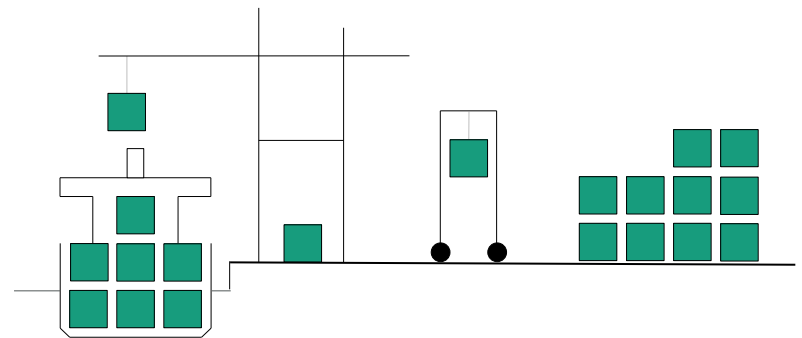# Decision Support for the crew scheduling problem in ship management

Ole John, Michael Böttcher, Carlos Jahn

Michael Böttcher

COMPIT 2013

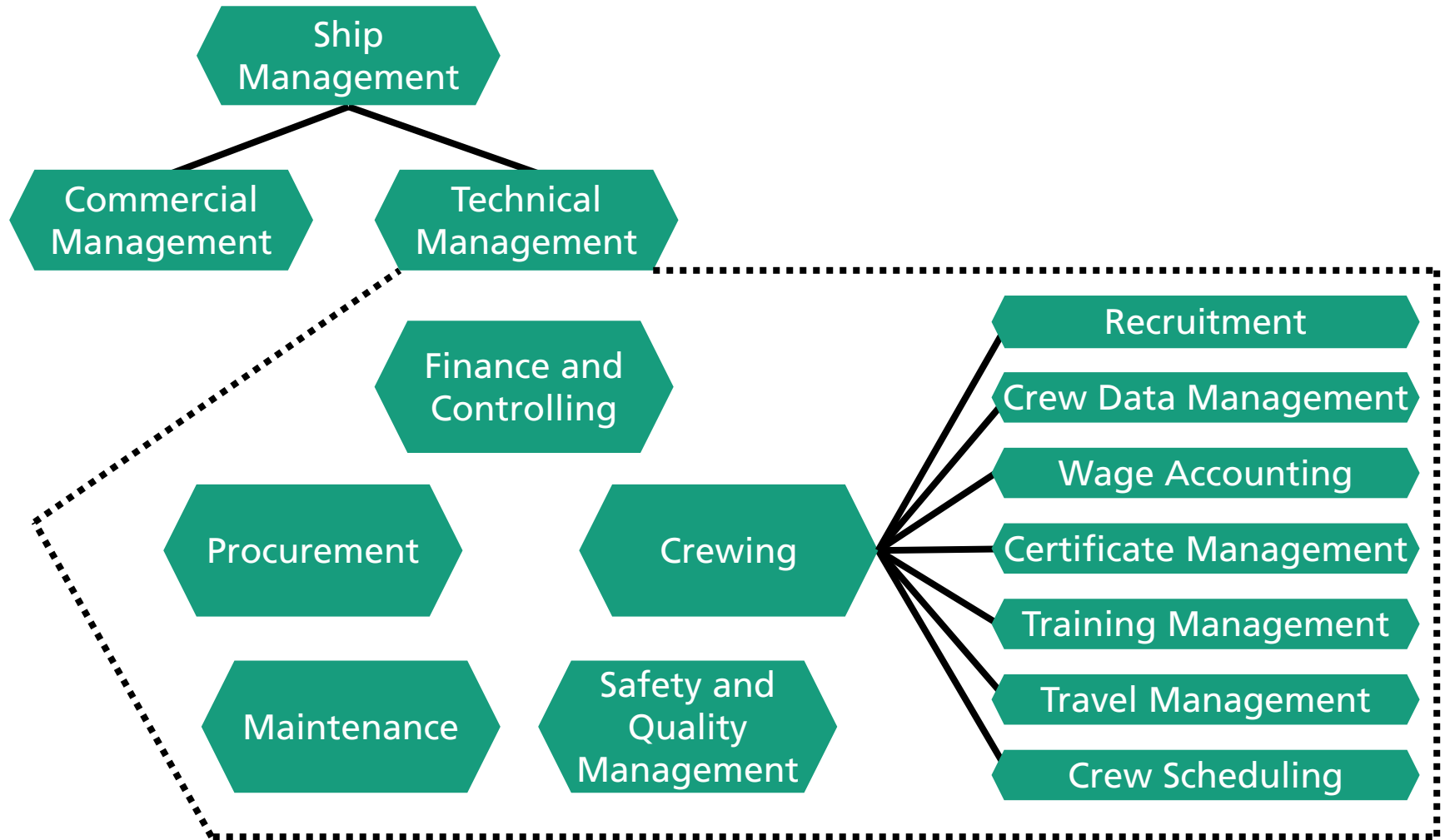Cortona 17.04.2013

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Agenda

1 Introduction

2 Challenges of crew scheduling in ship management

3 Problem description

4 Comparison to the airline sector

5 Benefits of mathematical optimization

6 Conclusion and future research

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Agenda

1   Introduction

2   Challenges of crew scheduling in ship management

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4   Comparison to the airline sector

5   Benefits of mathematical optimization
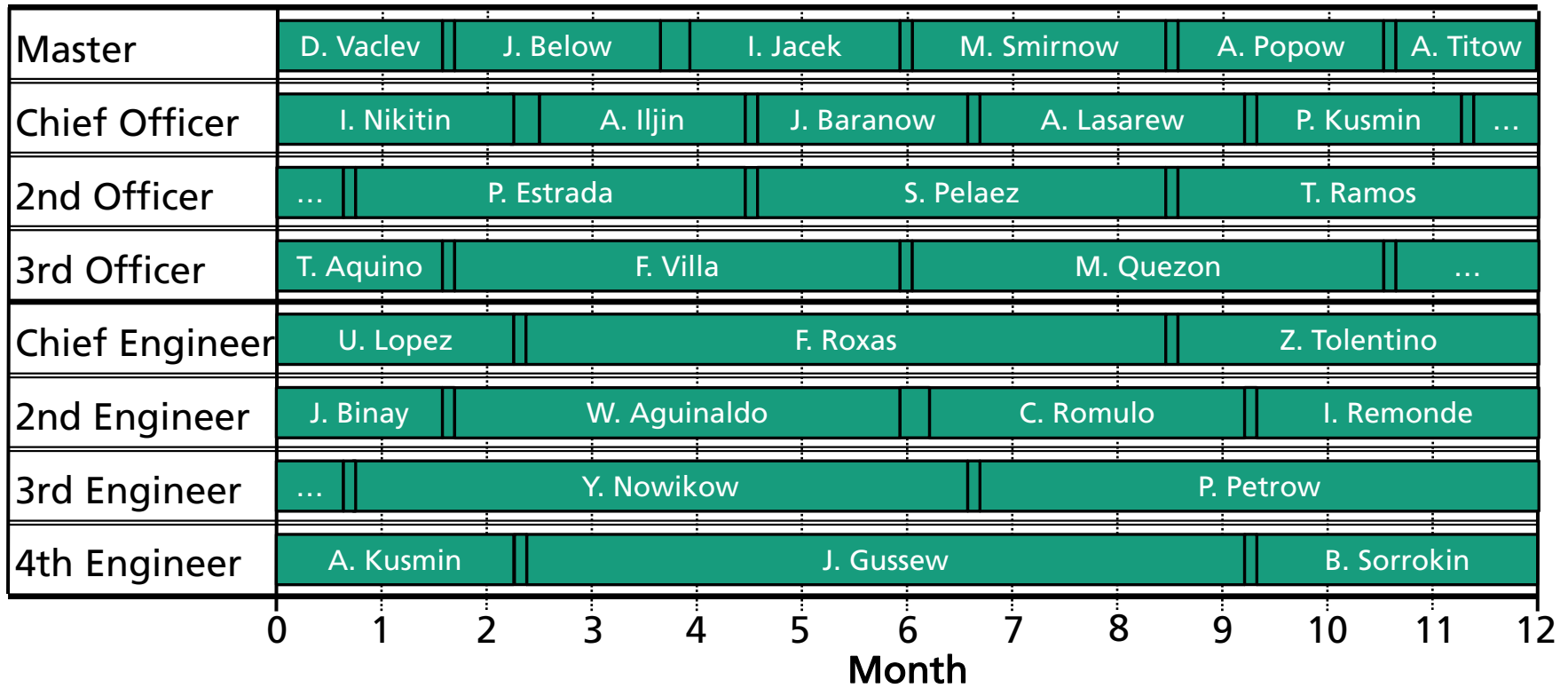
6   Conclusion and future research

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Crew scheduling as a part of ship management

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Output of crew scheduling in ship management

→ For every position on every ship: Assignment of seafarers for a specific time period

Example: Cap Roberta

Position	Schedule
Master	D. Vaclev · J. Below · I. Jacek · M. Smirnow · A. Popow · A. Titow
Chief Officer	I. Nikitin · A. Iljin · J. Baranow · A. Lasarew · P. Kusmin · …
2nd Officer	… · P. Estrada · S. Pelaez · T. Ramos
3rd Officer	T. Aquino · F. Villa · M. Quezon · …
Chief Engineer	U. Lopez · F. Roxas · Z. Tolentino
2nd Engineer	J. Binay · W. Aguinaldo · C. Romulo · I. Remonde
3rd Engineer	… · Y. Nowikow · P. Petrow
4th Engineer	A. Kusmin · J. Gussew · B. Sorrokin

