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Examples of solutions in area of scheduling and work planning

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Online Field Service
Task Planning

Task Description

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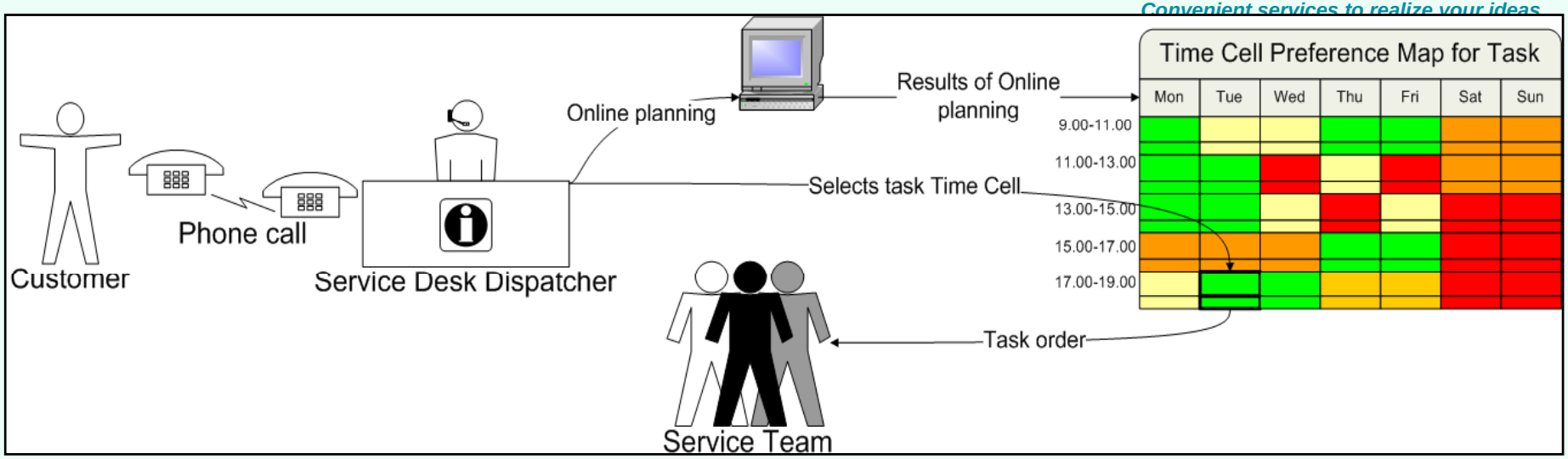

1. Service Desk accepts call and enters request
2. The Task Planning Module proposes possible variants in form of Time Cell Preference Map.
3. Dispatcher confirms visit with customer for certain time cell.
4. New task order for team issued, with task list, address and customer details

Requirements

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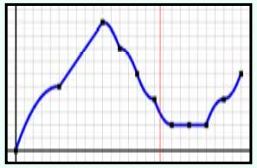
- Online task scheduling requires real-time algorithms. Batch task scheduling is not applicable.

- Assignment of service teams by
  - **Skills** and competence
  - **Service Zones**
  - **Shortest travel time** from previous / to next task location
  - **Levelling** of work load



- Assignment factors change with time

Index-based Solution

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- **Skills Index**: calculated, depends on service team members skills and requirements for planned task
- **Area Assignment Index**: persistent, stored at data base

- **Travel Time Index:** calculated, depends on previously scheduled tasks and current / next planned location
- **Work Load Index:** calculated, depending on already scheduled tasks

- **Preference Index** for Service Team calculated from all indexes
- **Time Cell Preference Index** calculated as maximum of Preference Indexes of all potential Service Teams for this time cell

