FEUP Universidade do Porto
Faculdade de Engenharia

Industrial Informatics

[Informática Industrial]

2022/23 edition

Analysis of the ERP Planning Module

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Plan for today's class

1st PART

1. Introduction to the ERPs' **planning module**
2. Practical exercise

2nd PART *

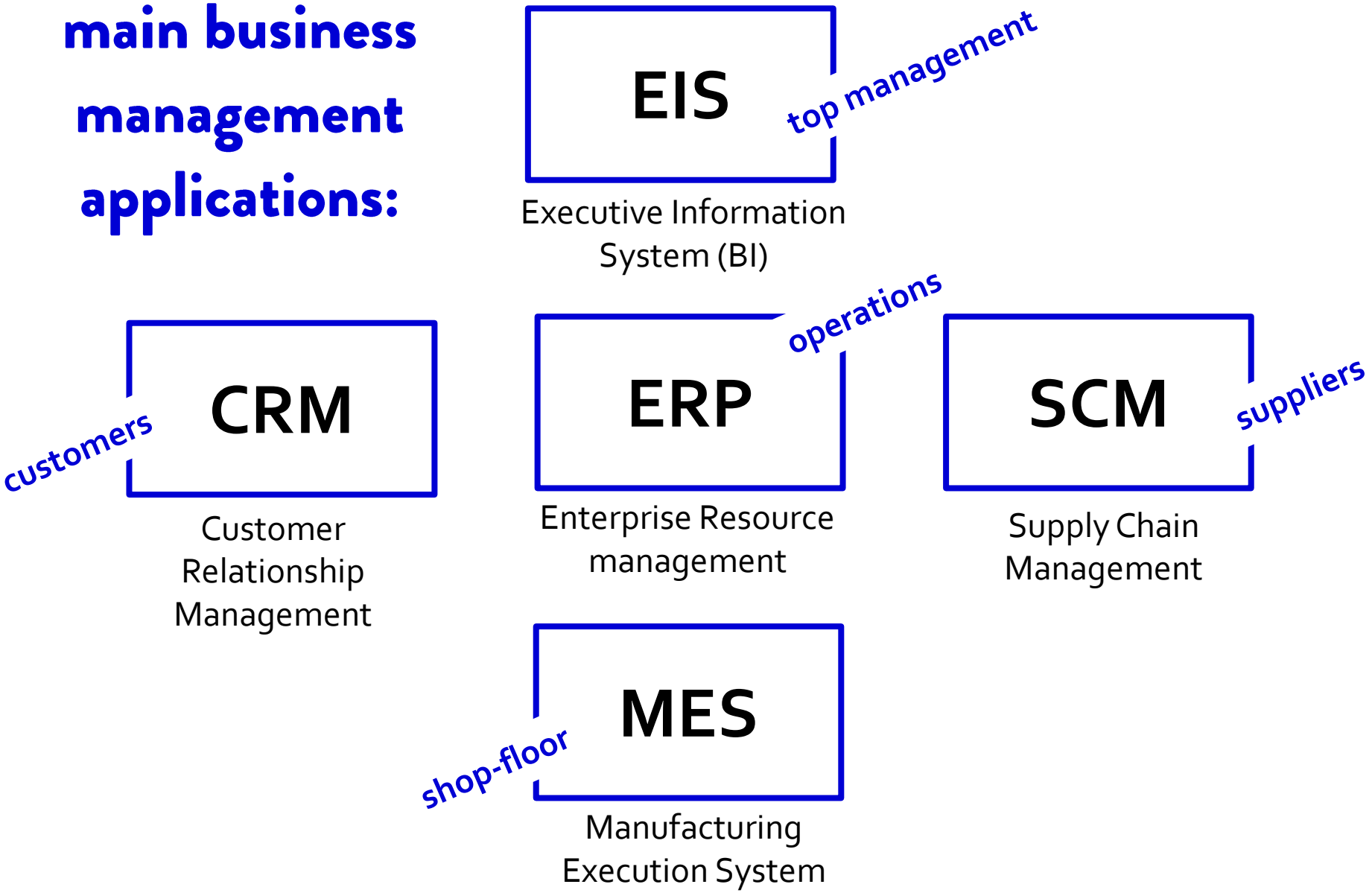
1. Introduction to the **PostgreSQL database** server
2. Simple SQL exercises

* slides in another document, also available in Moodle

1. Brief recap of the previous lesson

on business management applications

main business management applications:



the flagship !

BI

CRM

ERP

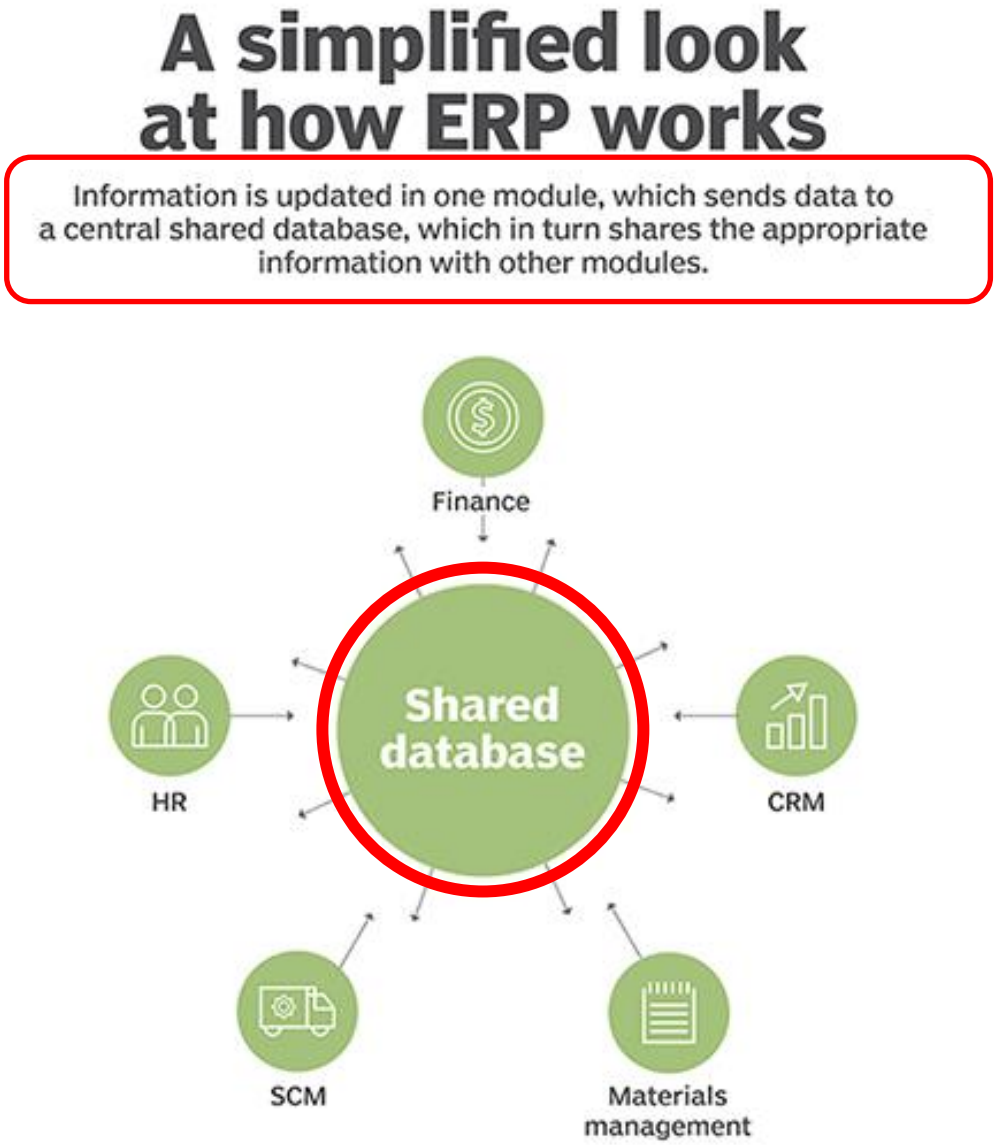
SCM

MES

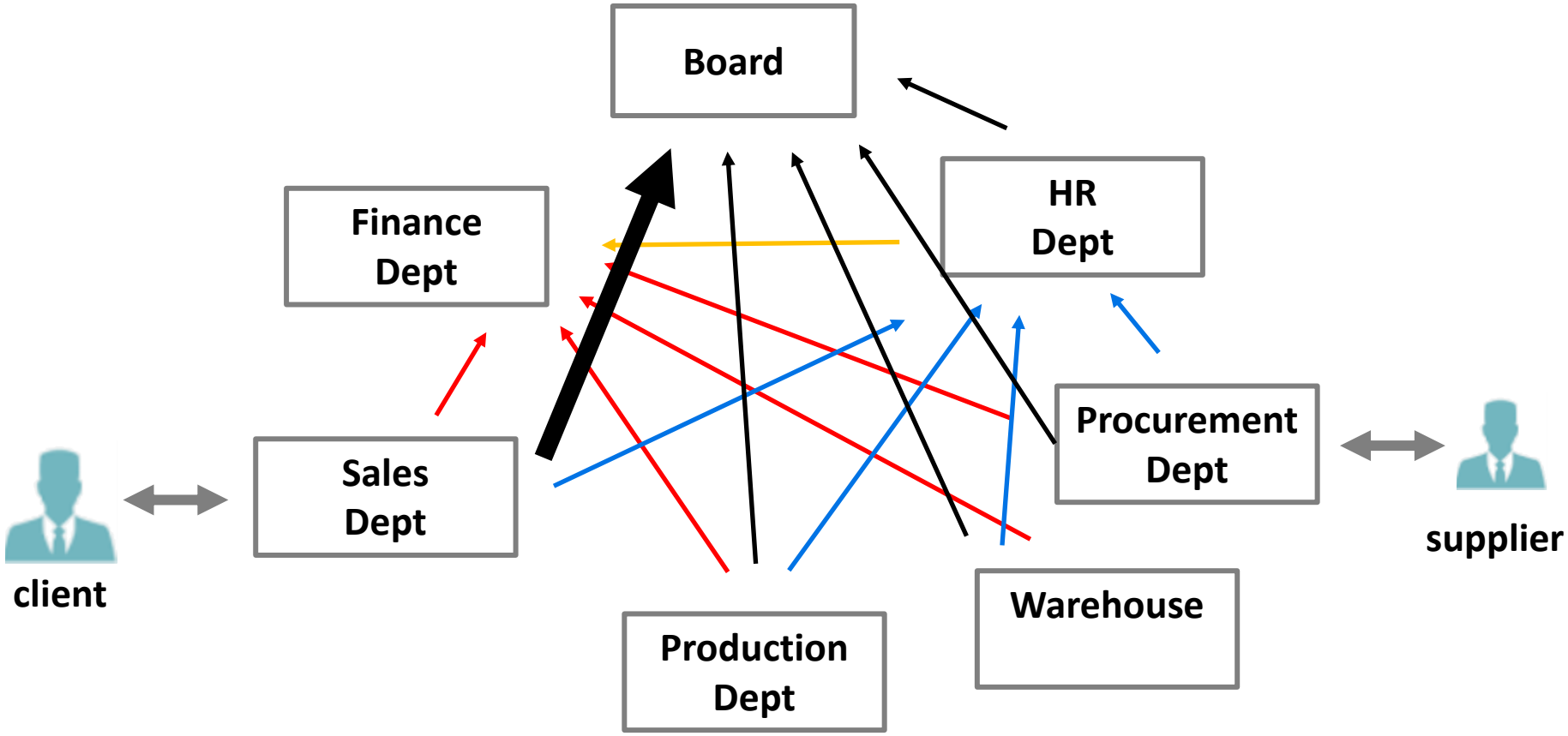
Enterprise Resource Planning

The **key ERPs' feature** stays on the fact that **all the modules share a common database**.

