Christian Brunbjerg Jespersen
cbrje@dtu.dk & christian-brunbjerg.jespersen@external.totalenergies.com

Contents

1 Project Overview **2**
1.1 Stakeholders . . . 2
1.2 Highlevel Work Flow . . . 2
1.3 Excel Examples . . . 3

2 Product Vision **3**

3 Product Architecture **4**

4 Project going forward **4**
4.1 Collaboration . . . 4
4.2 Milestones . . . 5
4.3 Company: Scipo . . . 5
4.4 Example Budget . . . 5

5 Appendix **7**

6 Scheduler: Strategic **7**

7 Scheduler: Tactical **8**

8 Supervisor **9**

9 Technician **10**

 Recipients: **Anne-Laure Debar**

Christian Brunbjerg Jespersen
cbrje@dtu.dk & christian-brunbjerg.jespersen@external.totalenergies.com

1 Project Overview

1.1 Stakeholders

- Brian Friis Nielsen (Total)
- Valentin Ispas (GMC - Norspie)
- Anne-Laure Debar (Total)
- Baptiste Dubillaud (Total)

1.2 Highlevel Work Flow

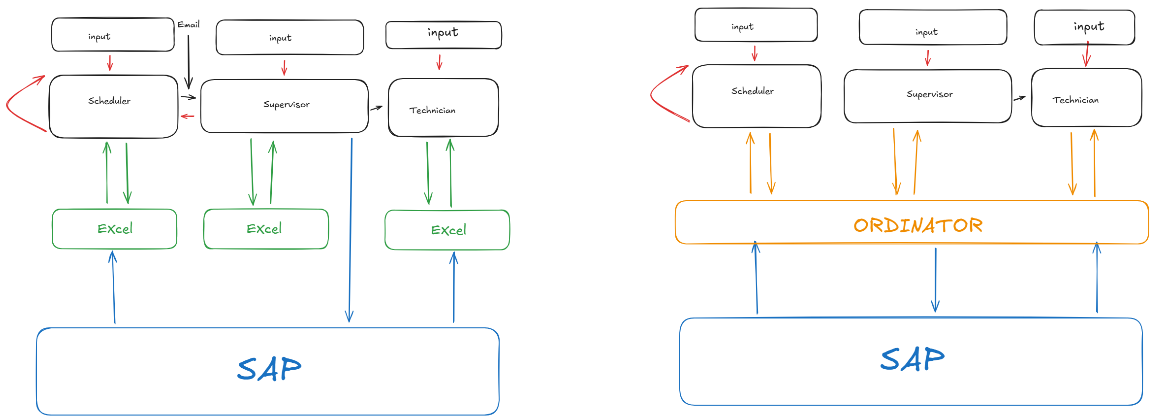

Figure 1: Schematic difference between the current way of doing things versus how it could be done in the future. Each stakeholder can immediately sees an optimized schedule based on the state in the optimization algorithms. This means that the moment that a **Scheduler**, **Supervisor**, or **Technician** sees that there is something wrong his part of the schedule it can be handled immediately. After an excel file has been sent in the as-is example the remaining stakeholders are working blind

Issues:

- Manually sending email around: Manual process leads to long iteration time on schedules
- State duplication: Information on the same **work order** is found in many places at any one time
- SAP is not made for optimization workflows: You copy the current SAP state to excel and continue working from there.
- Ordinator is a layer between SAP and the **scheduler** and **supervisor**: Ordinator holds all state which can be manipulated and optimizes it (scheduling, optimizations etc.).

Christian Brunbjerg Jespersen
cbrje@dtu.dk & christian-brunbjerg.jespersen@external.totalenergies.com