Algorithm Workflow

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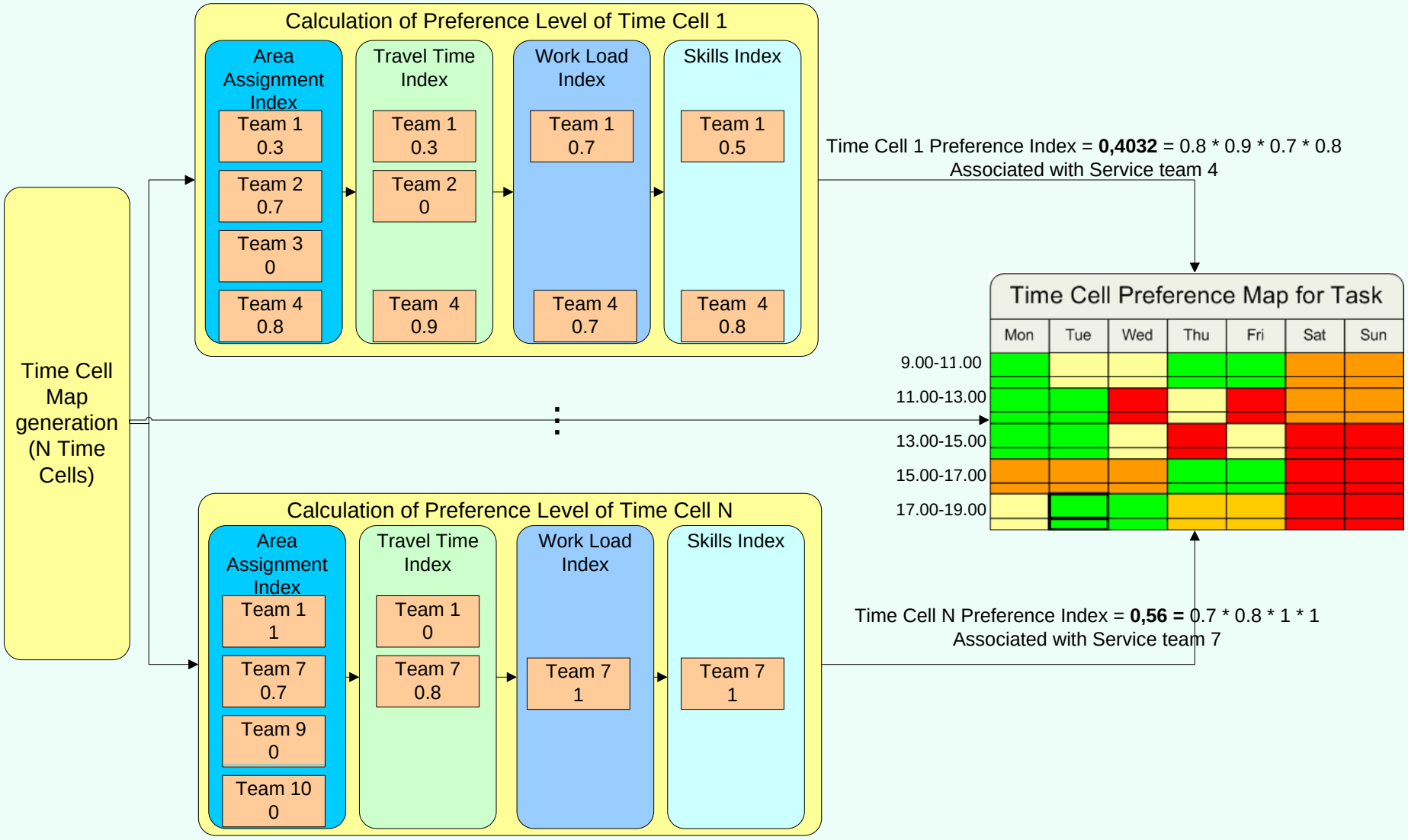

Algorithm Optimization

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- **Cutting of useless calculations**. Exclusion of Service Teams with zero Indexes minimizes calculations

- **Calculations order** defined by rules:
  - Indexes with higher probability to take zero value are to be calculated first
  - Indexes with higher computing efforts are to be calculated at the end

Calculation of Indexes according to the combination of these two factors minimizes calculation times.

Performance Optimization

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- All calculations are performed **on the server**, with higher database performance and faster hardware
- **In-memory Caching** of frequently used values avoids repeated calculations and minimizes database accesses
- **Rarely changed indexes** are calculated only when being changed at the planning period, instead of calculations for every Time Cell.