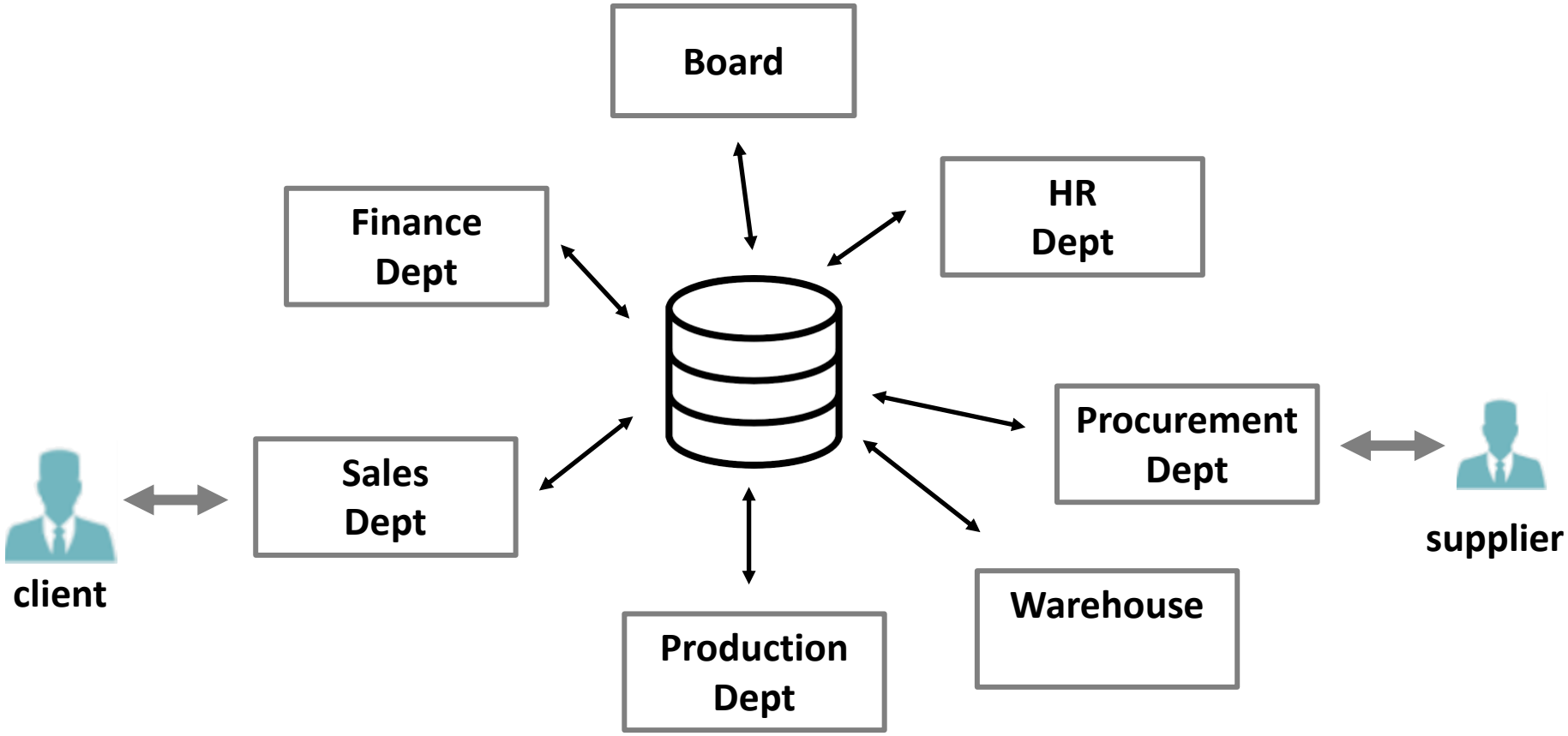
and **the same will** happen in the **INFI project !**



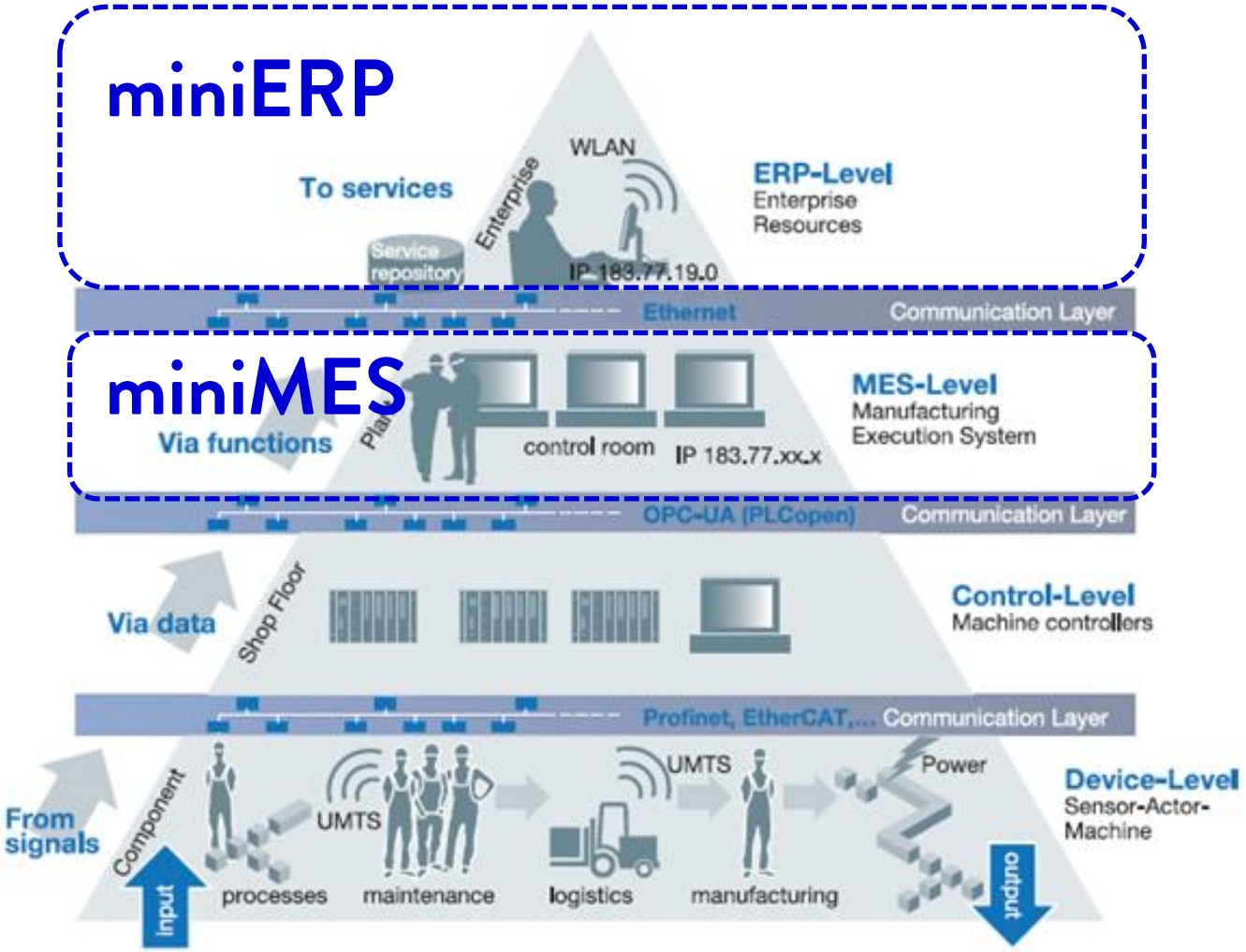
The **advantage of the database integration** became **obvious** from our **analysis of the information flows** inside the company ...



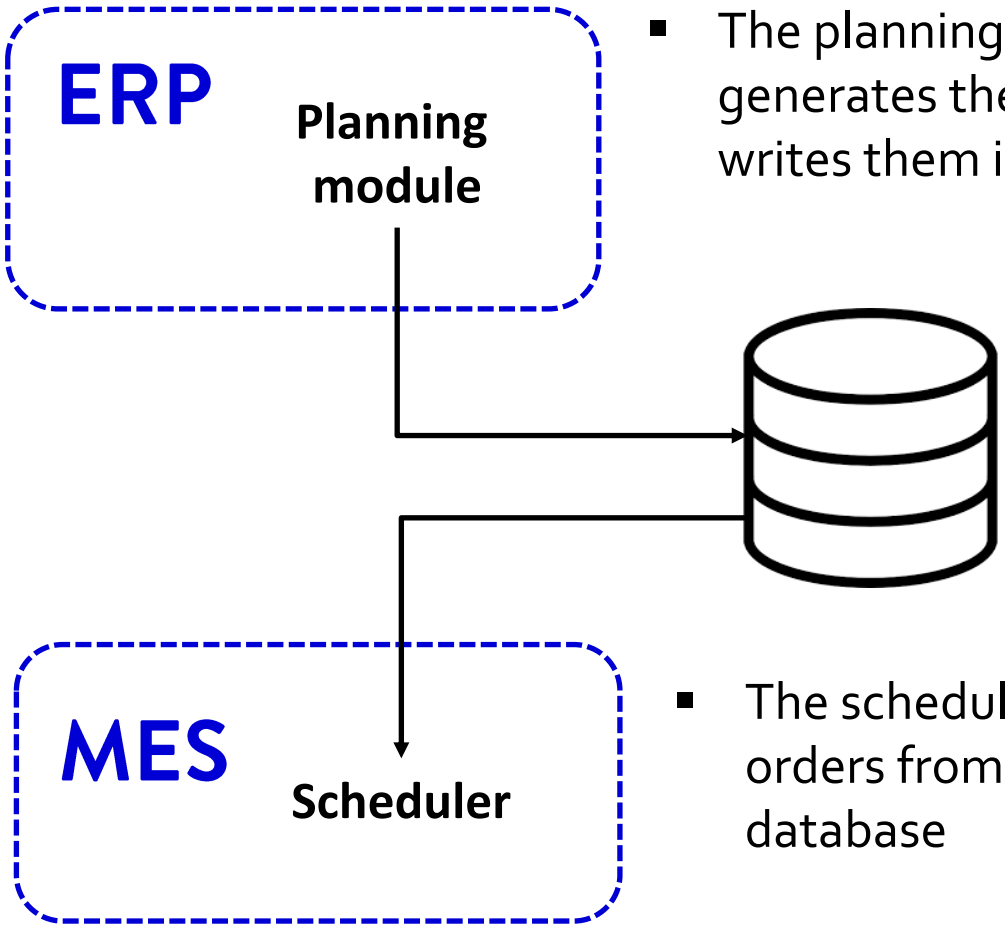
… as they are **much simpler** with an integrated database.