1.3 Excel Examples

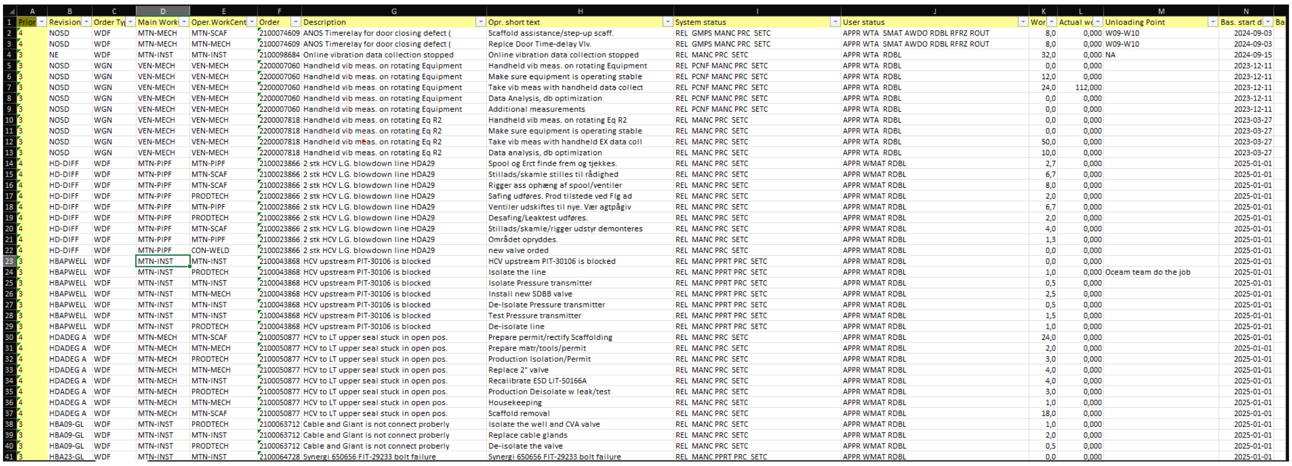

Figure 2: Schedulers view of the scheduling process

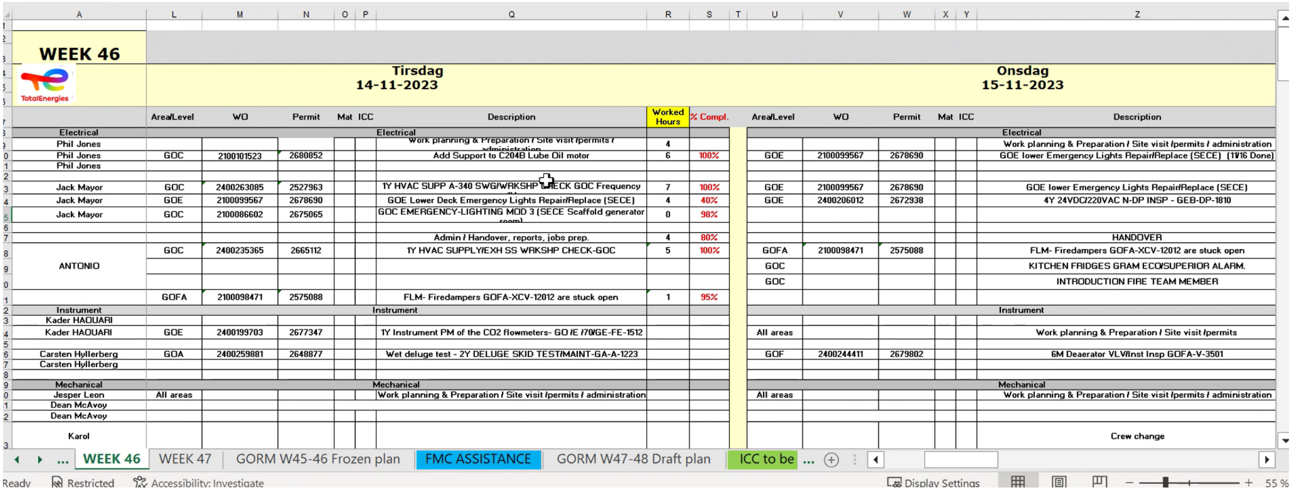

Figure 3: Supervisors and Technicians view of the scheduling process

2 Product Vision

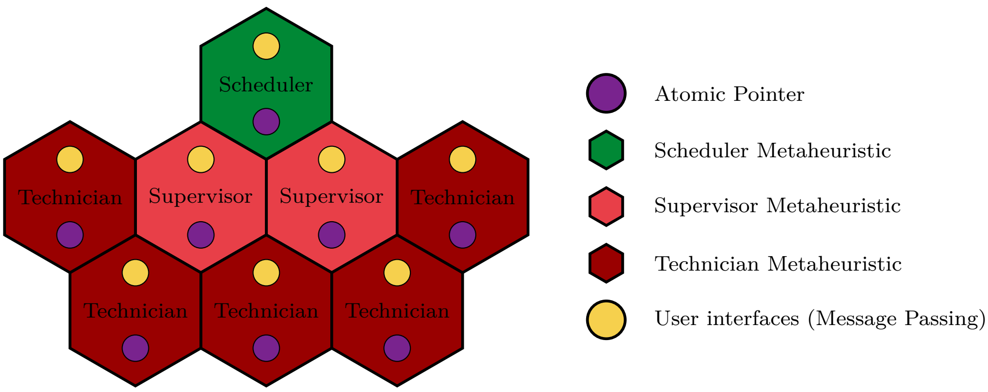

Figure 4: Each model represents a distinct stakeholder with its own UI (yellow) and their solution spaces are tied together with lock-free atomic pointer swaps (purple)

Christian Brunbjerg Jespersen
cbrje@dtu.dk & christian-brunbjerg.jespersen@external.totalenergies.com