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Sales Rep Visit Scheduling

Task Description

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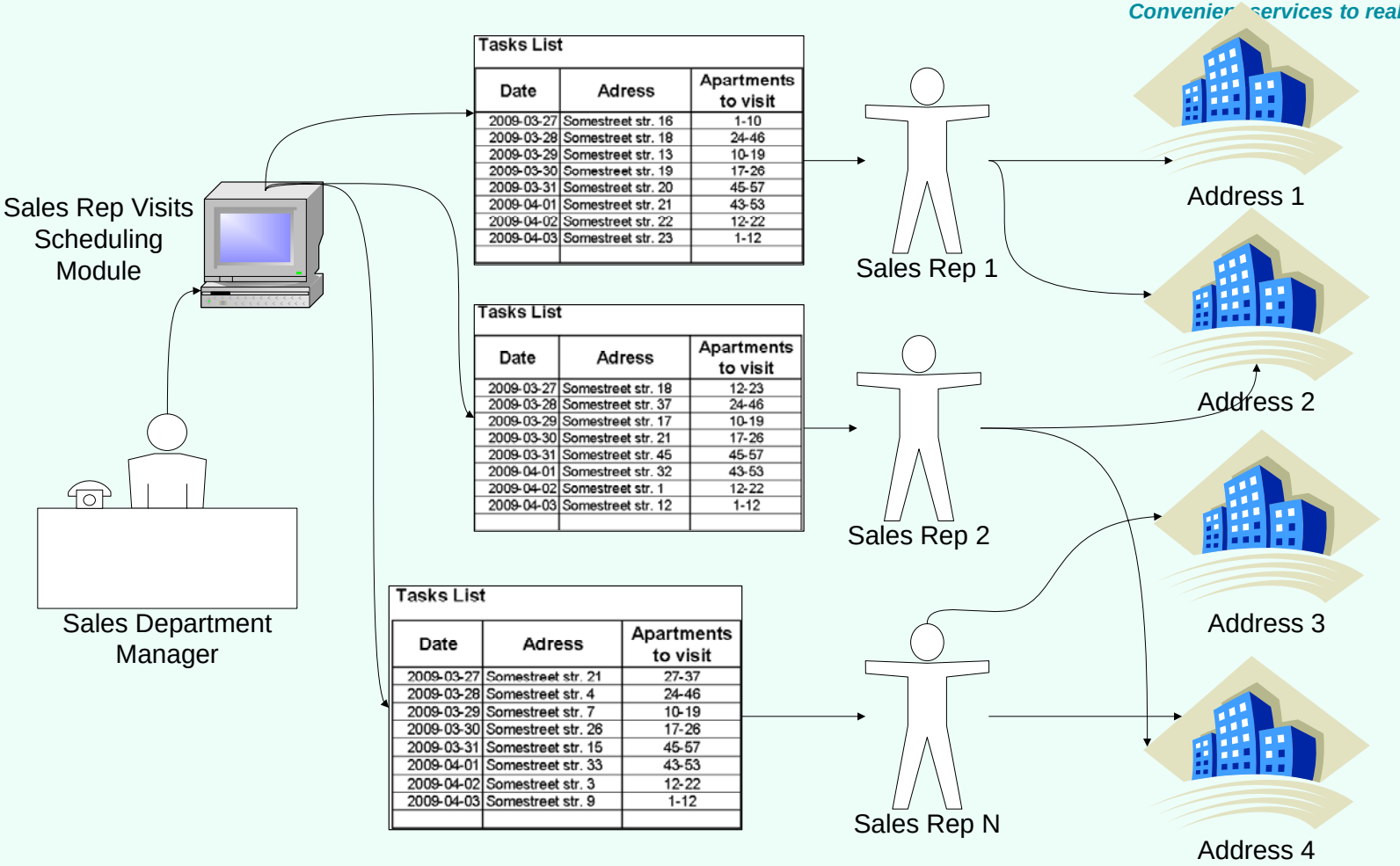

- Sales Manager selects addresses and enters Planning Period Begin Date
- Scheduling module generates Sales Rep visits schedule: Tasks Lists assigned to Sale Reps
- Sales Manager edits schedule if necessary

Requirements

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- **Leveling of Work Load**. Work items amount should be about equal for every Sales Rep, close to an optimal value, should not be less/greater then min/max value.
- **Work Items Grouping**. Task should contain only contiguous addresses.
- **Visits Period Reduction.** Schedules should be generated in a way which minimizes time to visit one building. The date range of a Task List should not contain weekends.
- **Customer Relation Consideration**. If a Sale Rep is somehow connected with an address, he should be assigned as a preference.
- **Schedule Generation Time**. A Schedule generation for 10,000 adresses for 40 Sales Reps shouldn’t take more then 10 minutes

Solution. Algorithm model

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- Several sets (**generations**) of schedule variants are generated.
- **The best variant** is selected. The best variant is one that corresponds the requirements better than others.
- A schedule variant optimality is defined based on the sum of all **penalties** for every requirement factor deviation.
- Penalty for each factor is a numerical measure of this factor **deviation** from etalon.