the INFI project



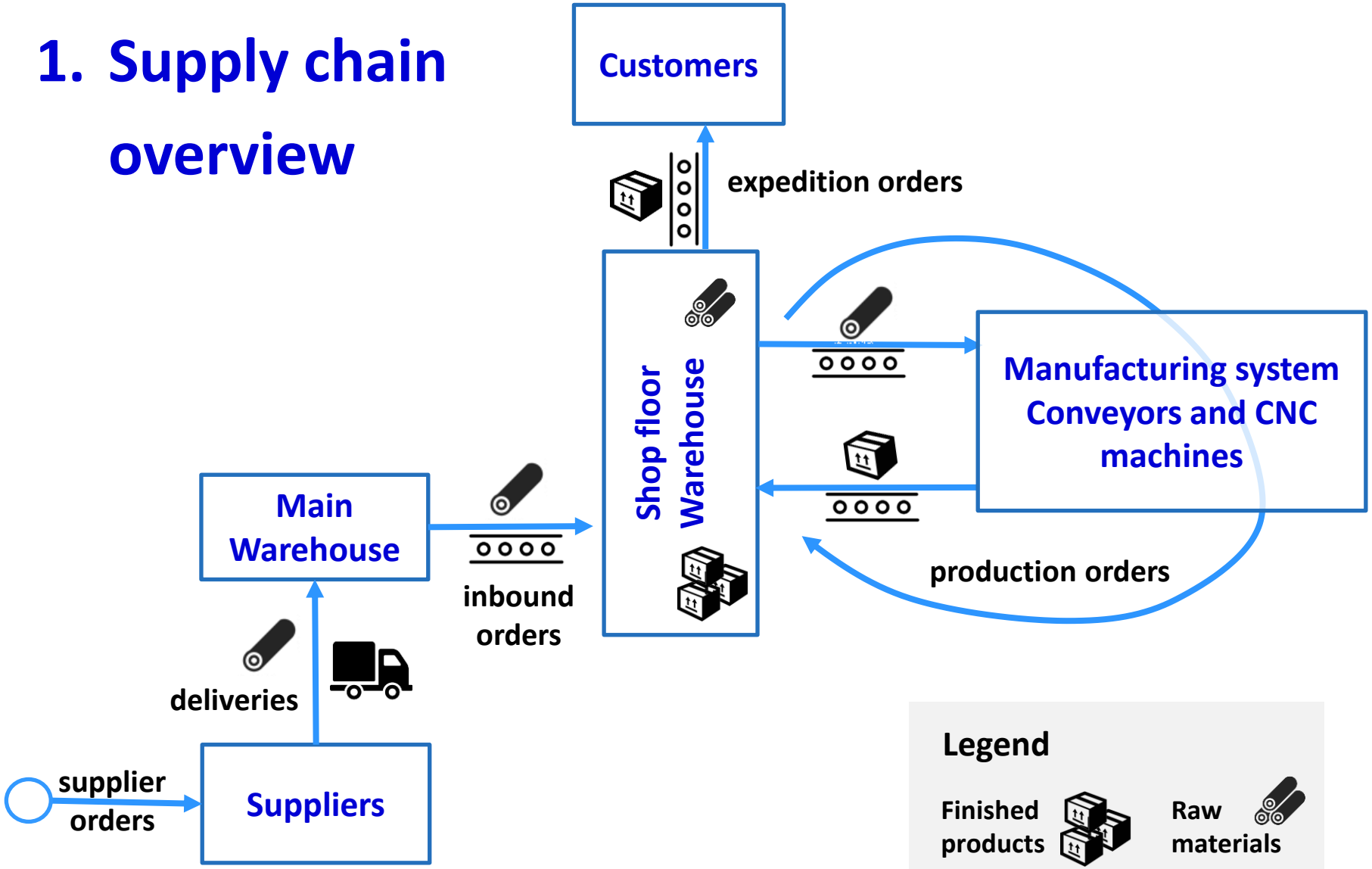
the miniERP and miniMES will communicate via DB



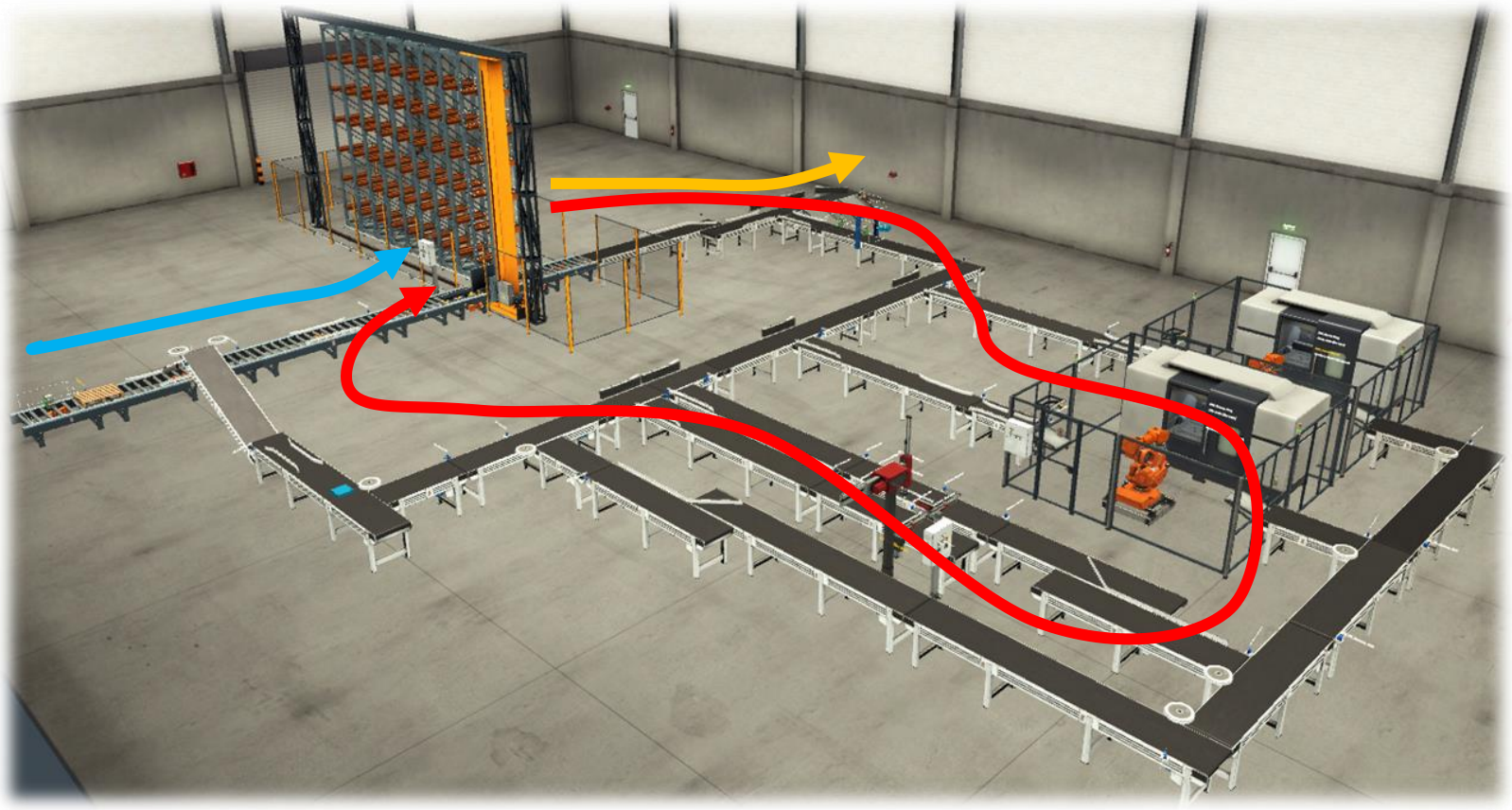
- The planning module generates the orders and writes them in the database
- The scheduler gets the orders from the database

