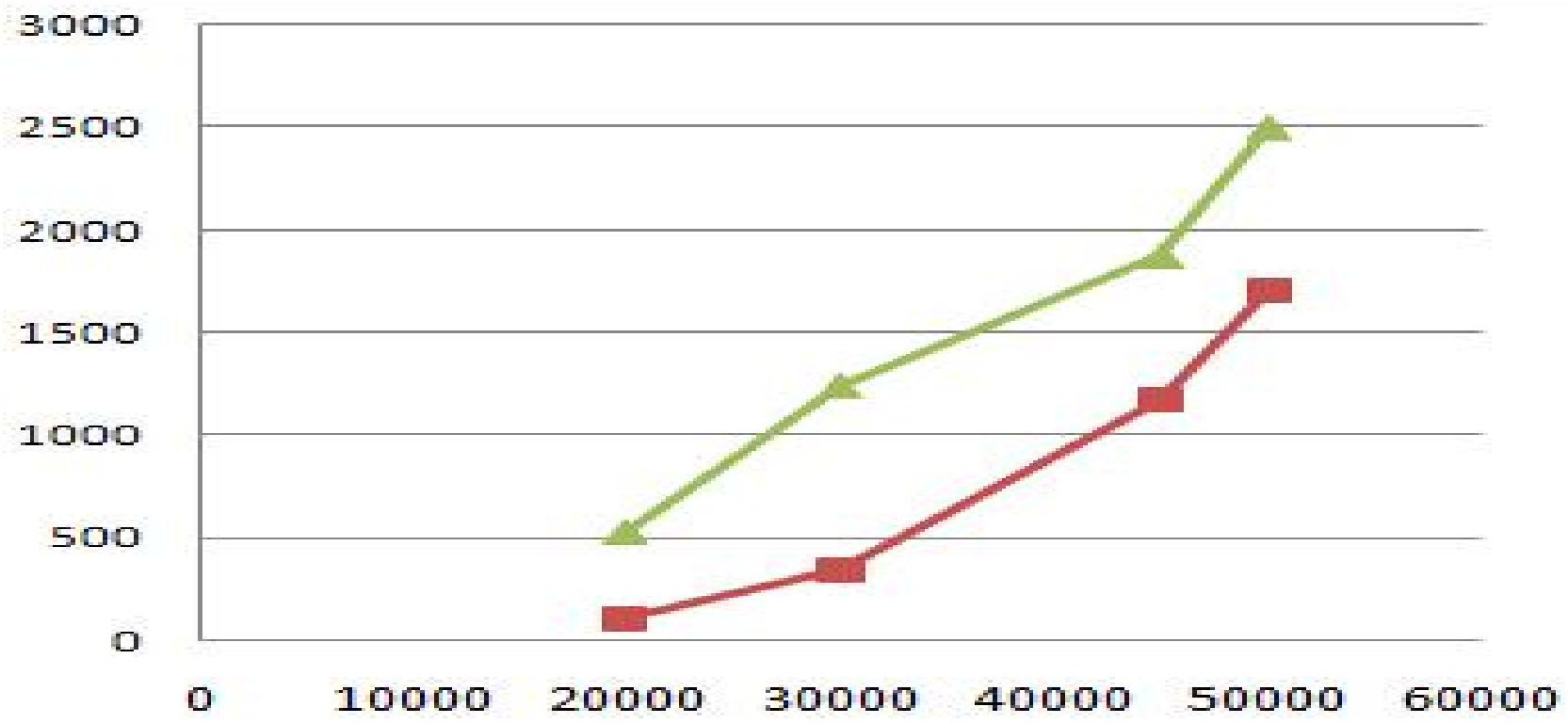
Procomp solver features

- The basis:
  - Cheapest insertion & savings
  - Threshold accepting metaheuristic
  - Several standard local searches
- A library that is always taylored to the problem
- A lot of emphasis on model and implementation
  - Approximation
  - Search restriction
- SPP algorithms of Geissberger et al.
  - Faster implementation
  - Small improvements
- Aggregation algorithm of Puranen et al.

Parallelization

- Solutions optimized separately
- Separate improvement threads
- Improvement for a given number of iterations
- Maintaining the best solution
- The best solution starting point for threads
- With large problems the initial solution procedure also parallelized

Scaling



Challenges in software development

- Routing and workforce management
- Uncertainty
- Long-term planning
- Optional deliveries
- Time-dependent variables
- Transshipment
- Combined transportation