Month: 0 1 2 3 4 5 6 7 8 9 10 11 12

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# Challenges of crew scheduling in ship management

- **Various requirements**

- **Large problem sizes**
  → Large ship managers have hundreds of ships and thousands of seafarers

- **Long term planning**
  → It is done mostly for short term

- **Less reliability of seafarers**

- **Feasibility check to manage new ships**
  → It is done mostly through a rough estimation

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Sequential approach
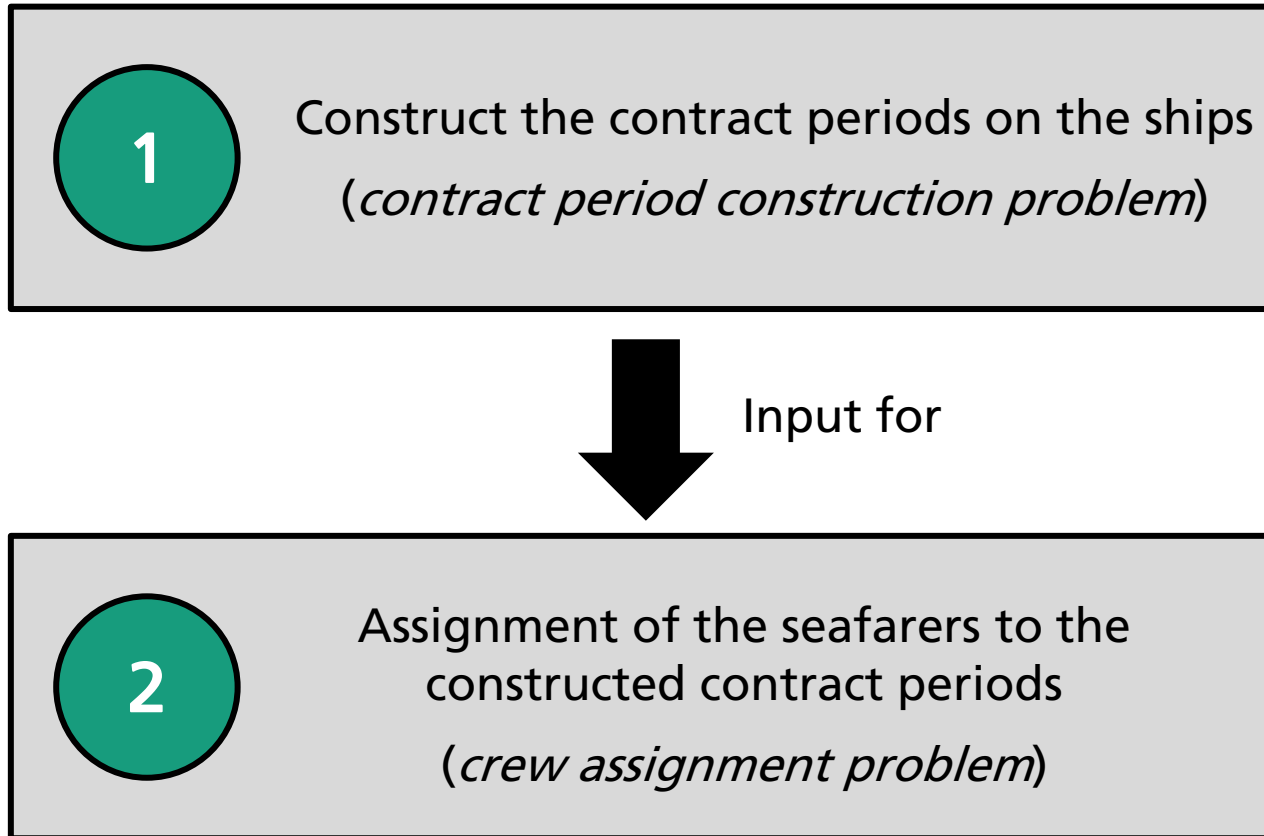
Sequential Approach – Contract Period Construction

Sequential Approach – Crew assignment

1 contract period construction   **2** *crew assignment*
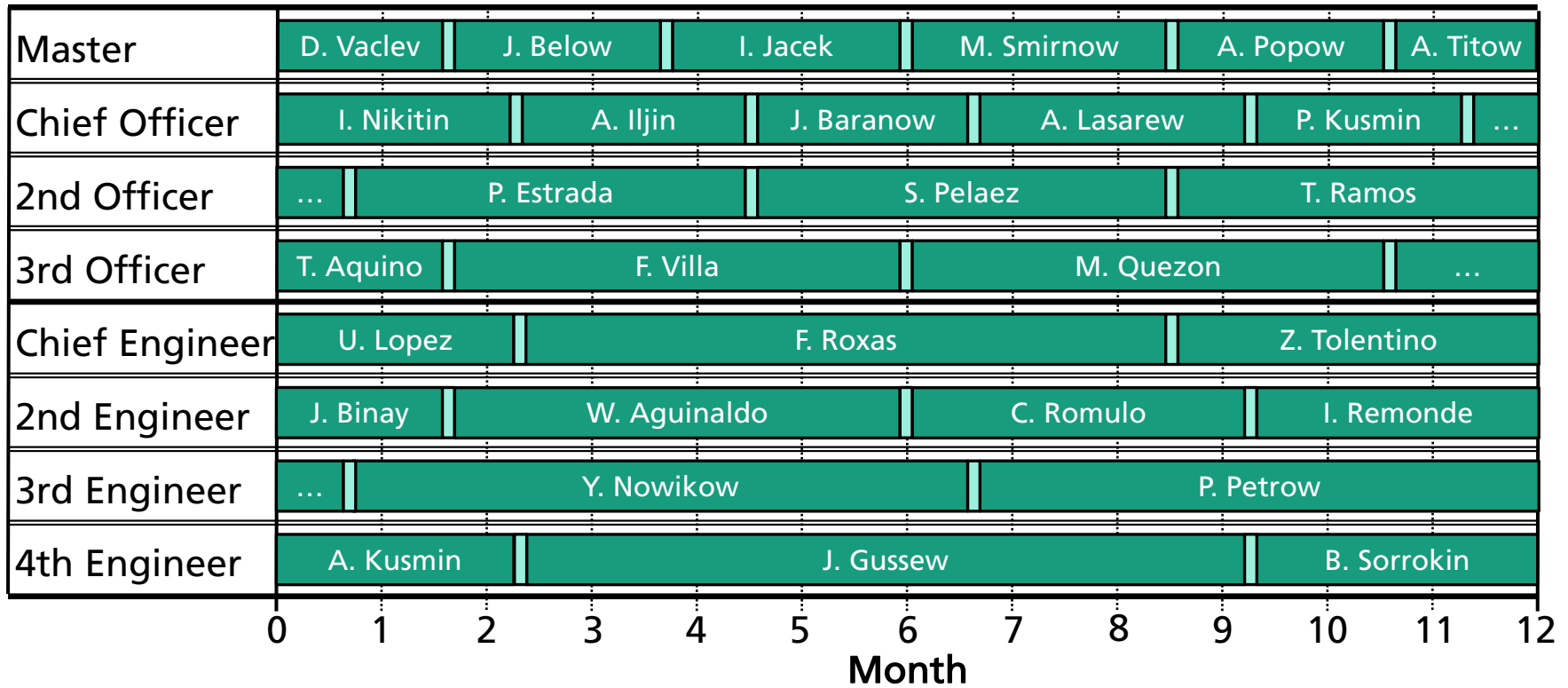
Contract Period Construction Problem - Constraints