2. Introduction to the planning module

1. Supply chain overview



Shop-floor and Warehouse

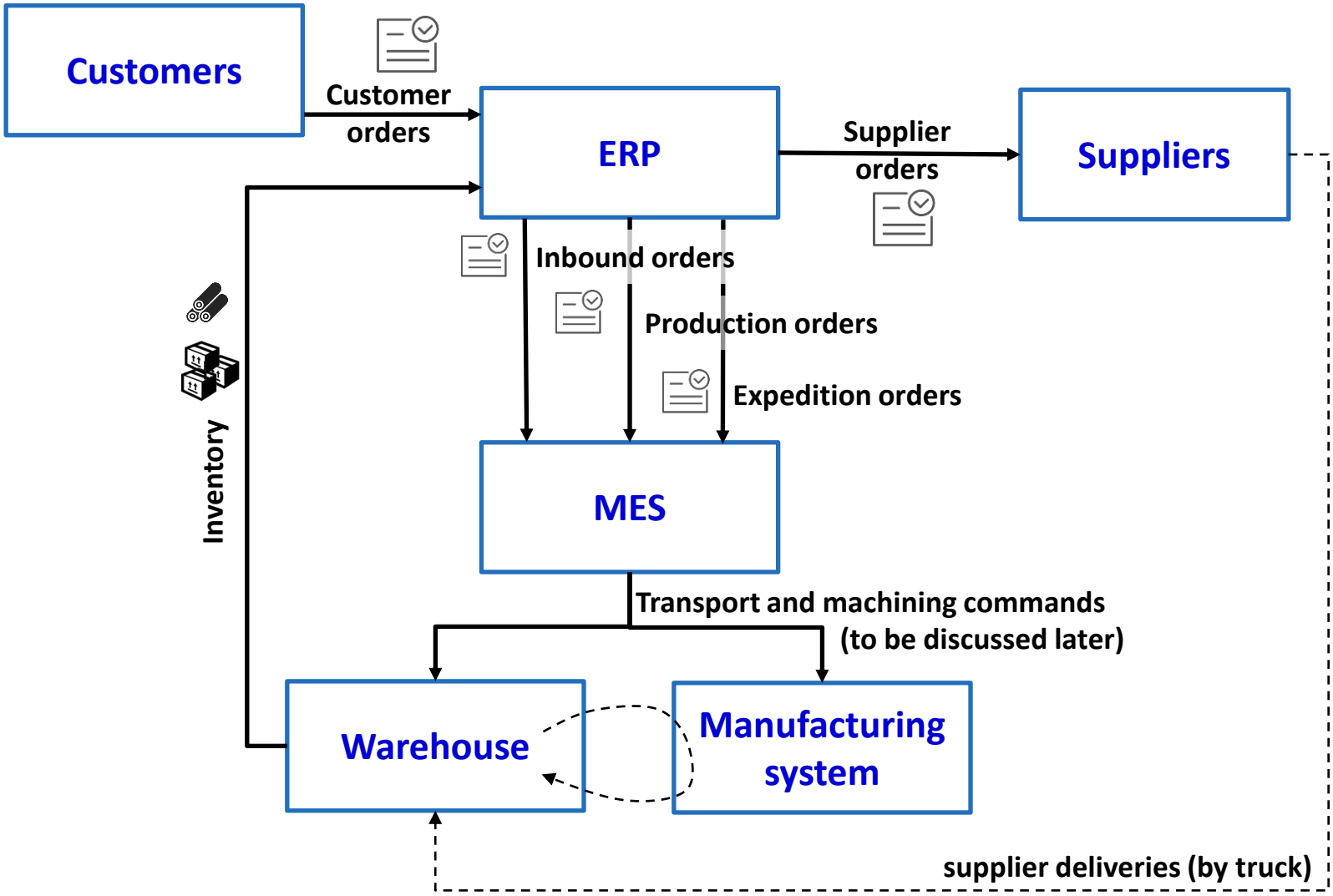


Inbound orders

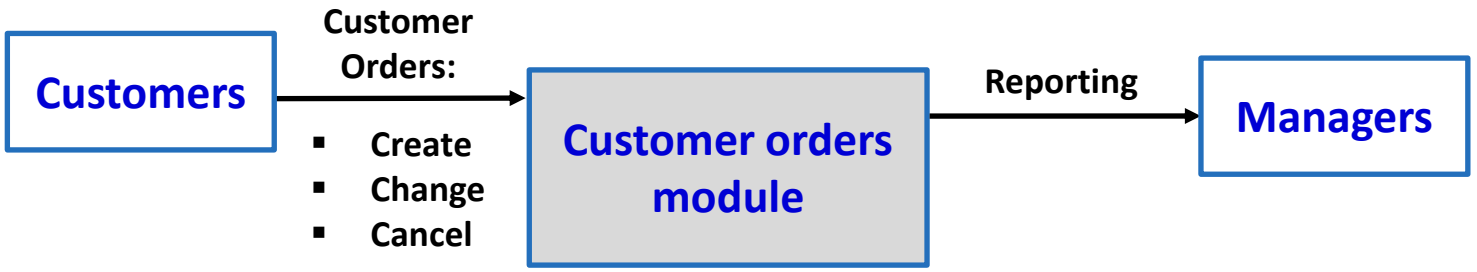
Production orders

Expedition orders

2. Overview of the management system



3. The customer orders module

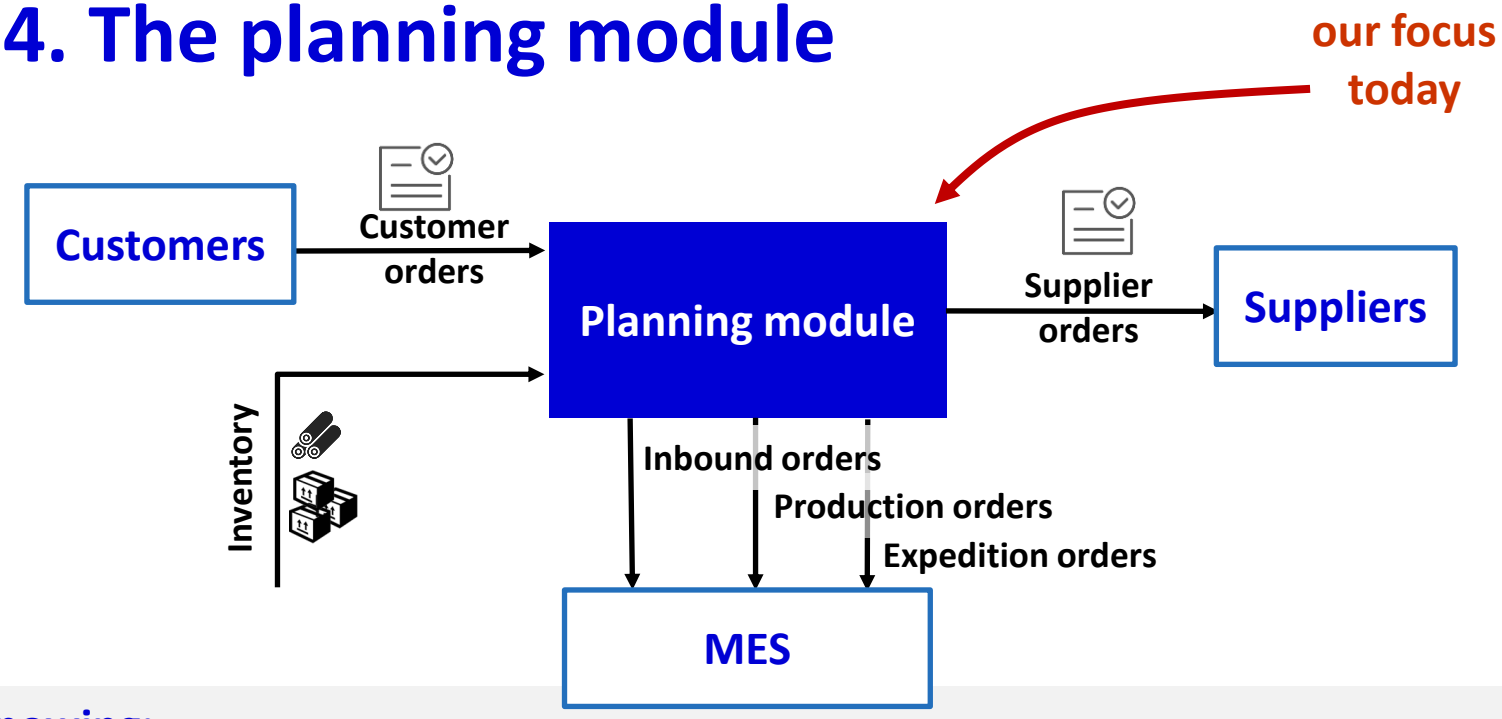


Use cases

- Registry of a new order
- Change a registered order (quantity and/or delivery date)
- Cancel a registered order

- Search customer orders (by customer, product, date)
- Report KPI's (e.g., quantities delivered, compliance to delivery dates, etc.)

4. The planning module



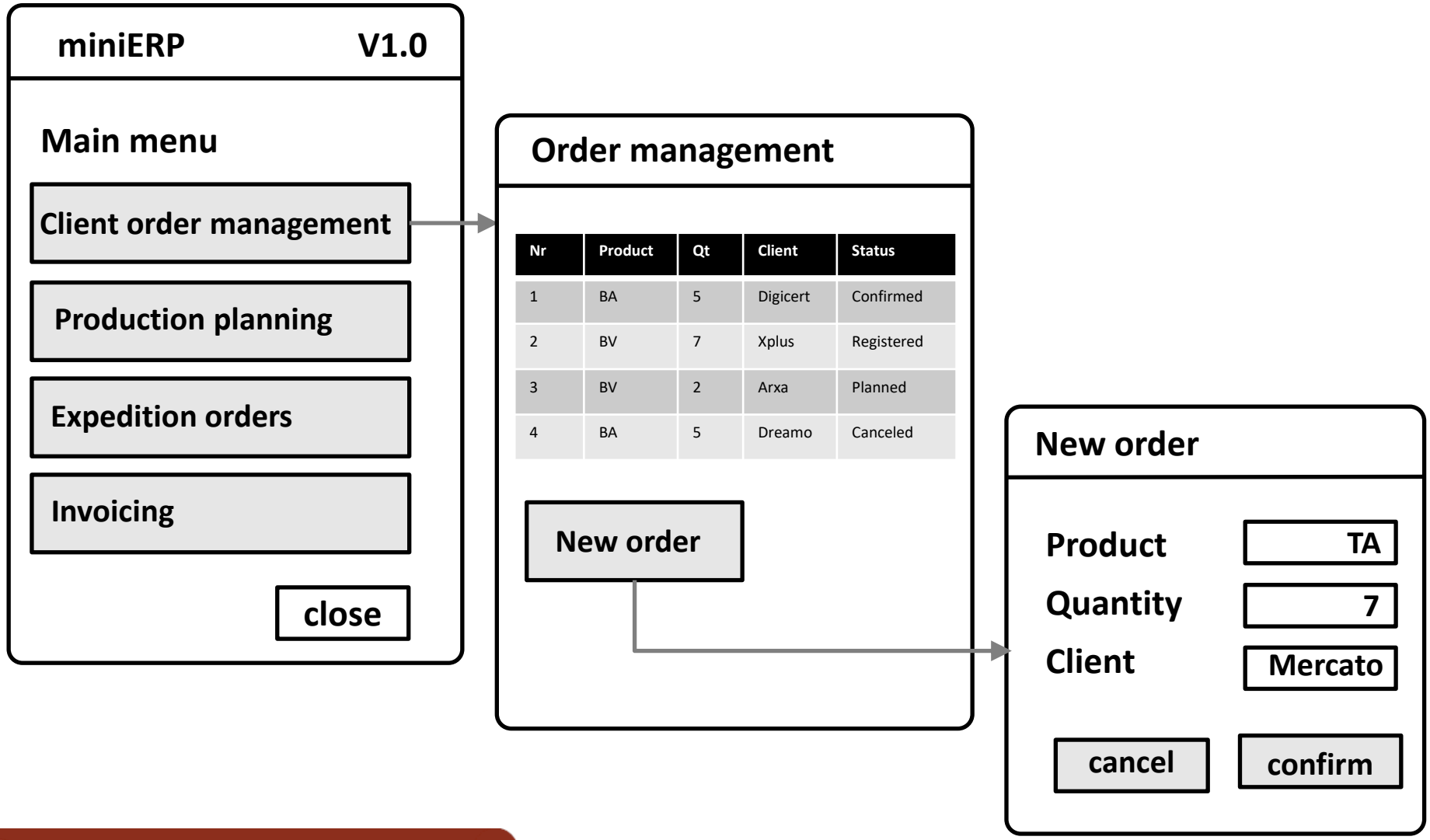
knowing:

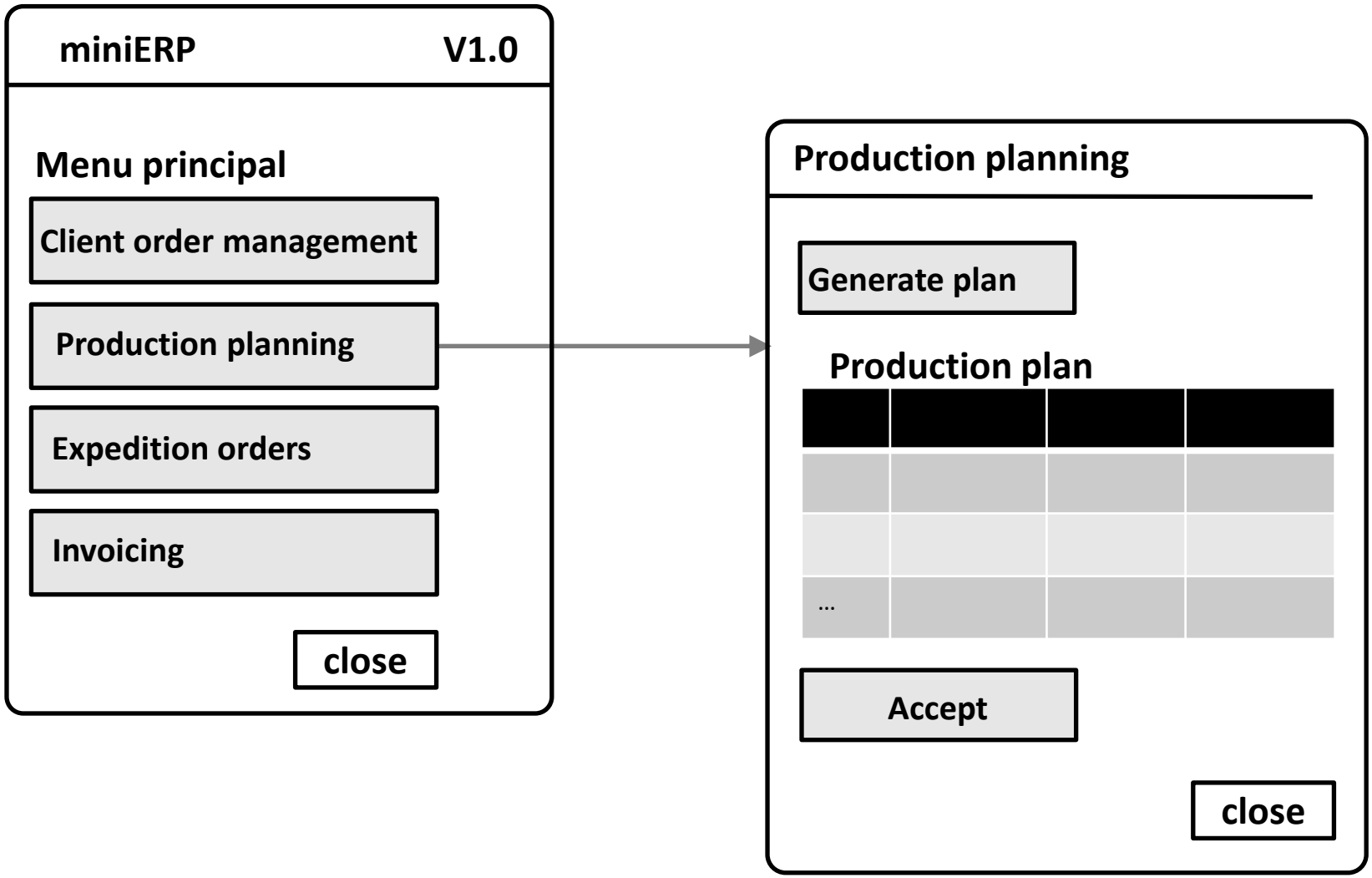
- the quantity and delivery date of each accepted customer order and
- the inventory of raw materials and finished products in the warehouse

plan:

- production, supplier, inbound and expedition orders to be executed in the plant

Client orders management | User interface mock-up's

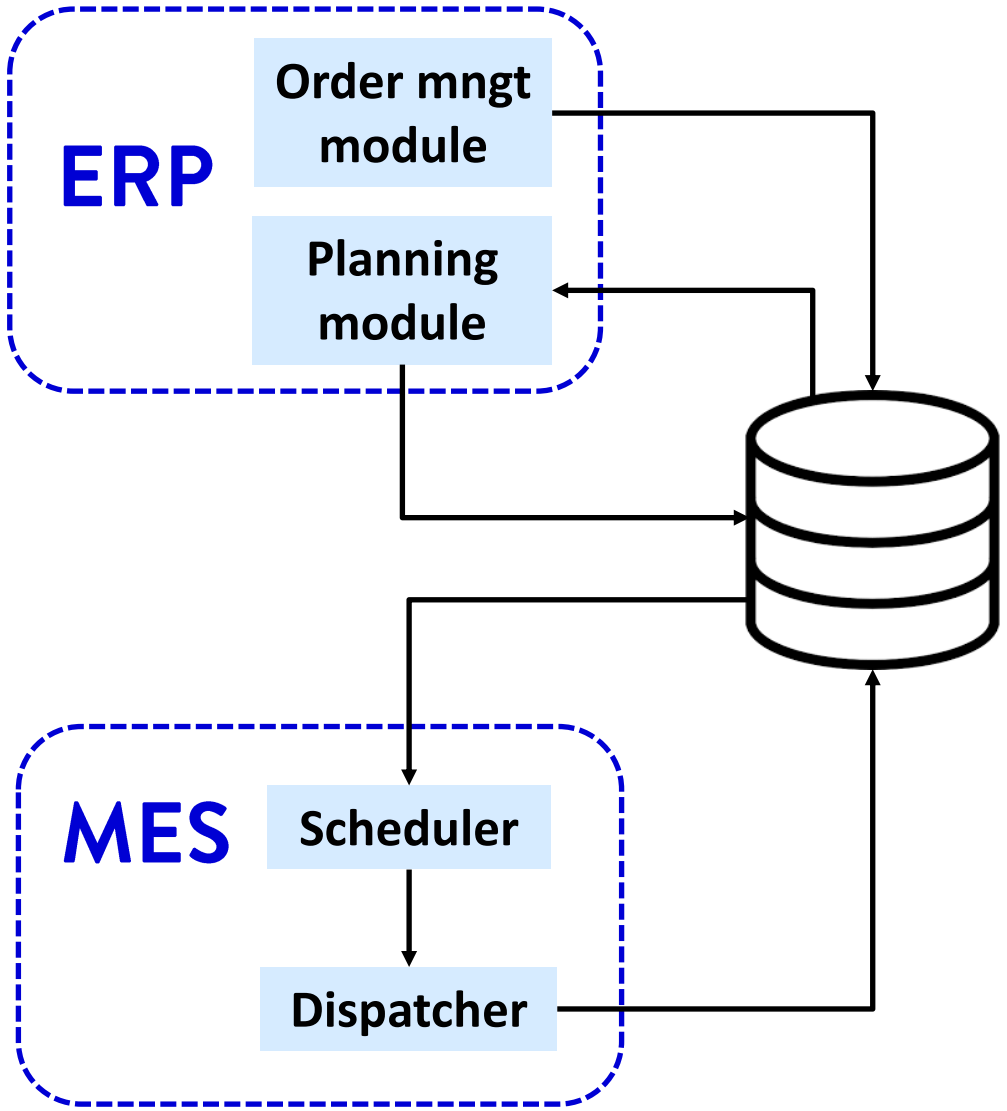



miniERP
V1.0
Menu principal
Client order management
Production planning
Expedition orders
Invoicing
close
Production planning
Generate plan
Production plan
...
Accept
close

the database

will be

everywhere



Plan for the coming classes

1. Analysis of the **planning module**
2. Introduction to the **PostgreSQL** database server
3. Retrieve and update data in PostgreSQL with **Lazarus DB**
4. Development of the **miniERP** application

Plan for the coming classes

today

1. Analysis of the **planning module**
2. Introduction to the **PostgreSQL** database server
3. Retrieve and update data in PostgreSQL with **Lazarus DB**
4. Development of the **miniERP** application

let's go, we have a lot to do ☺ !

3. Planning approach

Planning assumptions

1. The company maintains a **safety stock** for each type of **raw material**.

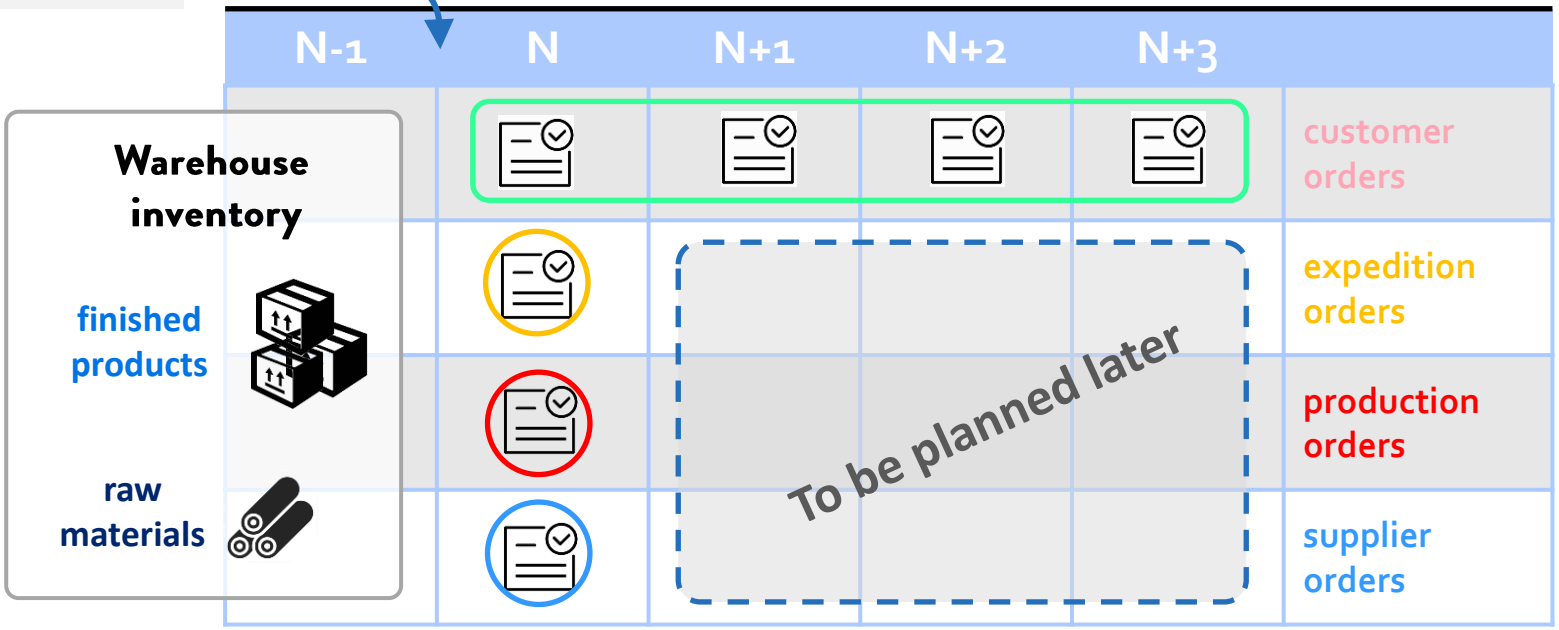
2. For **finished products** there is **no safety stock**, as they are produced according to the customer orders (make-to-order production system).

3. Planning has a **weekly periodicity**, and its **time horizon** is also one week.

4. The production, supplier and expedition orders to be **executed in week N** are **planned at the end of week N-1** (say, at Friday evening).

5. For all raw materials and all suppliers, **delivery time** is 1 week (a supplier order sent by the end of week N-1, will arrive at the plant till the end of week N).

planning of week N takes place here



For week N, we want to **plan** the:

- expedition orders
- production orders

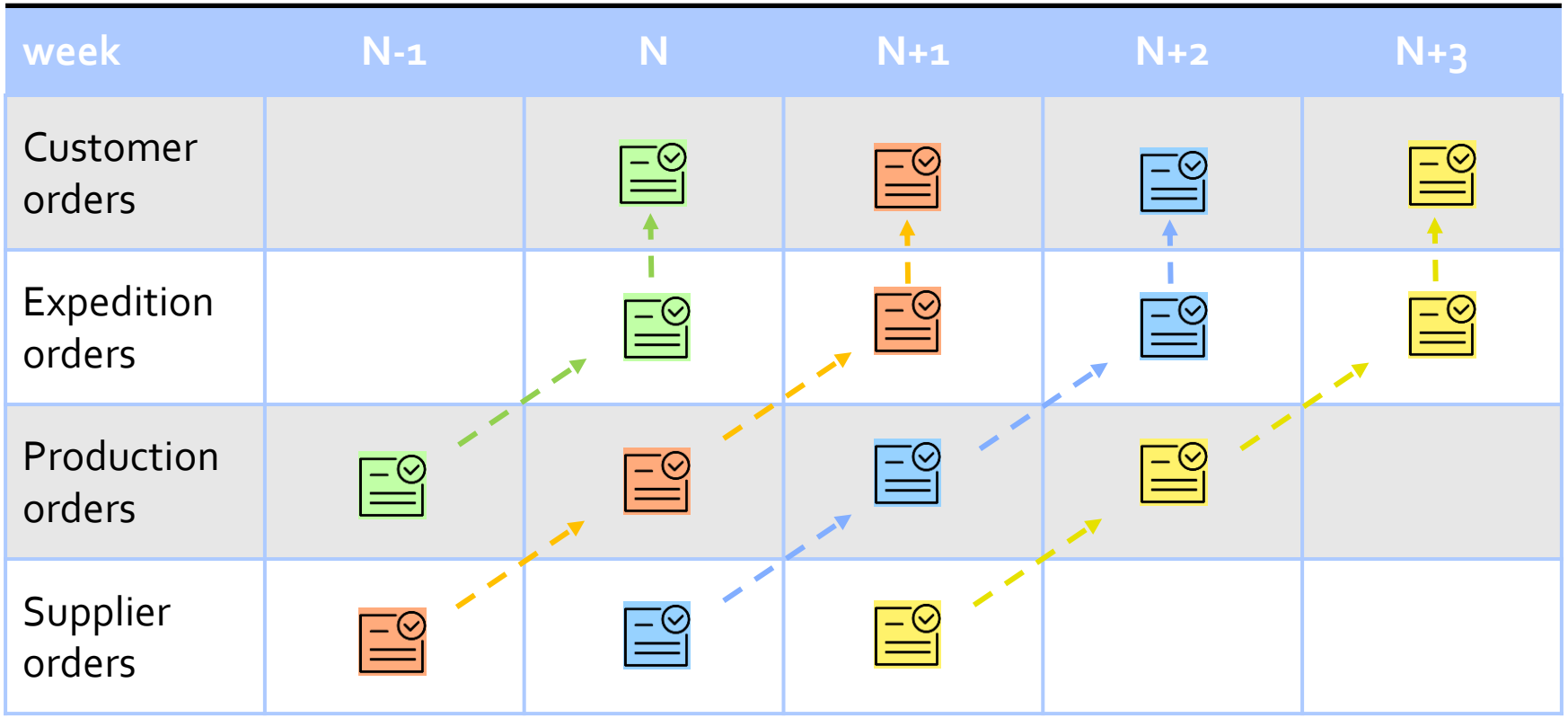
and

- supplier orders

knowing:

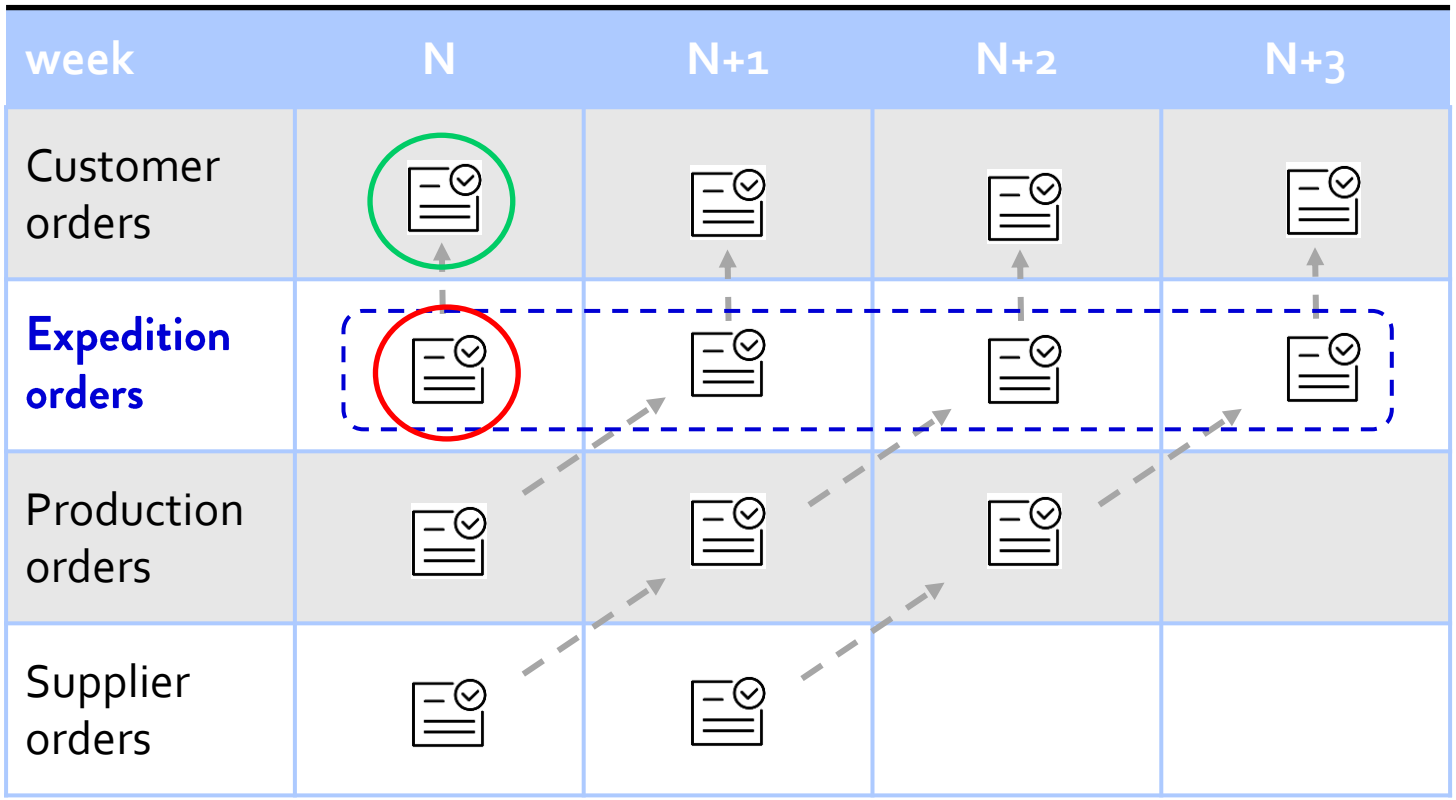
- the customer orders expected to be fulfilled in the forthcoming weeks
- the **raw materials** in the warehouse ready to be used in production
- the **finished products** in the warehouse ready to be expedited

Planning overview



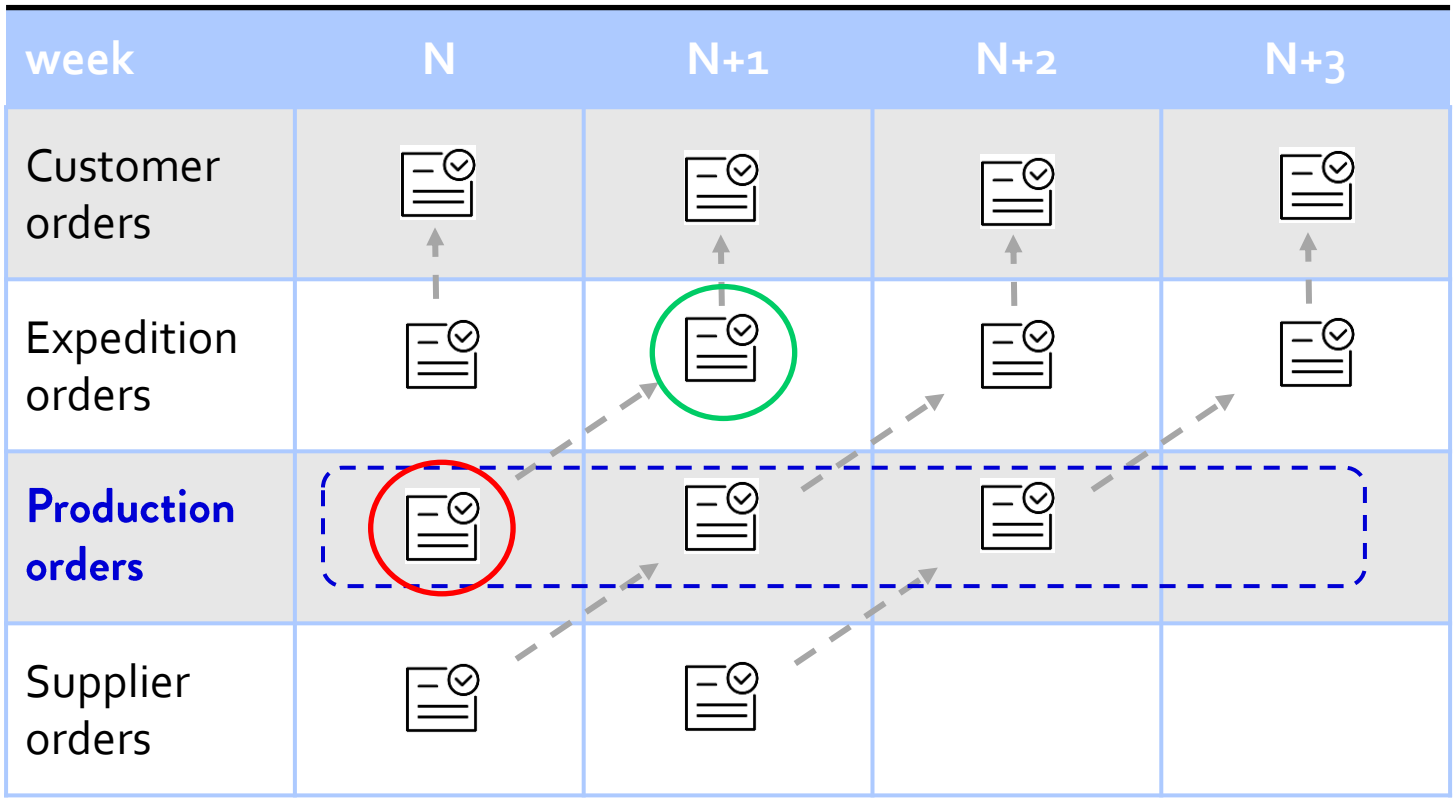
- raw materials ordered at the end of week N-1 will arrive in the plant till the end of week N
- these materials will be used in the production orders of week N+1,
- which in turn produce the finished products that will be expedited to customers in week N+2

Expedition order planning



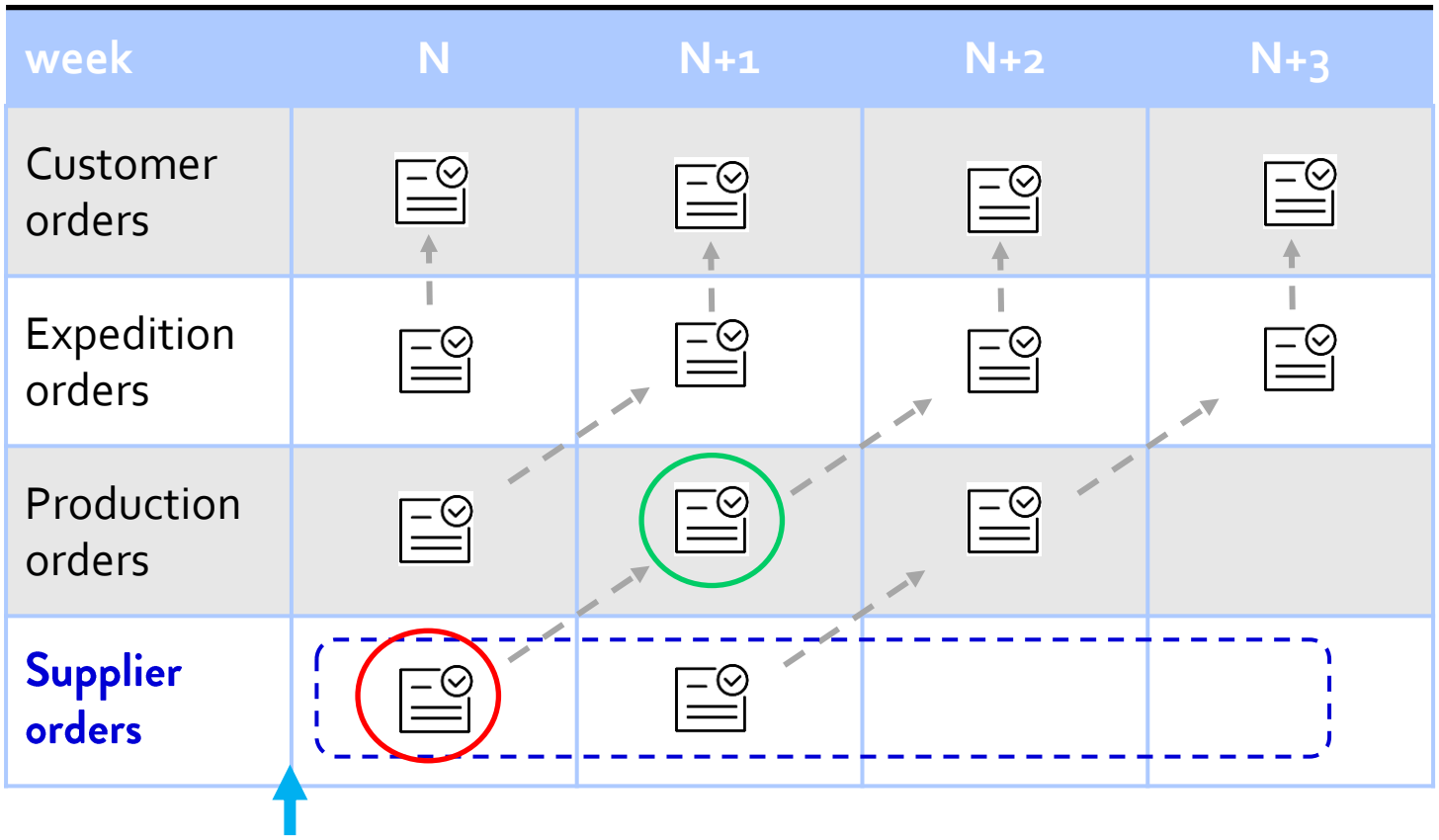
- An expedition order will be planned for week N per each customer order with delivery date in week N (there will be one expedition order per customer order)

Production order planning



- Products to be delivered at week N+1 are produced during week N
- Each week, there will be just 1 production order per product type. Its quantity will equal the sum of the quantities of the expedition orders planned for week N+1

Supplier order planning



- At the end of week N-1, are issued the supplier orders for the raw materials needed in the production orders of week N+1 .
- These orders will be delivered by the suppliers during week N.