3 Product Architecture

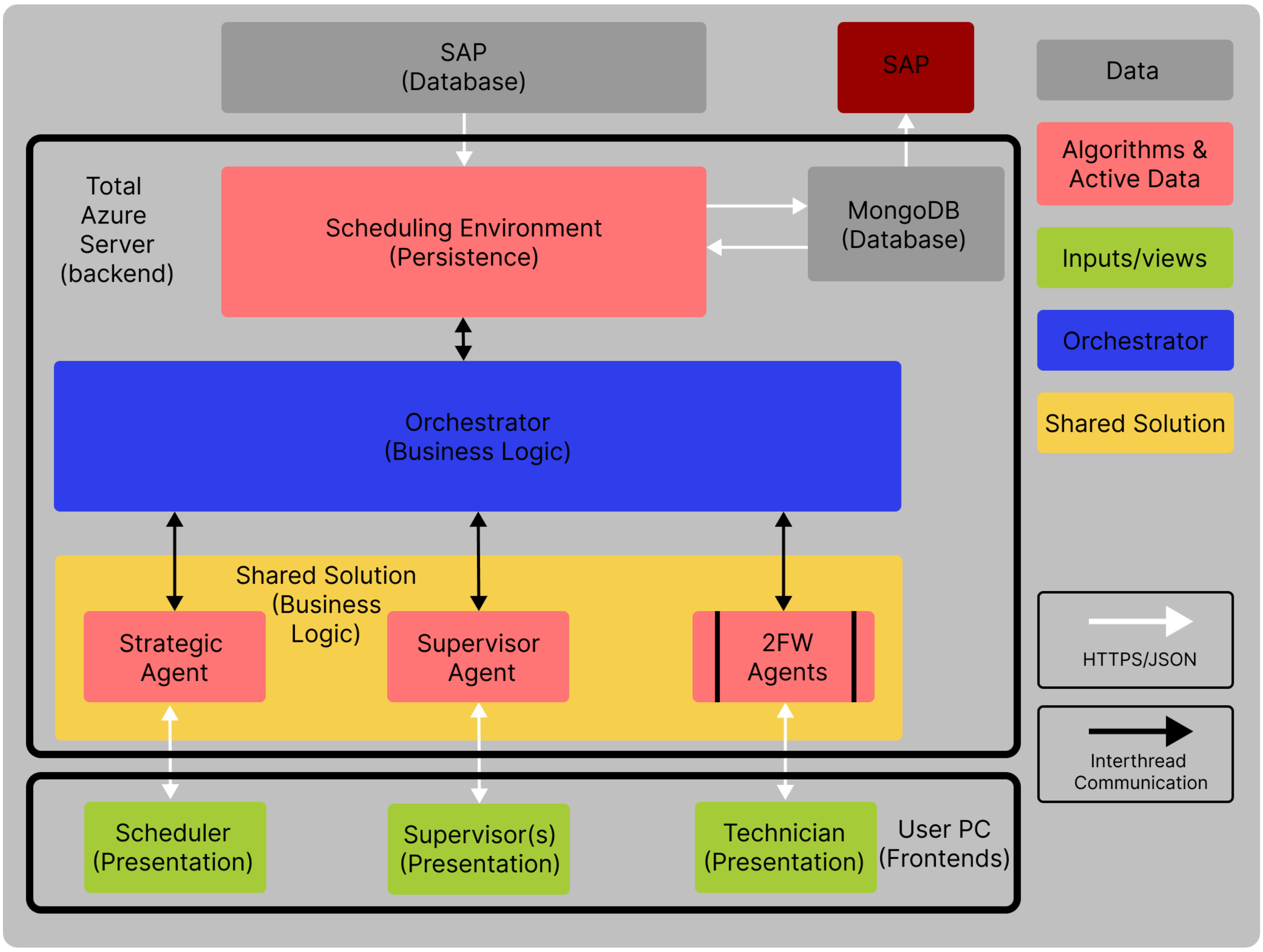

Figure 5: Software architecture of the Ordinator application. Databases are shown in **grey**, with either SAP or Mongodb based on the data requirements, SchedulingEnvironment holds all the needed data for the application to run and saves all the user interactions with the system, these interaction are held in the MongoDB database, the Orchestrator is shown in **blue** and is responsible for managing the whole system while it is running, the Shared Solution is shown in **yellow** and holds fast mutable state that is needed for the algorithms to optimize across the different stakeholders, each optimization algorithms themselves is shown in **light red**, where each models and optimizes the scheduling process for that specific stakeholder, finally the presentation views for each of the stakeholders which are shown in **green**

4 Project going forward

4.1 Collaboration

Main issues:

- I will need time in Esbjerg to further develop the project
  - I have family in Esbjerg that I might be able to stay with
- I lack the project management skill to run the whole project by myself
- There is one year left of the project, so the collaboration will have to depend on project scope
- The project will require developer time from **Loic**
- The project will require developer time from GMC and the maintenance department

Main questions:

- What do you think that it would take to convince Total to further the project?

Recipients: **Anne-Laure Debar**

Christian Brunbjerg Jespersen
cbrje@dtu.dk & christian-brunbjerg.jespersen@external.totalenergies.com

- The project could save the company a lot of money. Which steps should be taken to gain the best kind of support?

4.2 Milestones

1. Make the first iteration of Ordinator that can schedule for each kind of stakeholder
2. Providing each stakeholder with high quality excel exports
3. Host the program with both a **Scheduler** and **Supervisor** frontend
4. Create frontends together with Total

4.3 Company: Scipo

Would a company setup be an option if the project gains financial support. This may be a long short. I have a good and competent friend and I think that the two of us together would be able to deliver you a product of high quality. This kind of collaboration would go along the lines:

1. Develop Ordinator so mature that Total gains confidence in its likely success
2. Drafting a budget, specifying how many hours there is needed to deliver certain milestones.
3. Shared ownership of the product or open-source the code.

4.4 Example Budget

This is simply an example budget for how a development model could look like between **Total** and **Scipo** (an example company created for solving the scheduling problem for Total)

Scipo	Role	Total Hours	Cost per Hour	Skills	Period
Christian Jespersen	Core Developer	320	250 DKK	Optimization Algorithms	2025-09 to 2025-12
Sebastian Dall	Core Developer	320	250 DKK	API, Frontend, Project	2025-09 to 2025-12
Total	Role	Total Hours	Cost per Hour	Skills	Period
TOTAL_DEVELOPER Baptiste Dubillaud	Integration	50-70	500 DKK	Azure, IT infrastructure	2025-09 to 2025-12
TOTAL_MAINTENANCE_METHOD Brian Friis Niels	Domain Expert	40	500 DKK	Understanding of Business Flows	2025-09 to 2025-12
GMC_SCHEDULER Valentin Ispas	Domain Expert	30	500 DKK	Key Stakeholder	2025-09 to 2025-12
GMC_SUPERVISOR <UNKNOWN>	Domain Expert	20	500 DKK	Key Stakeholder	2025-09 to 2025-12
GMC_TECHNICIAN <UNKNOWN>	Domain Expert	20	500 DKK	Key Stakeholder	2025-09 to 2025-12
Material	Role	Total Hours	Cost per Hour	Skills	Period
Server	-	2000	1-5 DKK	-	2025-09 to 2025-12

Christian Brunbjerg Jespersen
cbrje@dtu.dk & christian-brunbjerg.jespersen@external.totalenergies.com

$$
\begin{aligned}
\text{Total Cost} &= (320 \times 250) + (320 \times 250) \\
&\quad + (70 \times 500) + (40 \times 500) + (30 \times 500) \\
&\quad + (20 \times 500) + (20 \times 500) + (2,000 \times 5) \\
&= 80,000 + 80,000 + 35,000 + 20,000 + 15,000 + 10,000 + 10,000 + 10,000 \\
&= 160,000 \quad \text{(Direct cost for Scipo)} \\
&\quad + 100,000 \quad \text{(Indirect cost for Total)} \\
&= 260,000 \quad \text{Total cost DKK}
\end{aligned}
$$

Total cost per 2 month period **260,000 DKK**

 Recipients: **Anne-Laure Debar**

Christian Brunbjerg Jespersen
cbrje@dtu.dk & christian-brunbjerg.jespersen@external.totalenergies.com

5 Appendix

The mathematical model formulations are based on interviews and the handbook (Palmer, 2019).