Constraint 1: A Crew Change can only be conducted in a port
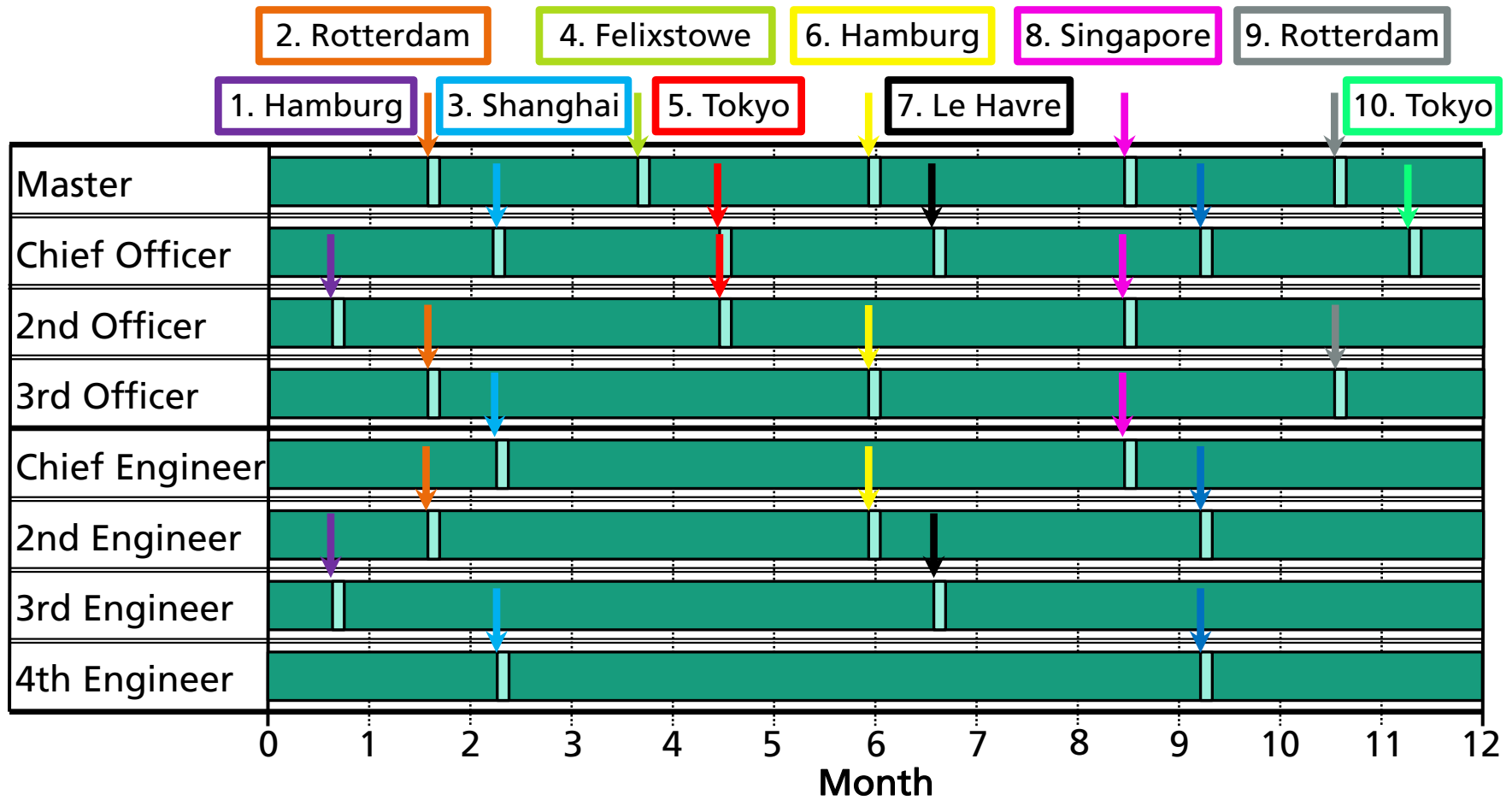
Contract Period Construction Problem - Constraints

Constraint 2: Minimum time interval between some crew changes
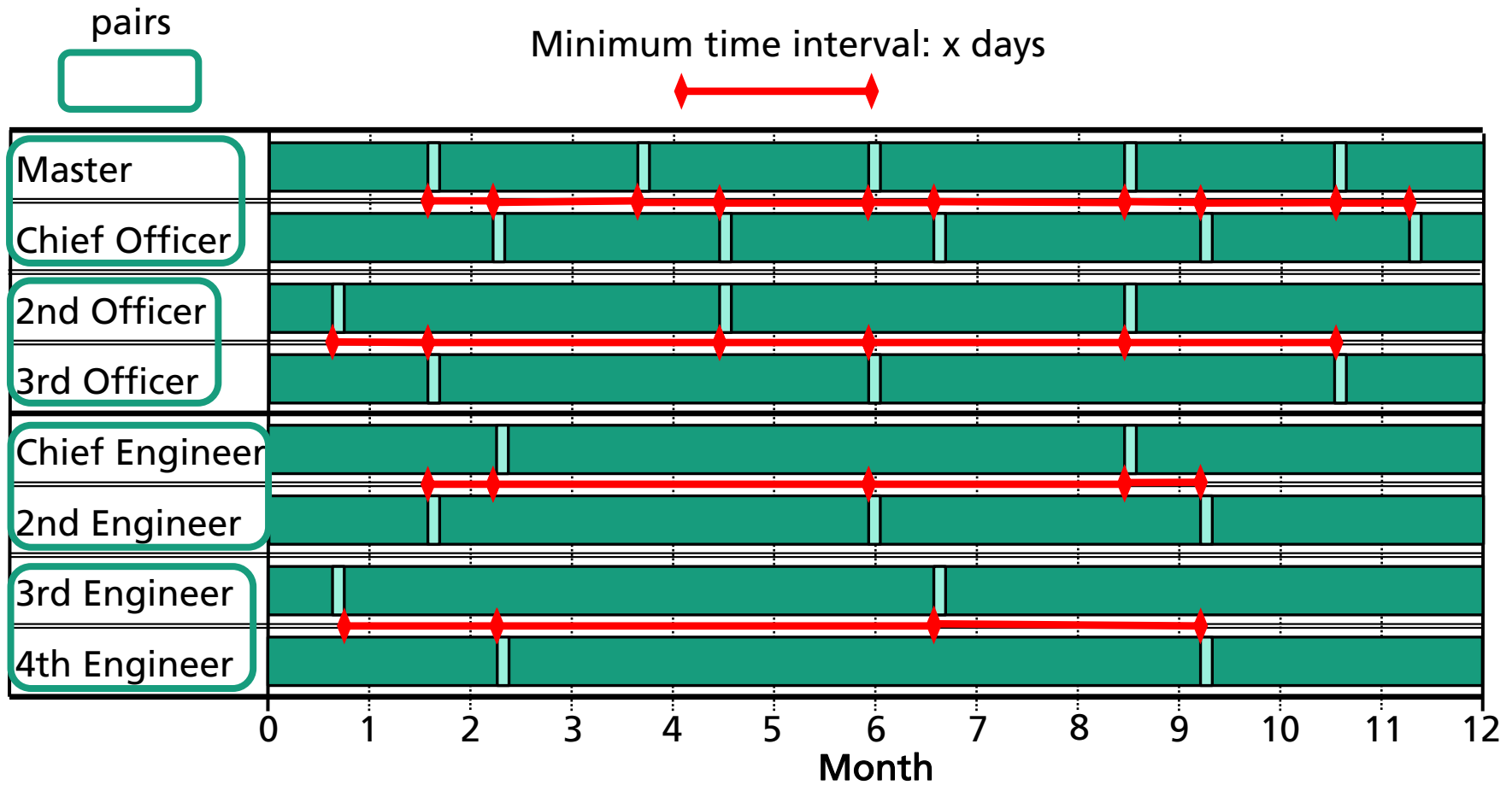
Contract Period Construction Problem - Constraints

Constraint 3: Maximum deviation from a fixed contract duration

Maximum deviation: x days

0-5 days deviation	10-20 days deviation
5-10 days deviation	20-30 days deviation

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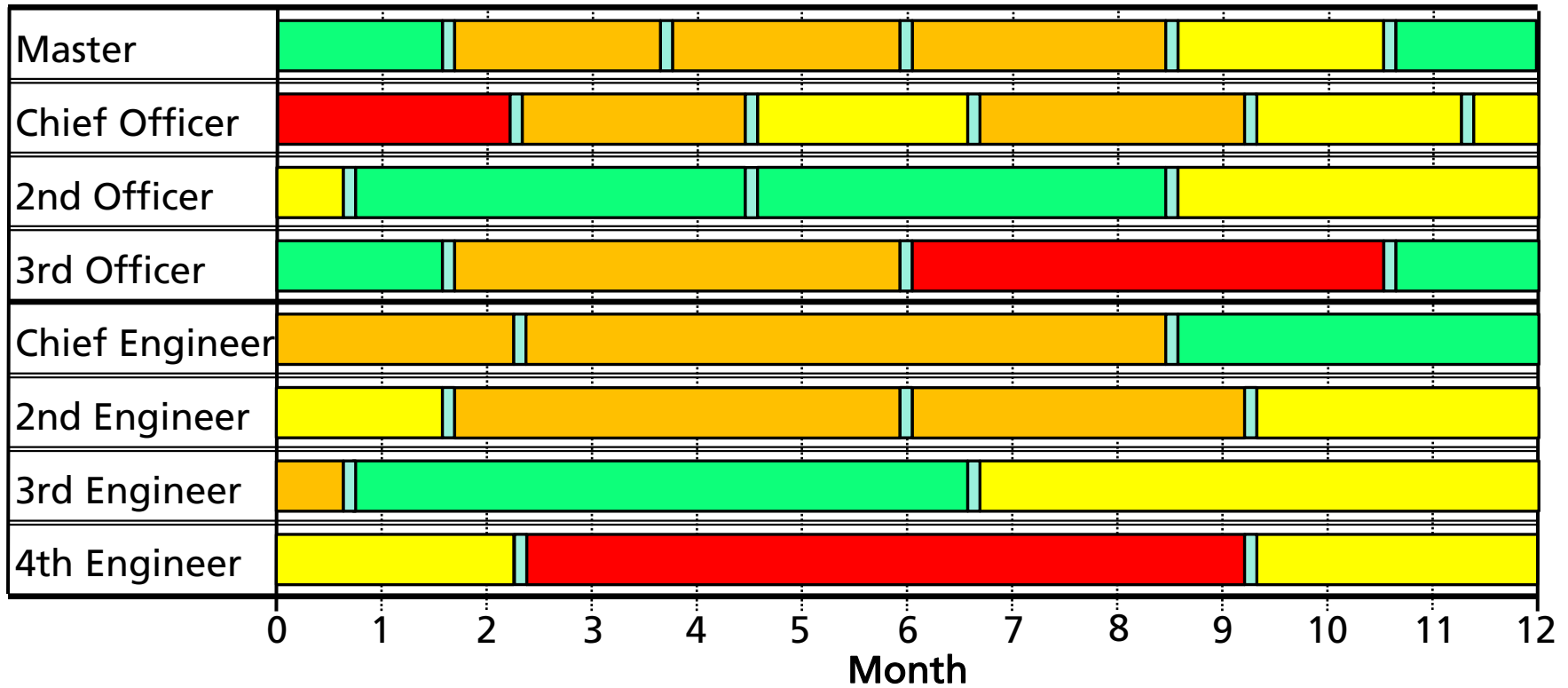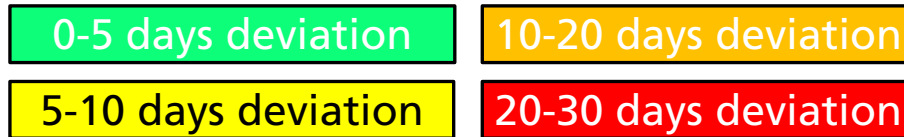
Contract Period Construction Problem

Further possible constraints:

- The number of position changes in the same port has to be less than a maximum value.