4. Practical exercise

4.1. Week N planning

Expedition orders planning

Assume that we "are" here

Quantities for product type P1

Quantities for product type P2

N-1	N	N+1	N+2	
	14 10	12 8	7 4	Customer orders
	?? ??			Expedition orders
				Production orders
				Supplier orders

Warehouse inventory

Finished products

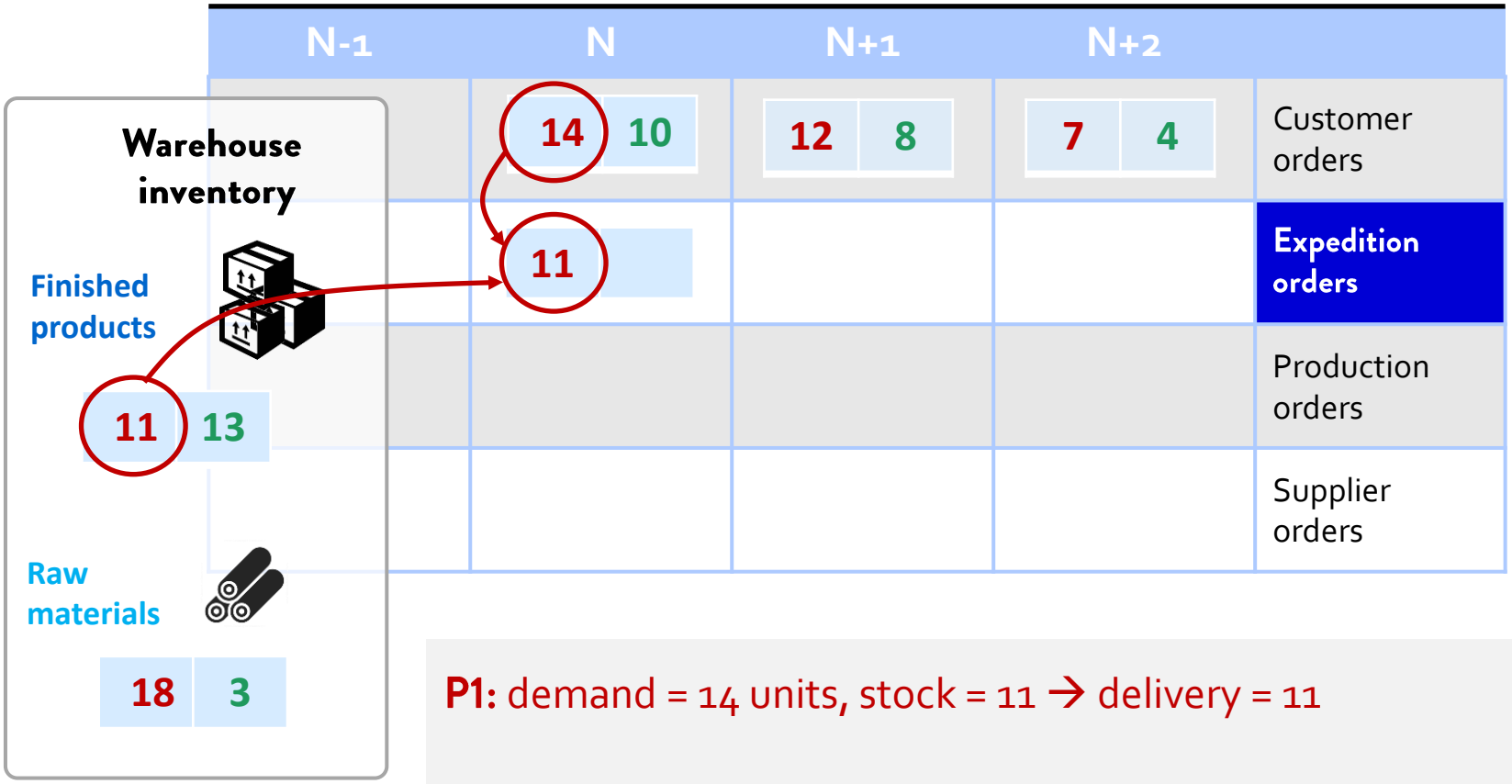
11 13

Raw materials

18 3

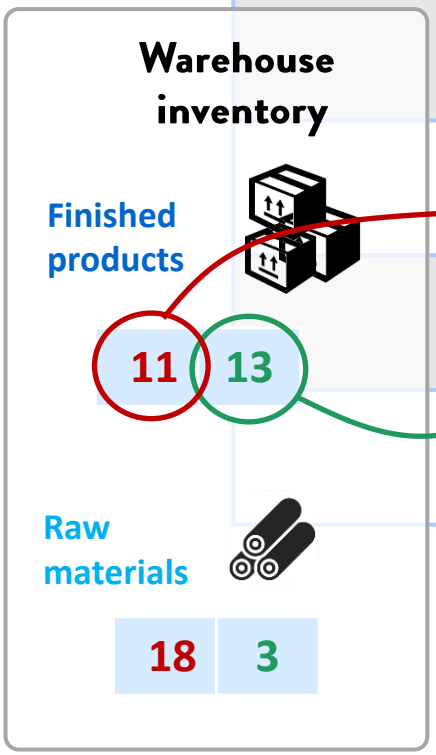
How many items of P1 and P2 should be planned for expedition in week N?

Expedition orders planning



P1: demand = 14 units, stock = 11 → delivery = 11

Expedition orders planning



N-1	N	N+1	N+2	
	14 10	12 8	7 4	Customer orders
	11 10			**Expedition orders**
				Production orders
				Supplier orders

P1: demand = 14 units, stock = 11 → delivery = 11

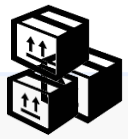
P2: demand = 10 units, stock = 13 → delivery = 10

Production orders planning

	N-1	N	N+1	N+2	
		14 10	12 8	7 4	Customer orders
		11 10			Expedition orders
		?? ??			**Production orders**
					Supplier orders

Warehouse inventory

Finished products



11 13

Raw materials

18 3

How many items of P1 and P2 should be produced in week N?

Production orders planning

Two steps procedure:

1st: calculate the quantity needed by product type knowing demand (i.e., customer orders)

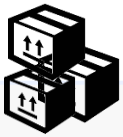
2nd: plan the orders that can actually be produced taken into account the raw materials

Production orders planning | 1st step. Quantity needed

	N-1	N	N+1		
		14 10	12 8		Customer orders
		11 10			Expedition orders
		?? ??		Quantity needed	Production orders
				Actual orders	
					Supplier orders

Warehouse inventory

Finished products

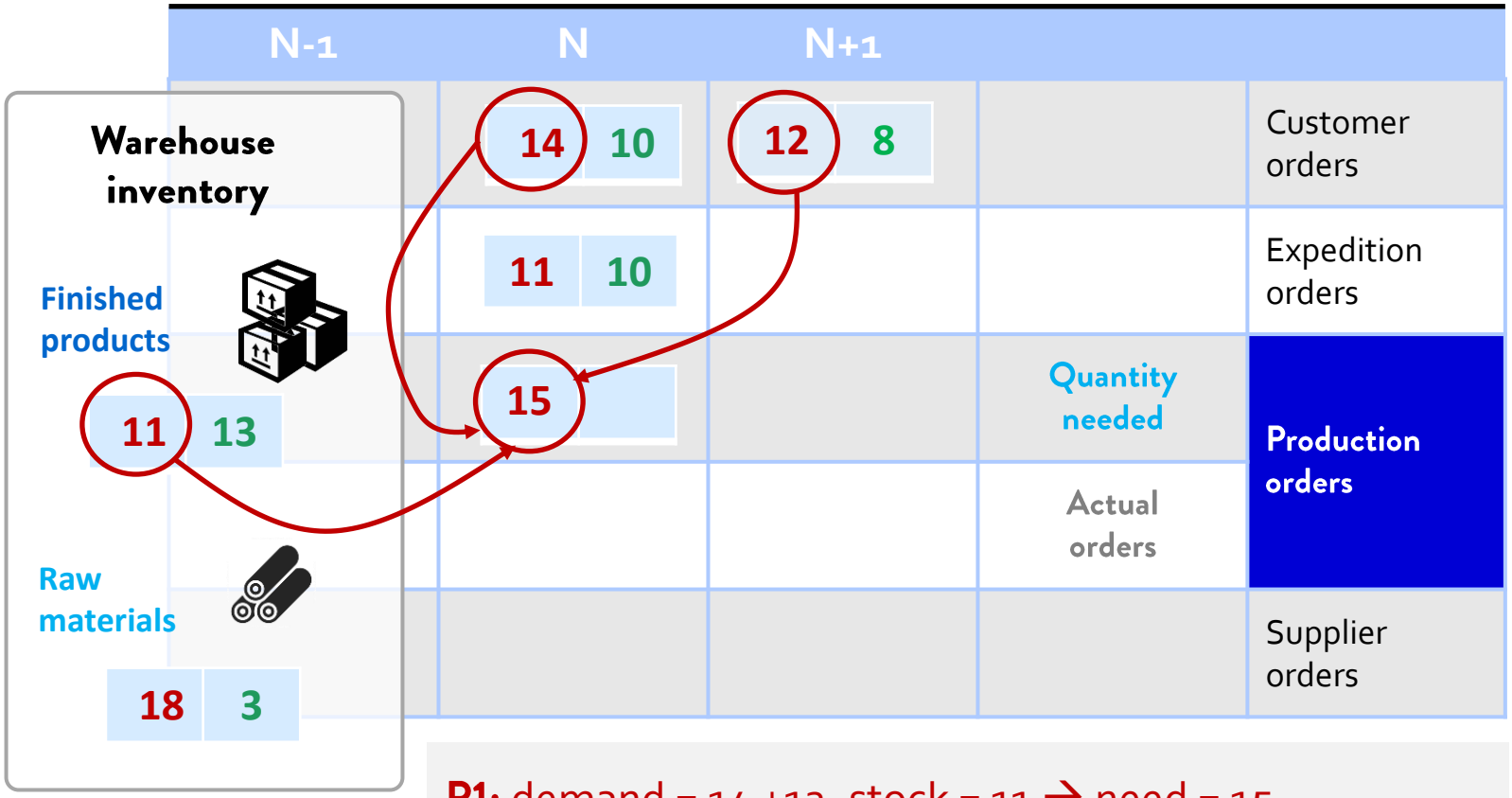


11 13

Raw materials

18 3

Production orders planning | 1st step. Quantity needed



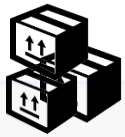
P1: demand = 14 +12, stock = 11 → need = 15

Production orders planning | 1st step. Quantity needed

	N-1	N	N+1		
		14 10	12 8		Customer orders
		11 10			Expedition orders
		15 5		Quantity needed	Production orders
				Actual orders	
					Supplier orders

Warehouse inventory

Finished products



11 13

Raw materials

18 3

P1: demand = 14 +12, stock = 11 → need = 15

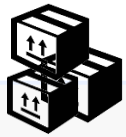
P2: demand = 10 + 8, stock = 13 → need = 5

Production orders planning | 2nd step. Actual orders

N-1	N	N+1		
	14 10	12 8		Customer orders
	11 10			Expedition orders
	15 5		Quantity needed	Production orders
	?? ??		Actual orders	
				Supplier orders