6 Scheduler: Strategic

Meta variables:

$$s \in S \tag{1}$$

$$\tau \in [0, \infty] \tag{2}$$

Minimize:

$$\begin{aligned} &+ \sum_{w \in W(\tau)} \sum_{p \in P(\tau)} strategic\_urgency_{wp}(\tau) \cdot \alpha_{wp}(\tau) \\ &+ \sum_{p \in P(\tau)} \sum_{r \in R(\tau)} strategic\_resource\_penalty \cdot \epsilon_{pr}(\tau) \\ &- \sum_{p \in P(\tau)} \sum_{w1 \in W(\tau)} \sum_{w2 \in W(\tau)} clustering\_value_{w1,w2} \cdot \alpha_{w1p}(\tau) \cdot \alpha_{w2p}(\tau) \end{aligned} \tag{3}$$

Subject to:

$$\sum_{w \in W(\tau)} work\_order\_workload_{wr} \cdot \alpha_{wp}(\tau) \leq \sum_{t \in T(\tau)} \psi_{prt}(\tau) + \epsilon_{pr}(\tau) \quad \forall p \in P(\tau) \quad \forall r \in R(\tau) \tag{4}$$

$$\sum_{r \in R(\tau)} \psi_{prt}(\tau) \leq technician\_work_{pt}(\tau, \beta(\tau)) \quad \forall p \in P(\tau) \quad \forall t \in T(\tau) \tag{5}$$

$$\sum_{p \in P(\tau)} \psi_{prt}(\tau) \leq technician\_skills_{rt}(\tau) \quad \forall r \in R(\tau) \quad \forall t \in T(\tau) \tag{6}$$

$$\sum_{w \in W(\tau)} \alpha_{wp}(\tau) = 1 \quad \forall p \in P(\tau) \tag{7}$$

$$\alpha_{wp}(\tau) = 0, \quad if \quad exclude_{wp}(\tau) \;\; \forall w \in W(\tau) \quad \forall p \in P(\tau) \tag{8}$$

$$\alpha_{wp}(\tau) = 1, \quad if \quad include_{wp}(\tau) \;\; \forall w \in W(\tau) \quad \forall p \in P(\tau) \tag{9}$$

$$\alpha_{wp}(\tau) \in \{0, 1\} \quad \forall w \in W(\tau) \quad \forall p \in P(\tau) \tag{10}$$

$$\psi_{prt}(\tau) \in \mathbb{R}^+ \quad \forall p \in P(\tau) \quad \forall r \in R(\tau) \quad \forall t \in T(\tau) \tag{11}$$

$$\epsilon_{pr}(\tau) \in \mathbb{R}^+ \quad \forall p \in P(\tau) \quad \forall r \in R(\tau) \tag{12}$$

Recipients: **Anne-Laure Debar**

Christian Brunbjerg Jespersen
cbrje@dtu.dk & christian-brunbjerg.jespersen@external.totalenergies.com

7 Scheduler: Tactical

Meta variables:

$$s \in S \tag{13}$$

$$\alpha(\tau) \tag{14}$$

$$\tau \in [0, \infty] \tag{15}$$

Minimize:

$$+ \sum_{o \in O(\tau, \alpha(\tau))} \sum_{d \in D(\tau)} tactical\_value_{do}(\tau) \cdot \beta_{do}(\tau)$$

$$+ \sum_{r \in R(\tau)} \sum_{d \in D(\tau)} tactical\_penalty \cdot \mu_{rd}(\tau) \tag{16}$$