- The number of crew changes for one ship has to be less than a maximum value.

Possible objective values:

- Minimize the number of crew changes (crew change fix costs)

- Minimize the deviation from the fixed contract durations

Crew assignment - Constraints

Constraint 1: Extended overlap for new seafarers in rank or in the company

□ 1 day overlap   ■ 5 days overlap

Master	D. Vaclev	J. Below	I. Jacek	M. Smirnow	A. Popow	A. Titow
Chief Officer	I. Nikitin	A. Iljin	J. Baranow	A. Lasarew	P. Kusmin	…
2nd Officer	…	P. Estrada	S. Pelaez	T. Ramos
3rd Officer	T. Aquino	F. Villa	M. Quezon	…
Chief Engineer	U. Lopez	F. Roxas	Z. Tolentino
2nd Engineer	J. Binay	W. Aguinaldo	C. Romulo	I. Remonde
3rd Engineer	…	Y. Nowikow	P. Petrow
4th Engineer	A. Kusmin	J. Gussew	B. Sorrokin

Month

Crew assignment - Constraints

Constraint 2: Minimum experience times for specific rank combinations

| 8 months | 6 months | 4 months | 2 months | 0 months |

	Month 0–12 timeline
Master	D. Vaclev · J. Below · I. Jacek · M. Smirnow · A. Popow · A. Titow
Chief Officer	I. Nikitin · A. Iljin · J. Baranow · A. Lasarew · P. Kusmin · …
2nd Officer	… · P. Estrada · S. Pelaez · T. Ramos
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Month: 0 1 2 3 4 5 6 7 8 9 10 11 12

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Crew assignment - Constraints

Constraint 2: Minimum experience times for specific rank combinations

| 8 months | 6 months | 4 months | 2 months | 0 months |

> x months

	0	1	2	3	4	5	6	7	8	9	10	11	12
Master	D. Vaclev	J. Below		I. Jacek		M. Smirnow		A. Popow		A. Titow			
Chief Officer	I. Nikitin		A. Iljin		J. Baranow		A. Lasarew		P. Kusmin		...		
2nd Officer	...	P. Estrada			S. Pelaez			T. Ramos					
3rd Officer	T. Aquino	F. Villa			M. Quezon			...					
Chief Engineer	U. Lopez		F. Roxas			Z. Tolentino							
2nd Engineer	J. Binay	W. Aguinaldo			C. Romulo		I. Remonde						
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Month

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Crew assignment - Constraints

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> x months

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Month: 0 1 2 3 4 5 6 7 8 9 10 11 12

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Crew assignment - Constraints