Generation of new schedule variants

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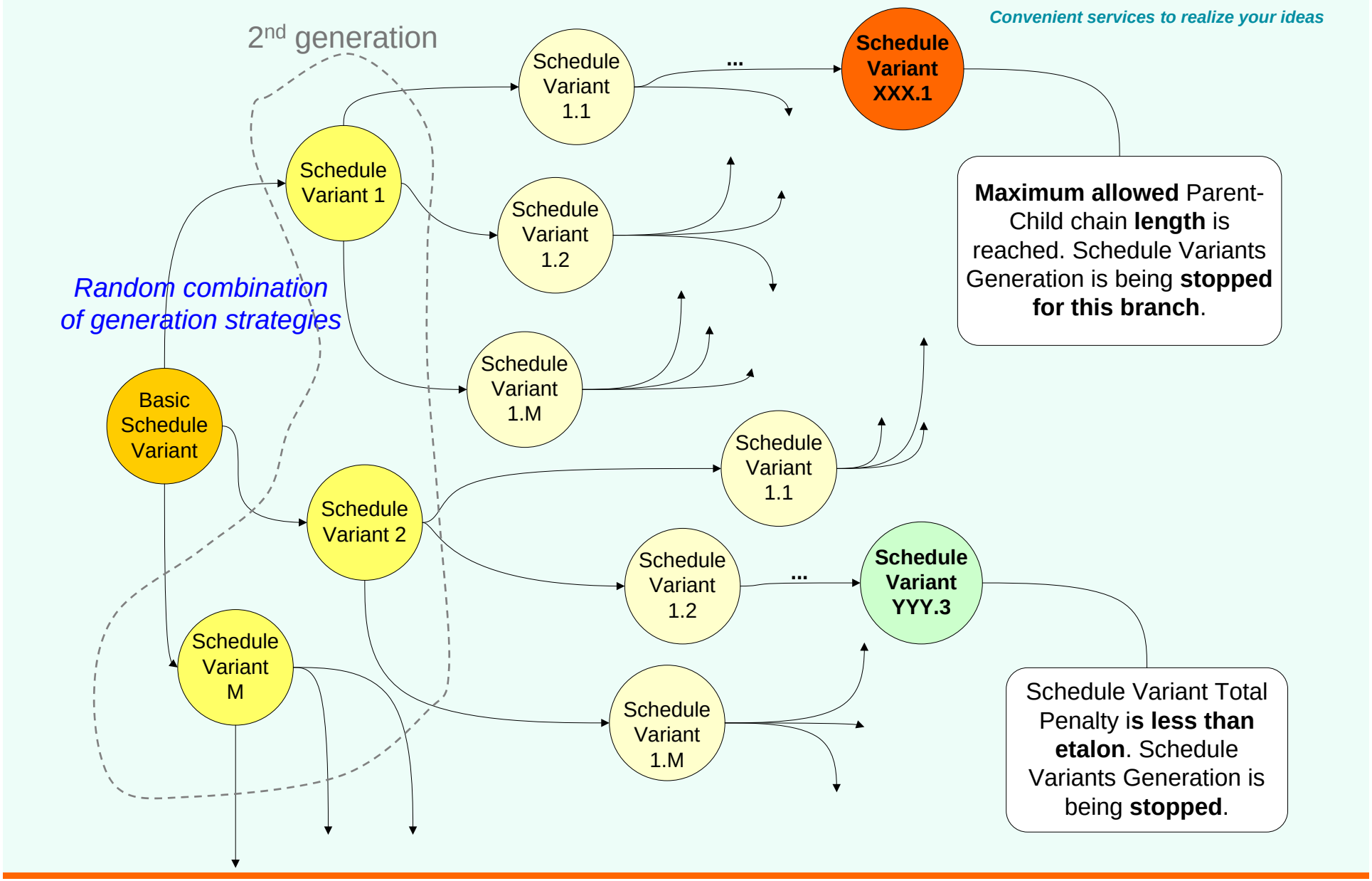

Generation of new schedule variants

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- The schedule variants generation combines **genetic** and **probabilistic approaches**.
- New variants are being generated based on previous ones, by applying random combinations of **generation strategies** from pool of about 10 strategies.
  - The generation strategy defines rules of tasks readjustment for **work item area of change**.
- Generation of schedule variants **continues, until**:
  - a schedule variant penalty becomes equal to or less than some Etalon penalty;
  - a parent-child variant chain length reaches the maximum allowed value.