Subject to:

$$\sum_{o \in O(\tau, \alpha(\tau))} work_o(\tau) \cdot \beta_{do}(\tau) \leq \Psi_{drt}(\tau) + \mu_{rd}(\tau) \quad \forall d \in D(\tau) \quad \forall r \in R(\tau) \tag{17}$$

$$\sum_{r \in R(\tau)} \Psi_{drt}(\tau) \leq tactical\_resource_{dr}(\tau) \quad \forall d \in D(\tau) \quad \forall t \in T(\tau) \tag{18}$$

$$\sum_{d \in D(\tau)} \Psi_{drt}(\tau) \leq technician\_skills_{rt}(\tau) \quad \forall r \in R(\tau) \quad \forall t \in T(\tau) \tag{19}$$

$$\beta_{do}(\tau) \leq number_o(\tau) \cdot operating\_time_o \cdot \sigma_{do}(\tau) \quad \forall d \in D(\tau) \quad \forall o \in O(\tau, \alpha(\tau)) \tag{20}$$

$$\sum_{d = earliest\_start_o(\tau)}^{latest\_finish_o(\tau)} \sigma_{do}(\tau) = duration_o(\tau) \quad \forall o \in O(\tau, \alpha(\tau)) \tag{21}$$

$$\sum_{d^* \in D_{duration_o(\tau)}(\tau)} \sigma_{d^*o}(\tau) = duration_o(\tau) \cdot \eta_{do}(\tau) \quad \forall o \in O(\tau, \alpha(\tau)) \quad \forall d \in D(\tau) \tag{22}$$

$$\sum_{o \in O(\tau, \alpha(\tau))} \eta_{do}(\tau) = 1, \quad \forall d \in D(\tau)$$

$$\sum_{d \in D(\tau)} d \cdot \sigma_{do1}(\tau) + \Delta_o(\tau) = \sum_{d \in D(\tau)} d \cdot \sigma_{do2}(\tau) \quad \forall (o1, o2) \in finish\_start_{o1,o2} \tag{23}$$

$$\sum_{d \in D(\tau)} d \cdot \sigma_{do1}(\tau) = \sum_{d \in D(\tau)} d \cdot \sigma_{do2}(\tau) \quad \forall (o1, o2) \in start\_start_{o1,o2} \tag{24}$$

$$\beta_{do}(\tau) \in \mathbb{R} \qquad \forall d \in D(\tau) \quad \forall o \in O(\tau, \alpha(\tau)) \tag{25}$$

$$\mu_{rd}(\tau) \in \mathbb{R} \qquad \forall r \in R(\tau) \quad \forall d \in D(\tau) \tag{26}$$

$$\sigma_{do}(\tau) \in \{0, 1\} \qquad \forall d \in D(\tau) \quad \forall o \in O(\tau, \alpha(\tau)) \tag{27}$$

$$\eta_{do}(\tau) \in \{0, 1\} \qquad \forall d \in D(\tau) \quad \forall o \in O(\tau, \alpha(\tau)) \tag{28}$$

$$\Delta_o(\tau) \in \{0, 1\} \quad \forall o \in O(\tau, \alpha(\tau)) \tag{29}$$

Recipients: **Anne-Laure Debar**

8 Supervisor

Meta variables:

$$z \in Z \tag{30}$$
$$\alpha(\tau) \tag{31}$$
$$\theta(\tau) \tag{32}$$
$$\tau \in [0, \infty] \tag{33}$$

Maximize:

$$\sum_{a \in A(\tau,\alpha(\tau))} \sum_{t \in T(\tau)} supervisor\_value_{at}(\tau, \lambda_t(\tau), \Lambda_t(\tau)) \cdot \gamma_{at}(\tau) \tag{34}$$

Subject to:

$$\sum_{a \in A_o(\tau,\alpha(\tau))} \rho_a(\tau) = work_o(\tau) \quad \forall o \in O(\tau, \alpha(\tau)) \tag{35}$$
$$\sum_{t \in T(\tau)} \sum_{a \in A_o(\tau,\alpha(\tau))} \gamma_{at}(\tau) = \phi_o(\tau) \cdot number_o(\tau) \quad \forall o \in O(\tau, \alpha(\tau)) \tag{36}$$
$$\sum_{o \in O_w(\tau,\alpha(\tau))} \phi_o(\tau) = |O_w(\tau, \alpha(\tau))| \cdot \Phi_w(\tau) \quad \forall w \in W(\tau, \alpha(\tau)) \tag{37}$$
$$\sum_{a \in A_o(\tau,\alpha(\tau))} \gamma_{at}(\tau) \leq 1 \quad \forall o \in O(\tau, \alpha(\tau)) \quad \forall t \in T(\tau) \tag{38}$$
$$\gamma_{at}(\tau) \leq feasible_{at}(\theta(\tau)) \quad \forall a \in A_o(\tau, \beta_) \quad (\tau) \forall o \in O(\tau, \alpha(\tau)) \quad \forall t \in T(\tau) \tag{39}$$
$$\gamma_{at}(\tau) \in \{0, 1\} \quad \forall o \in O(\tau, \alpha(\tau)) \quad \forall t \in T(\tau) \tag{40}$$
$$\phi_o(\tau) \in \{0, 1\} \quad \forall o \in O(\tau, \alpha(\tau)) \tag{41}$$
$$\Phi_w(\tau) \in \{0, 1\} \quad \forall w \in W(\tau, \alpha(\tau)) \tag{42}$$
$$\rho_a(\tau) \in [lower\_activity\_work_a(\tau), work_a(\tau)] \quad \forall a \in A(\tau, \alpha(\tau)) \tag{43}$$

9 Technician

Meta variables:

$$t \in T(\tau) \tag{44}$$
$$\alpha(\tau) \tag{45}$$
$$\gamma(\tau) \tag{46}$$
$$\tau \in [0, \infty] \tag{47}$$

Maximize:

$$\sum_{a \in A(\tau, \gamma_t(\tau))} \sum_{k \in K(\gamma(\tau))} \delta_{ak}(\tau) \tag{48}$$

Subject to:

$$\sum_{k \in K(\gamma(\tau))} \delta_{ak}(\tau) \cdot \pi_{ak}(\tau) = activity\_work_a(\tau, \rho(\tau)) \cdot \theta_a(\tau) \quad \forall a \in A(\tau, \gamma_t(\tau)) \tag{49}$$
$$\lambda_{a21}(\tau) \geq \Lambda_{a1last(a1)}(\tau) + preparation_{a1,a2} \quad \forall a1 \in A(\tau, \gamma_t(\tau)) \quad \forall a2 \in A(\tau, \gamma_t(\tau)) \tag{50}$$
$$\lambda_{ak}(\tau) \geq \Lambda_{ak-1}(\tau) - constraint\_limit \cdot (2 - \pi_{ak}(\tau) + \pi_{ak-1}(\tau)) \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \tag{51}$$
$$\delta_{ak}(\tau) = \Lambda_{ak}(\tau) - \lambda_{ak}(\tau) \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \tag{52}$$
$$\lambda_{ak}(\tau) \geq event_{ie} + duration_{ie} - constraint\_limit \cdot (1 - \omega_{akie}(\tau)) \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \quad \forall i \in I(\tau) \quad \forall e \in E(\tau) \tag{53}$$
$$\Lambda_{ak}(\tau) \leq event_{ie} + constraint\_limit \cdot \omega_{akie}(\tau) \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \quad \forall i \in I(\tau) \quad \forall e \in E(\tau) \tag{54}$$
$$\lambda_{a1}(\tau) \geq time\_window\_start_a(\beta(\tau)) \quad \forall a \in A(\tau, \gamma_t(\tau)) \tag{55}$$
$$\Lambda_{alast(a)}(\tau) \leq time\_window\_finish_a(\beta(\tau)) \quad \forall a \in A(\tau, \gamma_t(\tau)) \tag{56}$$
$$\pi_{ak}(\tau) \in \{0, 1\} \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \tag{57}$$
$$\lambda_{ak}(\tau) \in [availability\_start(\tau), availability\_finish(\tau)] \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \tag{58}$$
$$\Lambda_{ak}(\tau) \in [availability\_start(\tau), availability\_finish(\tau)] \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \tag{59}$$
$$\delta_{ak}(\tau) \in [0, work_{a\_to\_o(a)}(\tau)] \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \tag{60}$$
$$\omega_{akie}(\tau) \in \{0, 1\} \quad \forall a \in A(\tau, \gamma_t(\tau)) \quad \forall k \in K(\gamma(\tau)) \quad \forall i \in I(\tau) \quad \forall e \in E(\tau) \tag{61}$$
$$\theta_a(\tau) \in \{0, 1\} \quad \forall a \in A(\tau, \gamma_t(\tau)) \tag{62}$$

References

Palmer, R.D., 2019. Maintenance Planning and Scheduling Handbook, 4th Edition . 4th edition ed., McGraw Hill.