Constraint 2: Minimum experience times for specific rank combinations

Crew assignment - Constraints

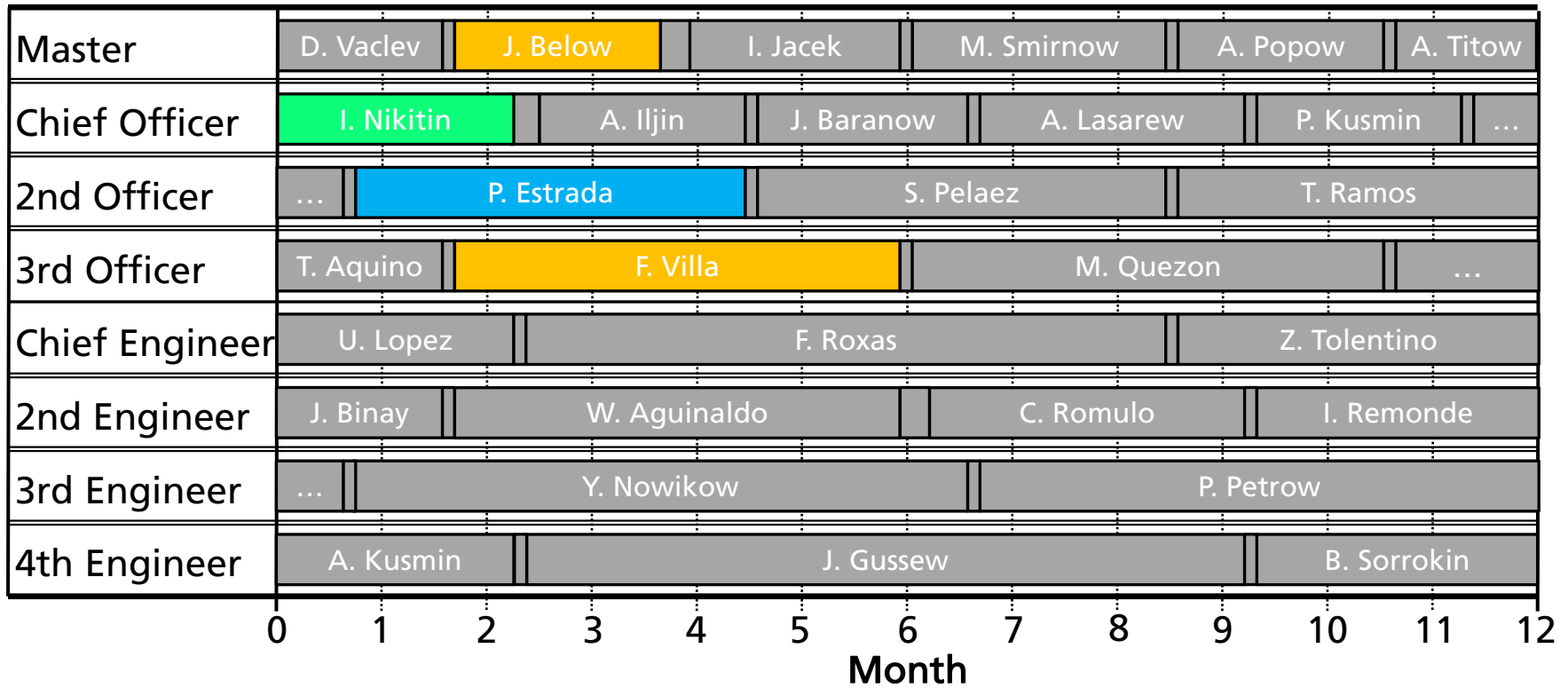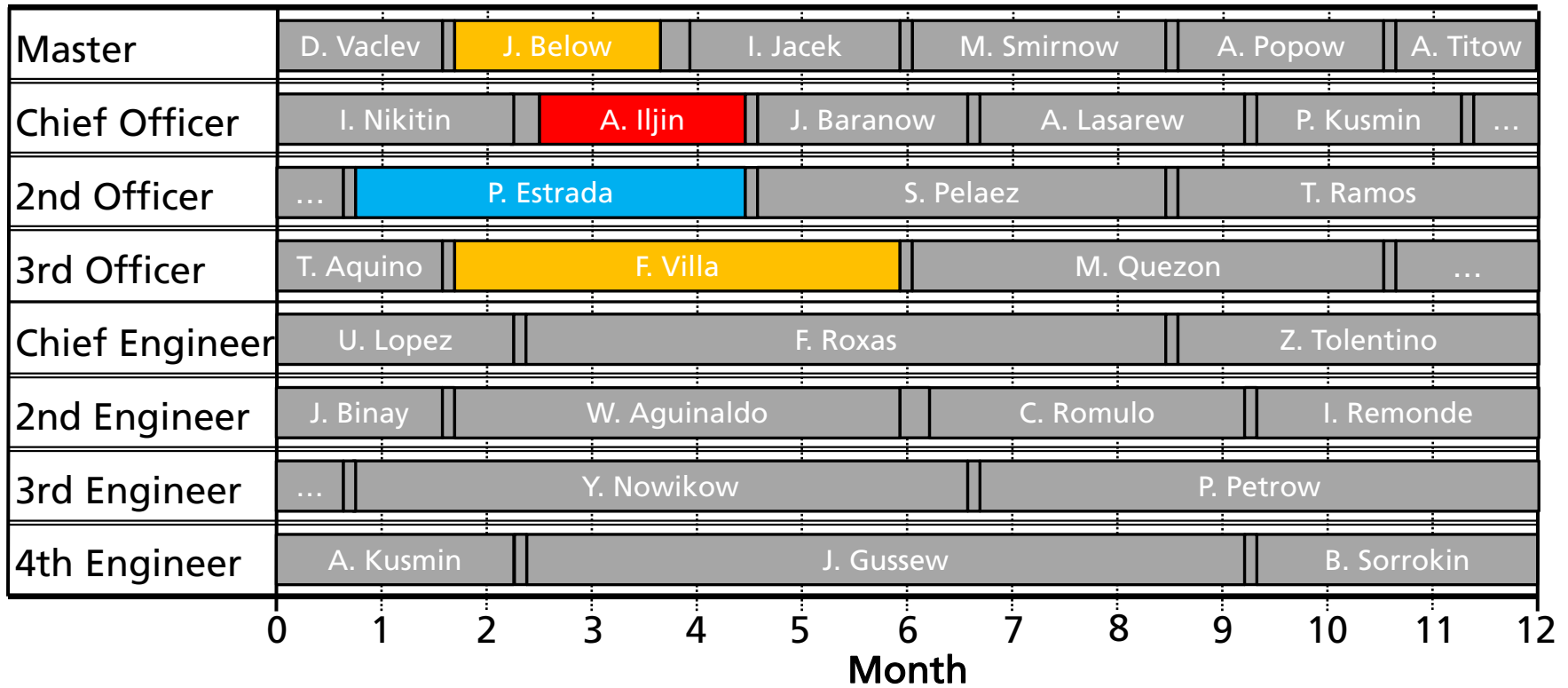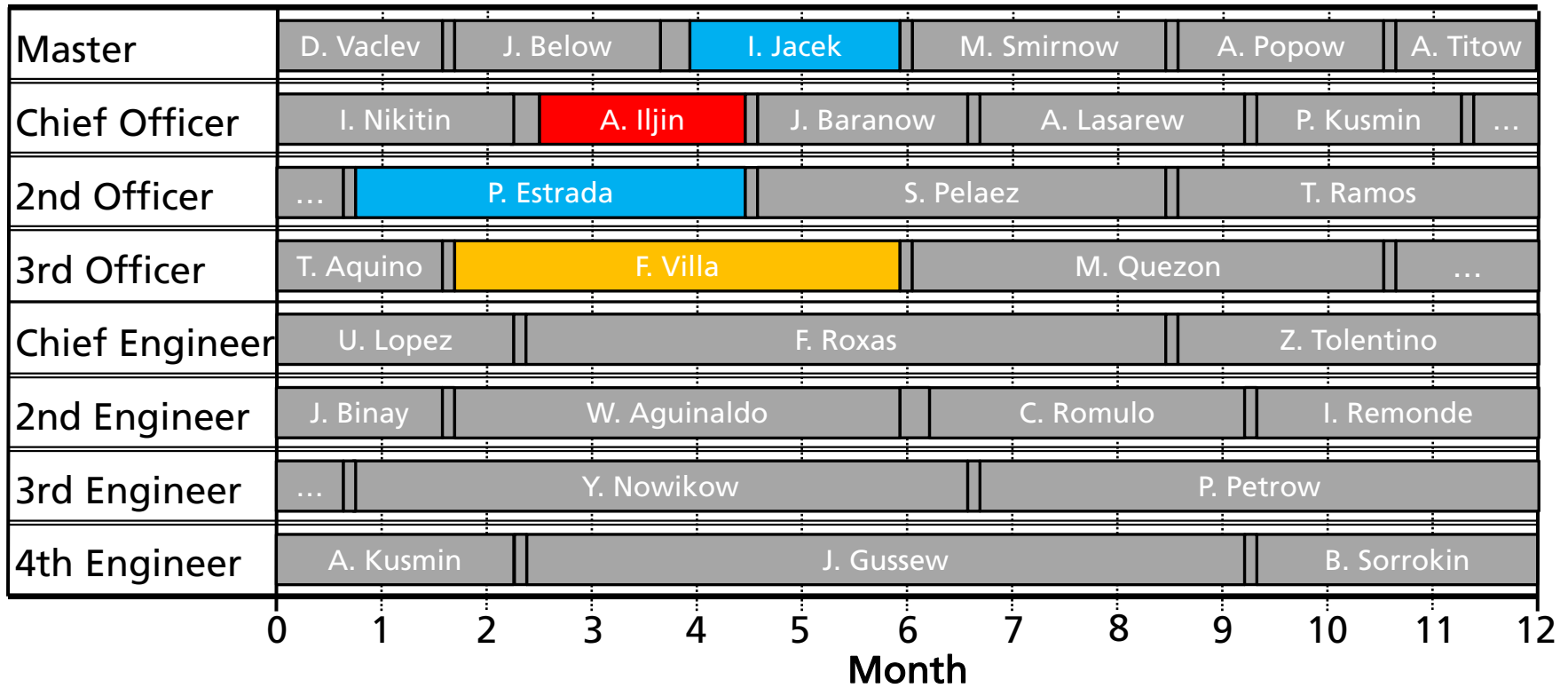