New variant generation approach

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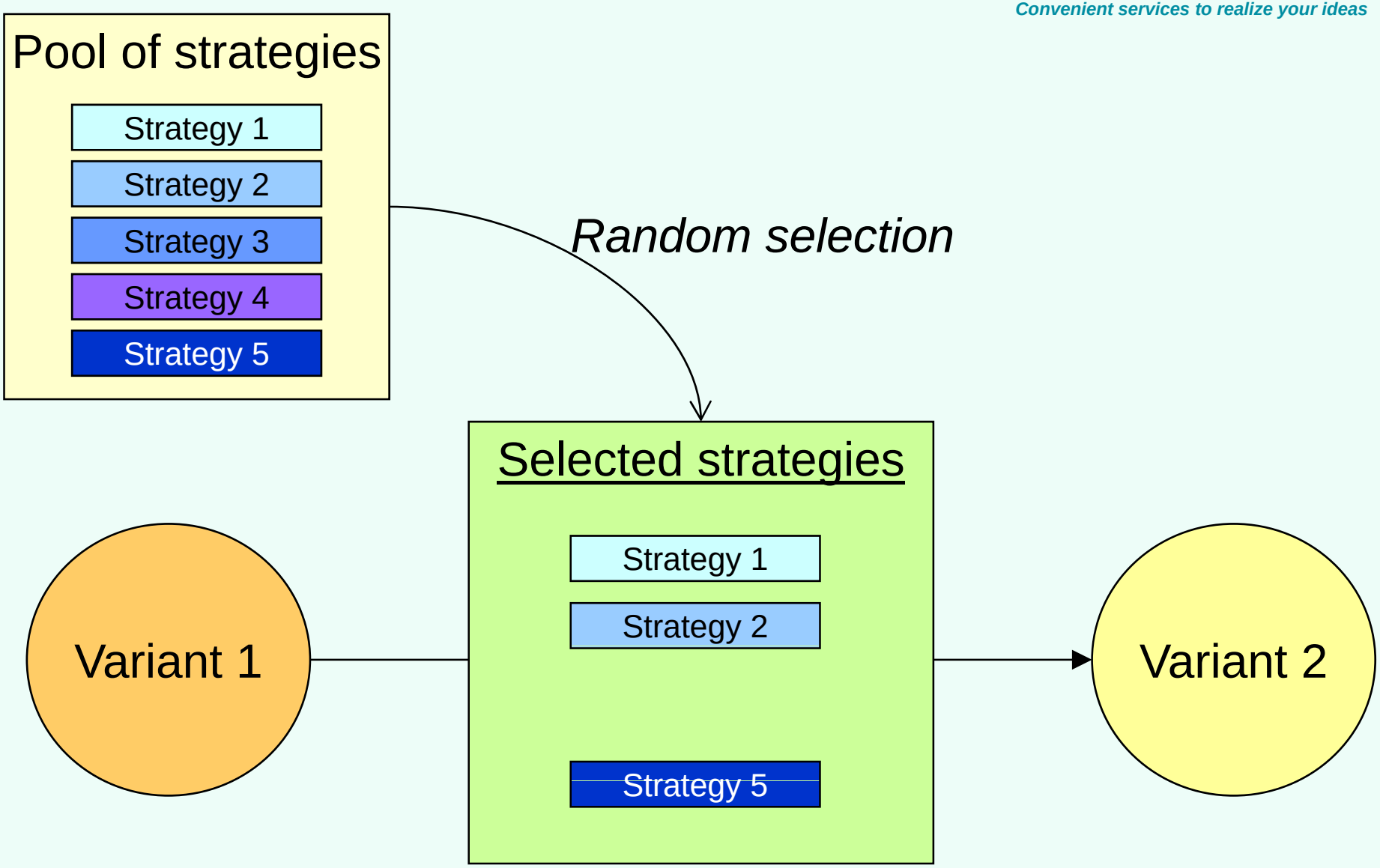