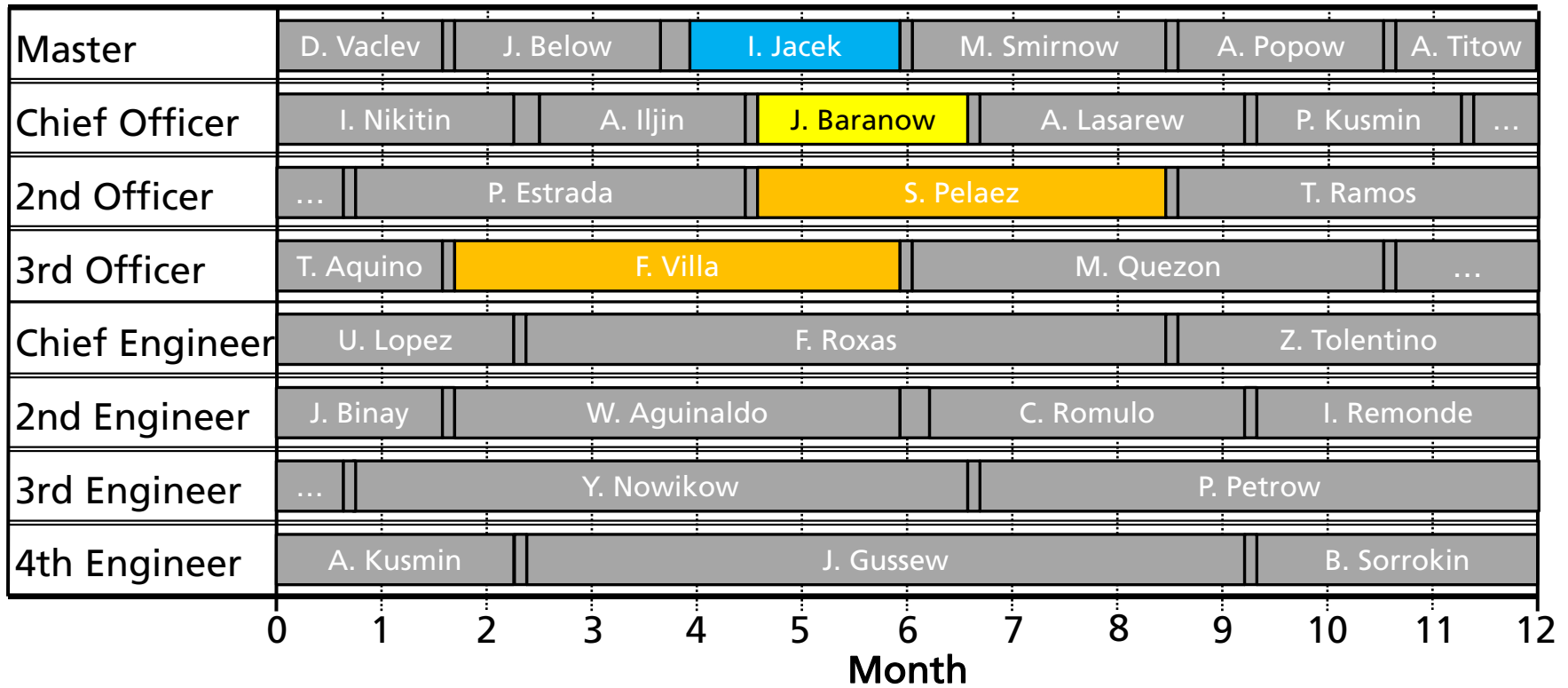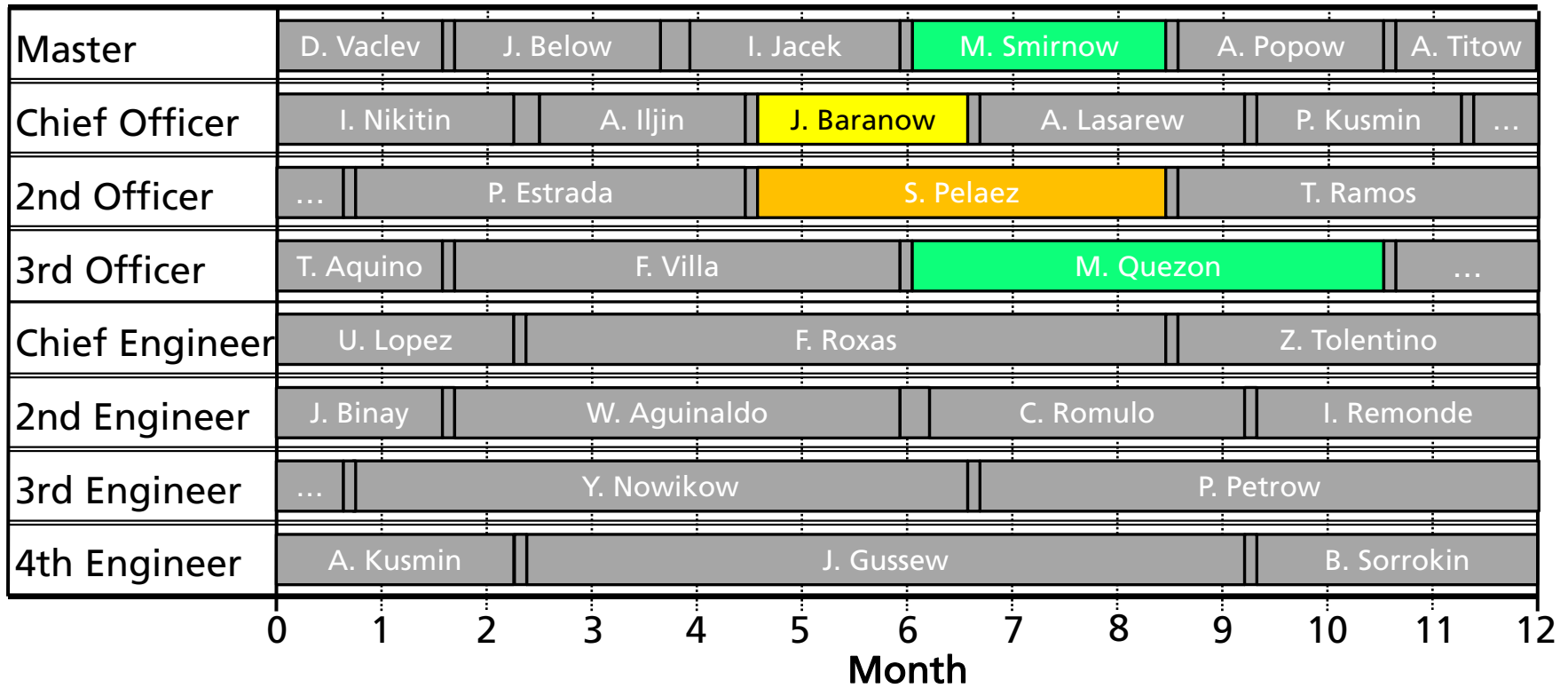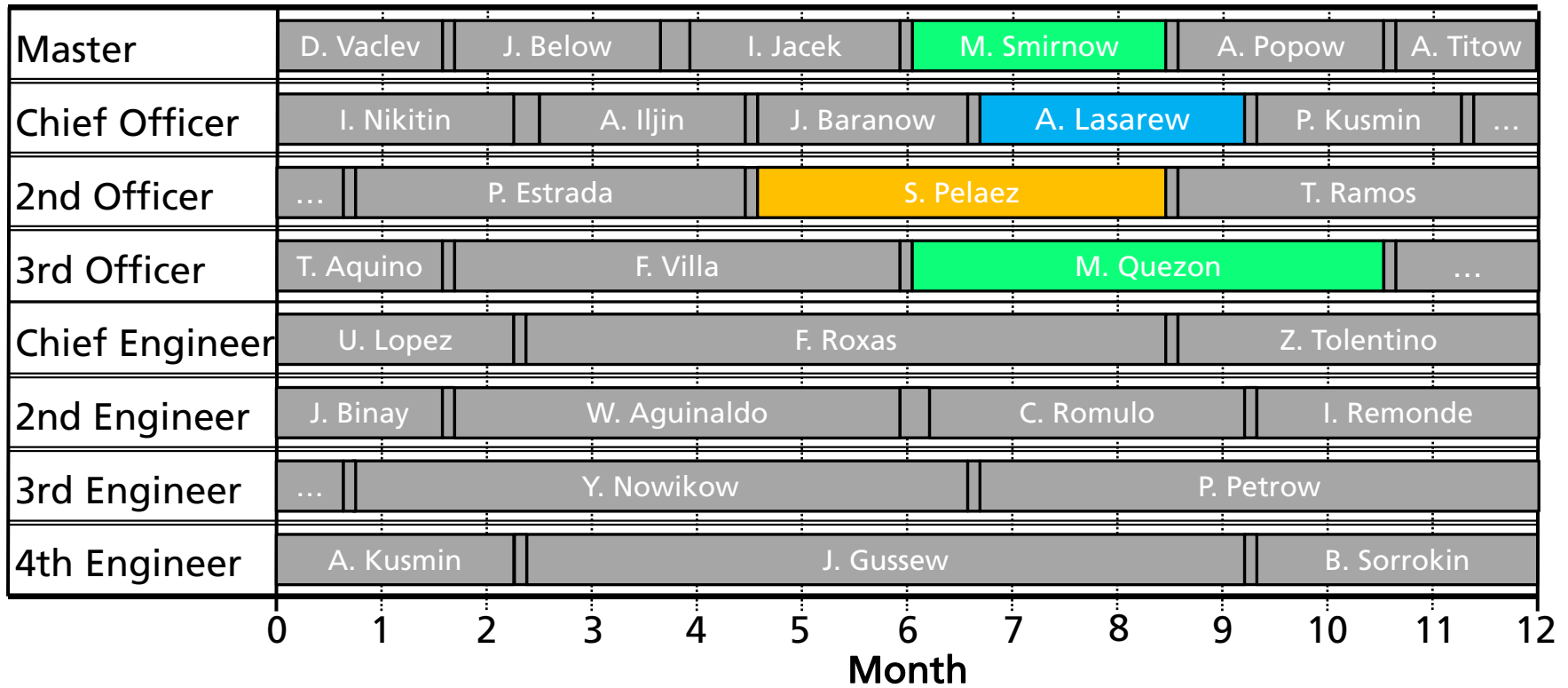**Constraint 2**: Minimum experience times for specific rank combinations

Crew assignment - Constraints

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0 1 2 3 4 5 6 7 8 9 10 11 12

Month

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Crew assignment - Constraints

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Month

0 1 2 3 4 5 6 7 8 9 10 11 12

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Crew assignment - Constraints

Constraint 2: Minimum experience times for specific rank combinations

Crew assignment - Constraints

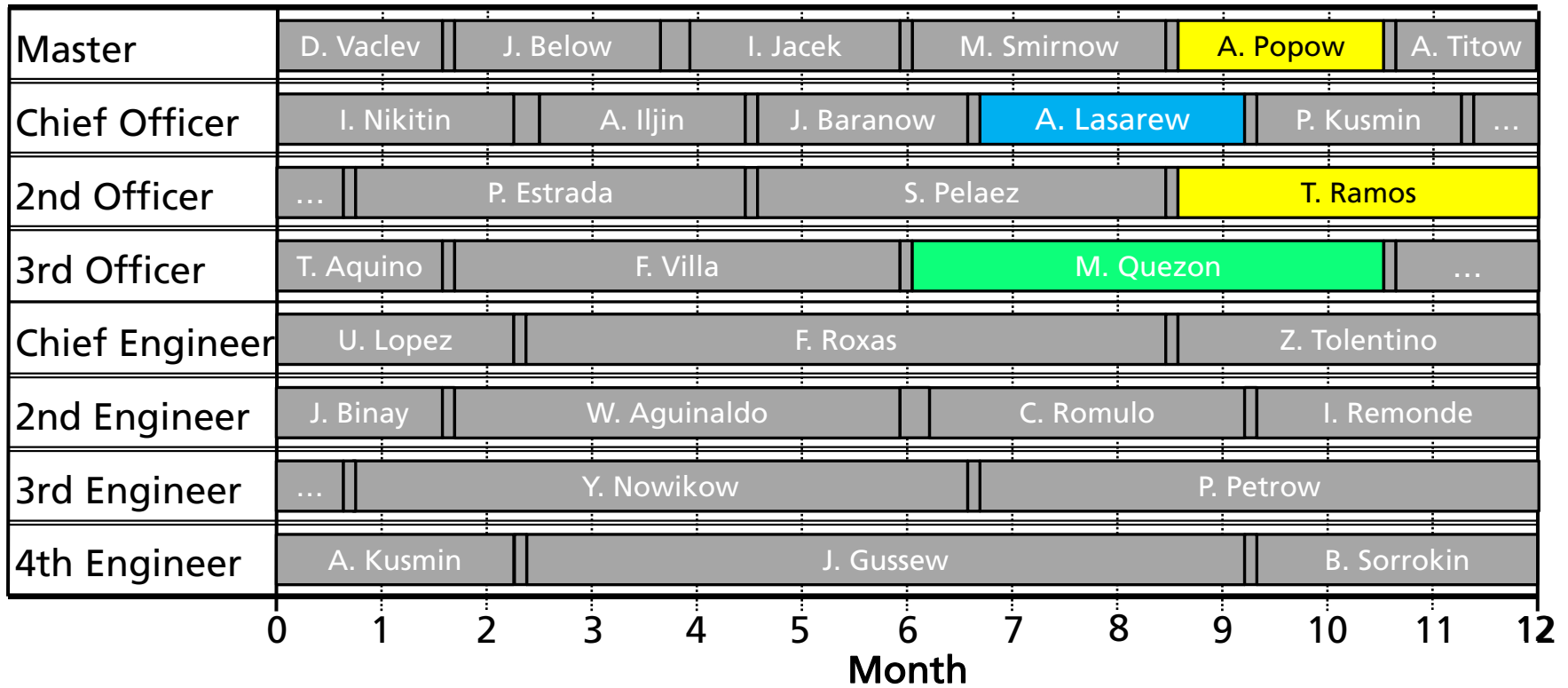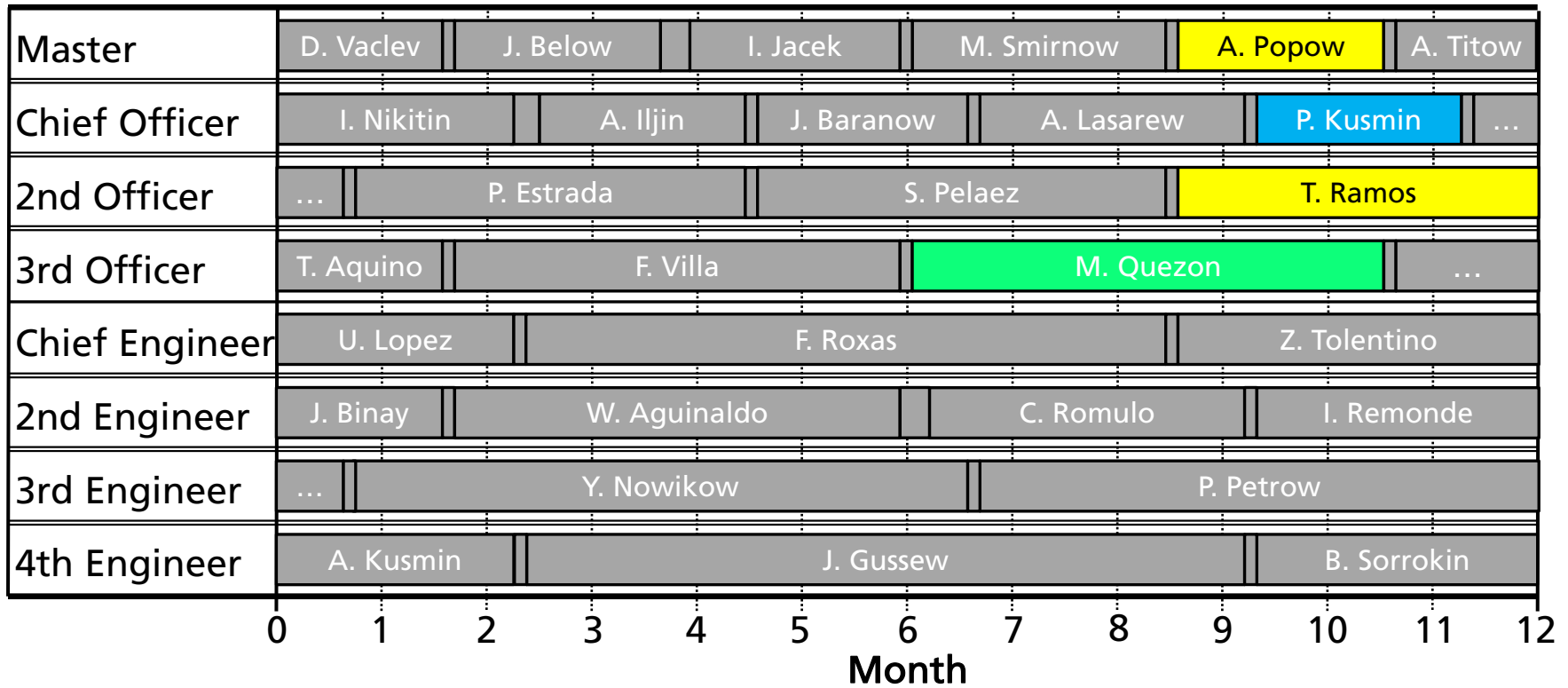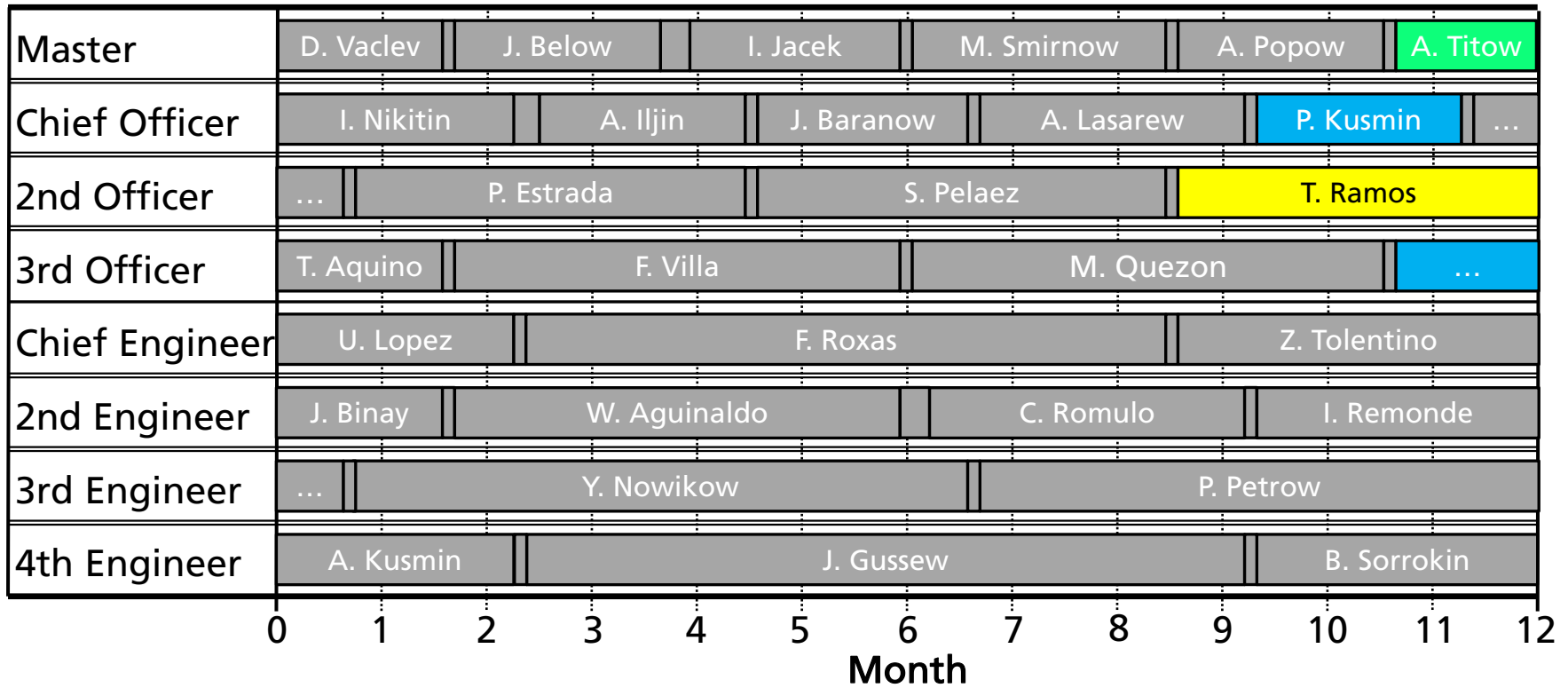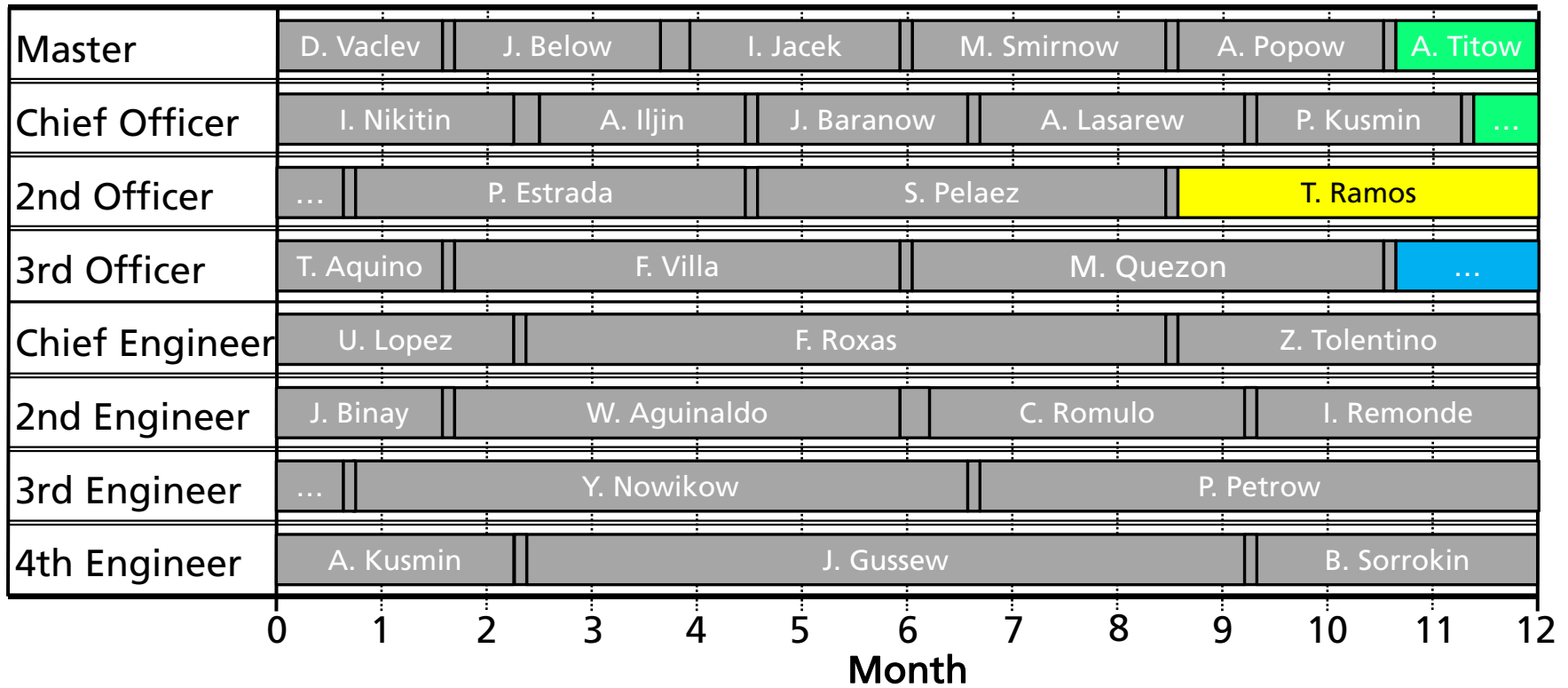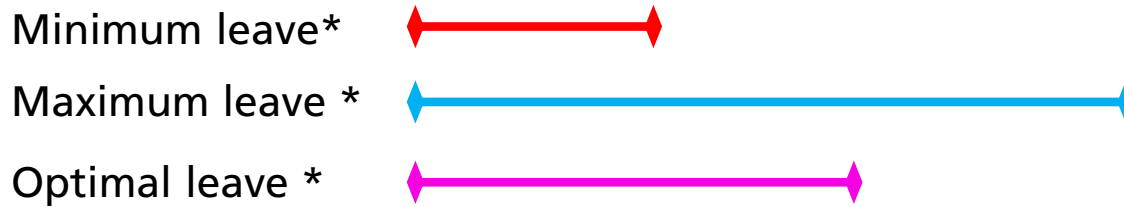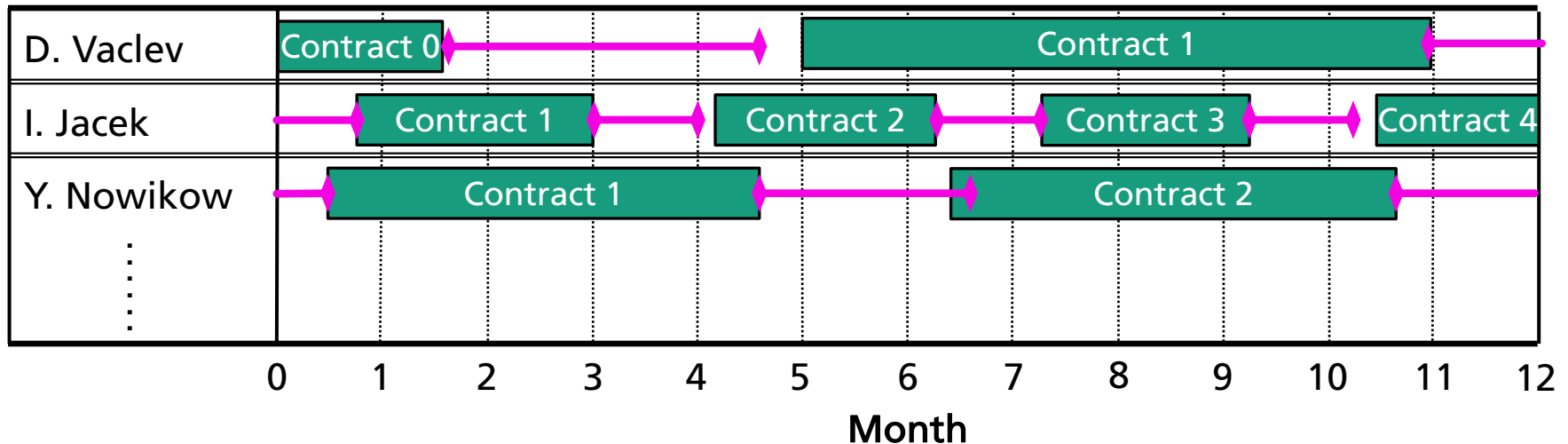**Constraint 2:** Minimum experience times for specific rank combinations