Regrouping of work items between tasks

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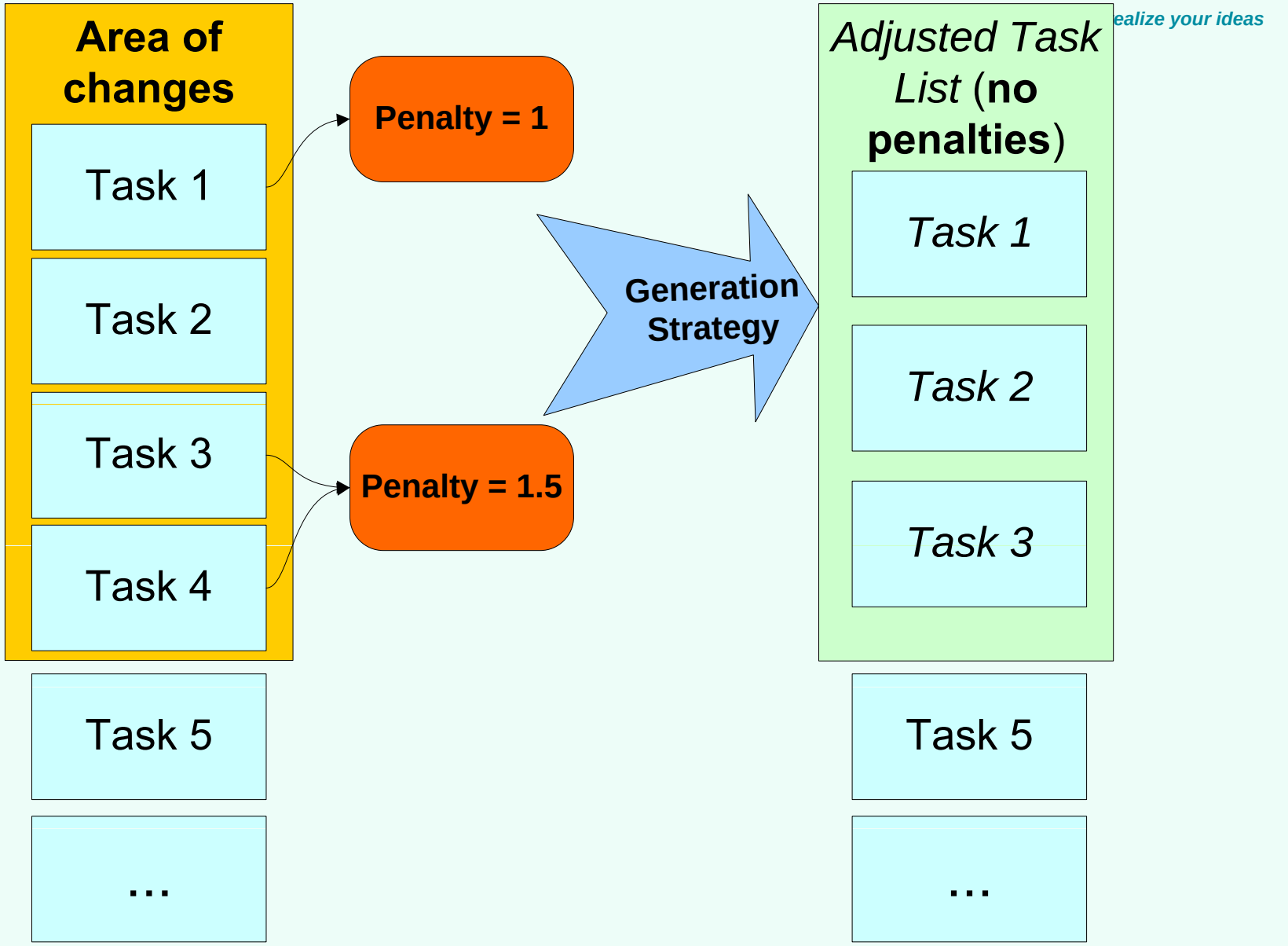

Algorithm Optimization

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- **The Genetic approach** avoids exhaustive searches for optimal Schedule Variants, and provides an acceptable Schedule Variant within required time.

- The list of possible **generation strategies** for areas of changes depends on factor types, which are sources of penalty for this area. This increases the algorithm intelligence and minimizes the final Schedule Variant total penalty.

- **A set of parameters** allows to manage the algorithm effectiveness and performance. Main parameters are an etalon penalty value, a max parent-child variant chain length, and a count of generation strategies combinations.