Crew assignment - Constraints

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0 1 2 3 4 5 6 7 8 9 10 11 12

Month

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Crew assignment - Constraints

Constraint 2: Minimum experience times for specific rank combinations

Crew assignment - Constraints

Constraint 3: Consideration of minimum and maximum leave times

Minimum leave*

Maximum leave *

Optimal leave *

View of a seafarer

| D. Vaclev | Contract 0 | | | | | | Contract 1 | | | | | |

| I. Jacek | | Contract 1 | | Contract 2 | | Contract 3 | | Contract 4 | | | | |

| Y. Nowikow | | Contract 1 | | | Contract 2 | | | | | | | |

Month

* depends on the contract duration

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Crew Assignment Problem

Further possible constraints:

- Every seafarer could be assigned only to a specific ship type (container, bulker …)

- Earliest contract start dates of the seafarer have to be considered

- Preferred assignment of permanently employed seafarers

Possible objective values:

- Minimize the deviation of seafarer experience times among the ships

- Minimize the deviation of real leave times from optimal leave times

Agenda

1 Introduction

2 Challenges of crew scheduling in ship management

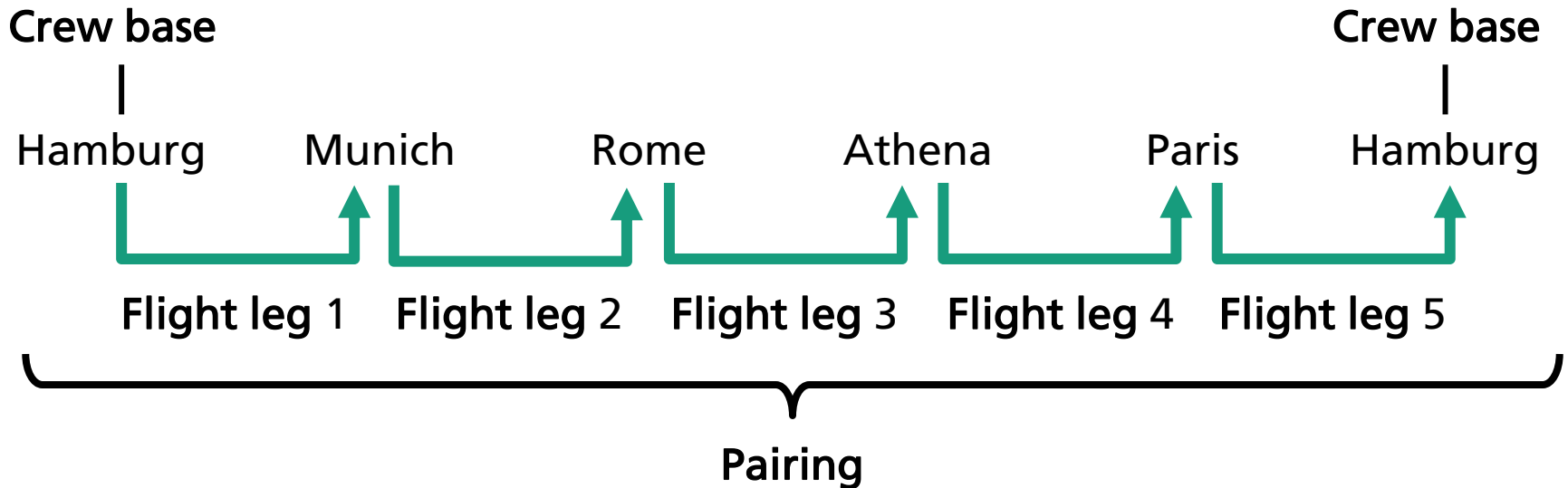**3** Problem description

4 Comparison to the airline sector

5 Benefits of mathematical optimization

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The crew scheduling problem in airline sector

Crew base   **Crew base**

Hamburg   Munich   Rome   Athena   Paris   Hamburg

Flight leg 1   **Flight leg** 2   **Flight leg** 3   **Flight leg** 4   **Flight leg** 5

Pairing

<u>Usual a sequential approach is used:</u>

1 Solving the Crew Pairing Problem

2 Solving the Crew Assignment Problem

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Comparison of maritime and airline problem structure

Comparison aspect	Airline sector	Maritime sector
Basic unit	Flight leg	Contract period
Typical length of basic unit	hours	months
Given start/end time of basic unit	yes	no **1**
Feasible sequence of basic units	Pairing (Sequence of flight legs)	Sequence of contract periods
Restrictions for sequences	high	low **2**

1 Leads to increased complexity in maritime context

➡ the presented subsequent approach is pursued to cope with it

2 Leads to reduced complexity in maritime context

➡ integration of the crew pairing in the assignment problem is pursued

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Benefits of mathematical optimization for crew scheduling

- Optimized crew scheduling for the whole fleet of ships

- Possibility to create a reliable long term plan (e.g. one year)

- Increase the reliability of the seafarers through a reliable crew schedule and vice versa

- Possibility to conduct strategic capacity planning

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Conclusion and future research

Conclusion

- The state of research in crew scheduling in ship management is far behind the airline context

- No suitable approach about long term crew scheduling could be identified in literature

- There are various benefits of using OR techniques for crew scheduling in ship management

Future research

- Develop a solution method (under consideration of methods in airline sector)

- Critical review of the presented approach

Thank you for your attention!

[Quelle: Hafen Hamburg HHM / M. Lindner]

Contact

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21073 Hamburg

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