Warehouse inventory

Finished products

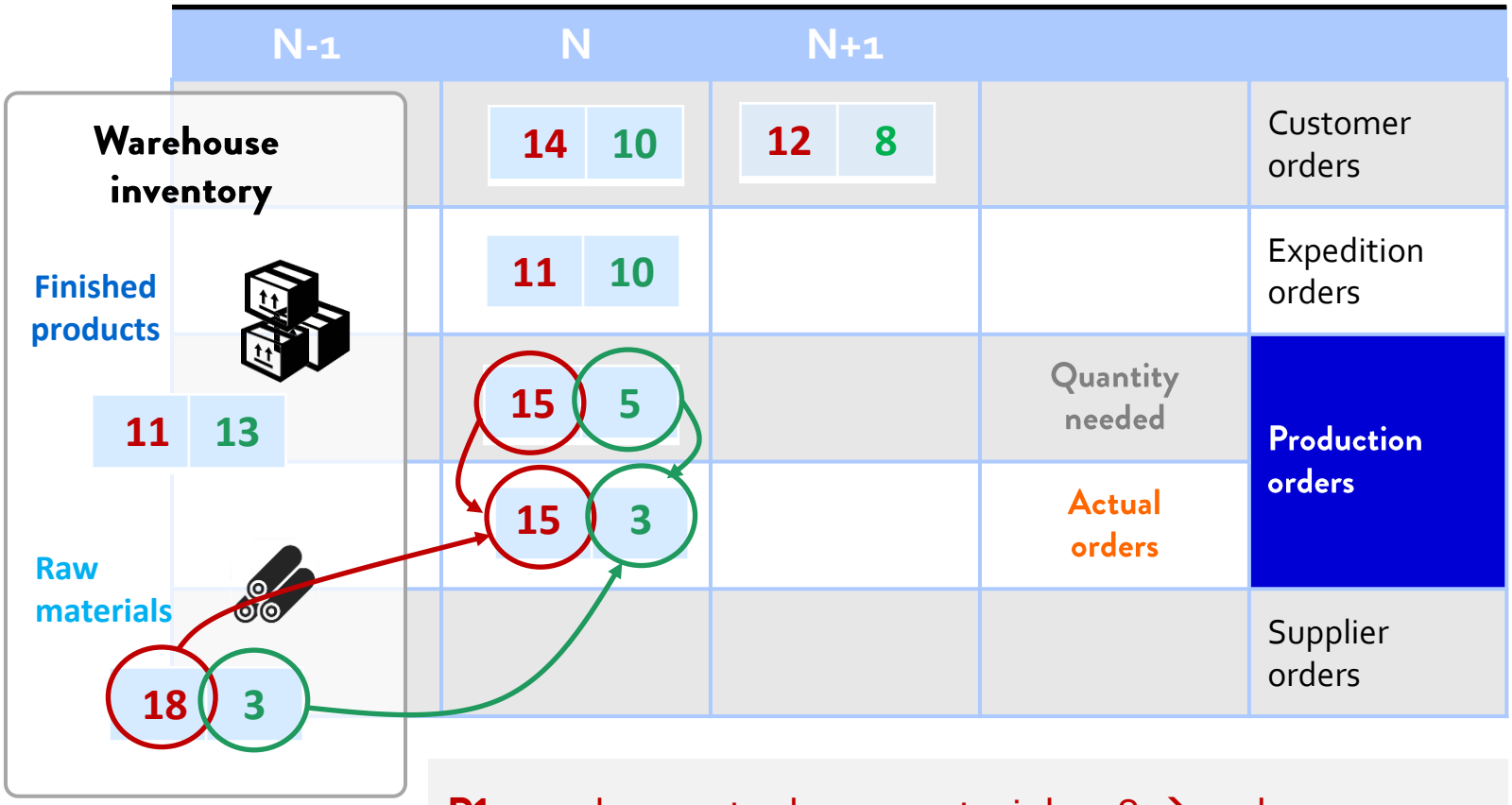


11 13

Raw materials

18 3

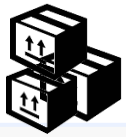
Production orders planning | 2nd step. Actual orders



P1: need = 15, stock raw material = 18 → order = 15

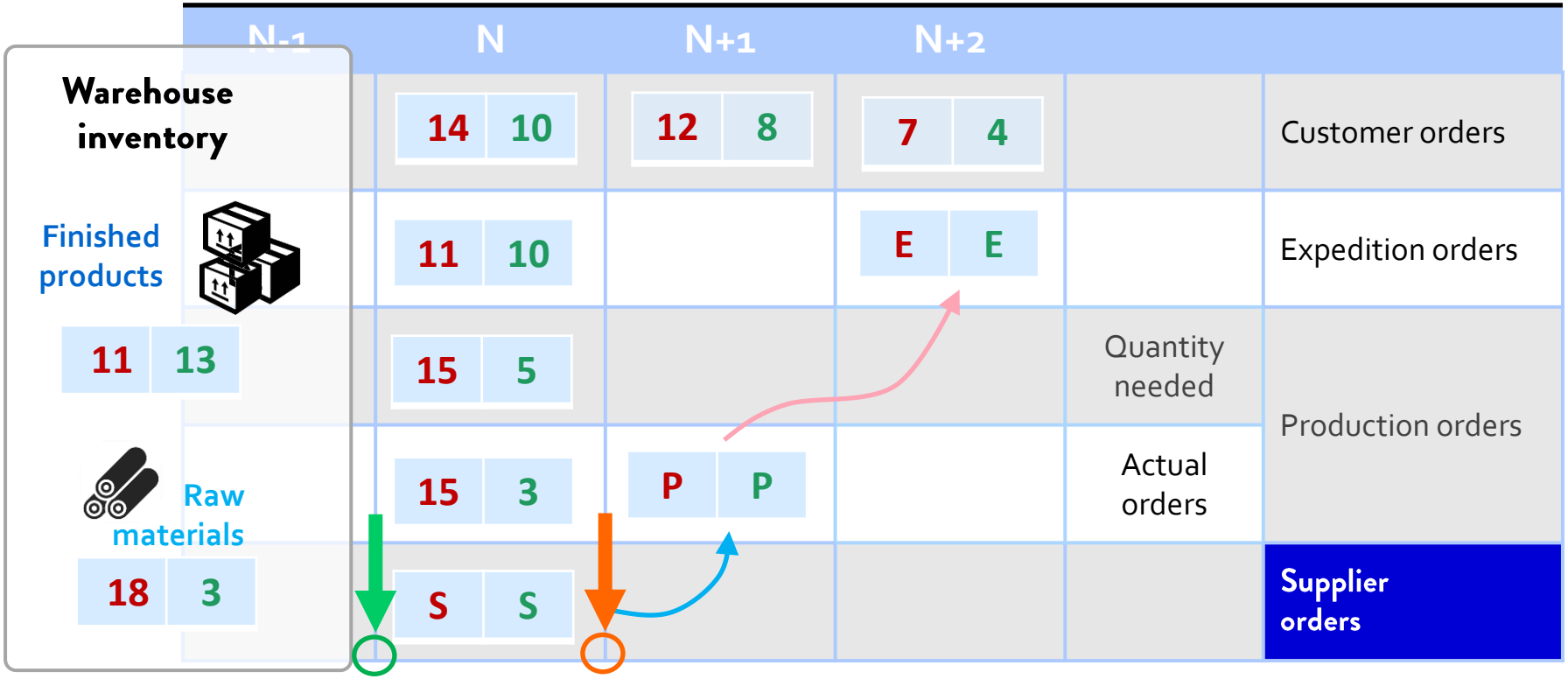
P2: need = 5, stock raw material = 3 → order = 3

Suppliers orders planning

N-1	N	N+1	N+2		
Warehouse inventory	14 10	12 8			Customer orders
Finished products 	11 10				Expedition orders
11 13	15 5			Quantity needed	Production orders
Raw materials 	15 3			Actual orders	
18 3	?? ??				Supplier orders
6 2 safety stock					

How many items of each raw material type should be sourced from suppliers in week N?

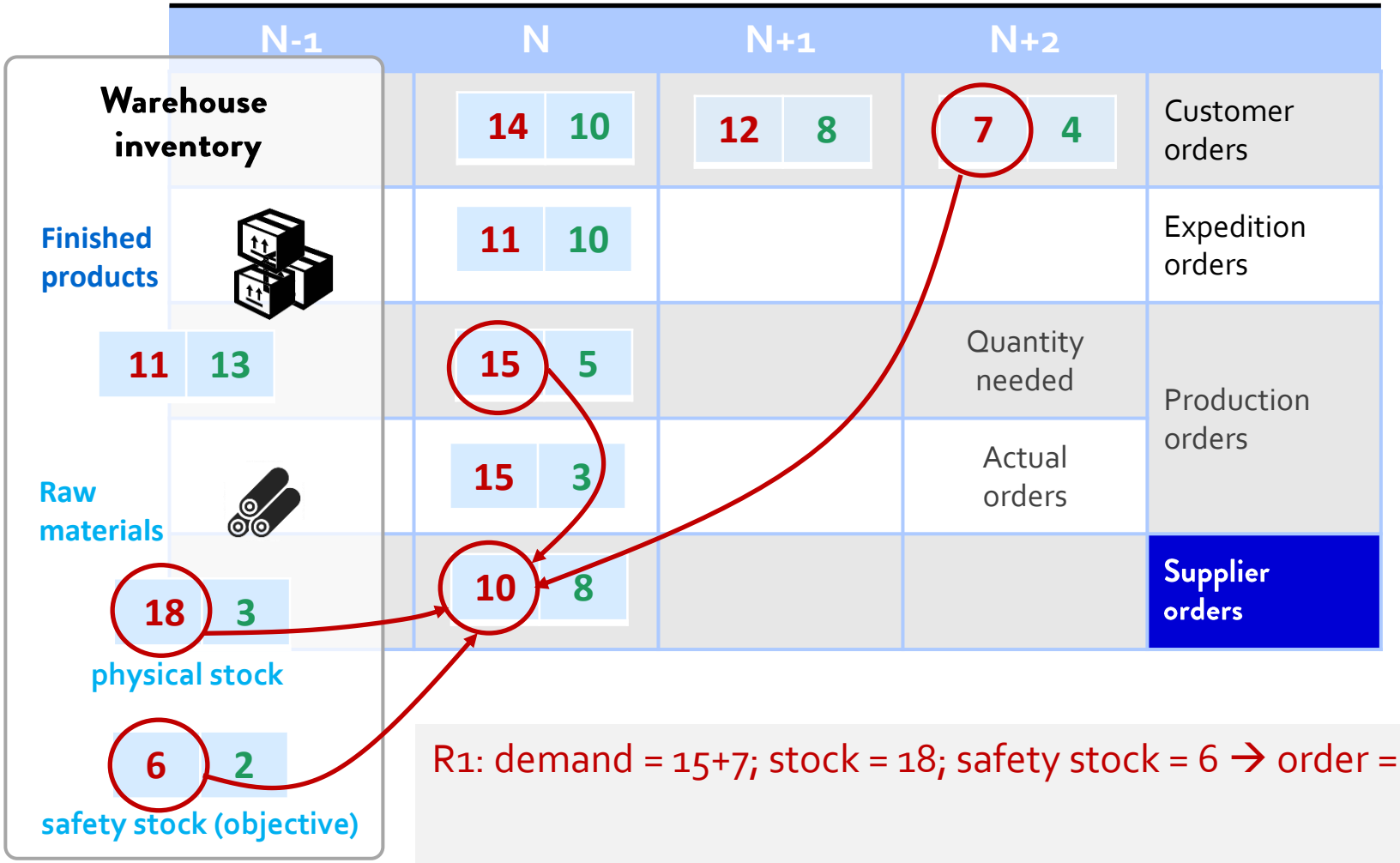
Suppliers orders planning



Keep in mind that:

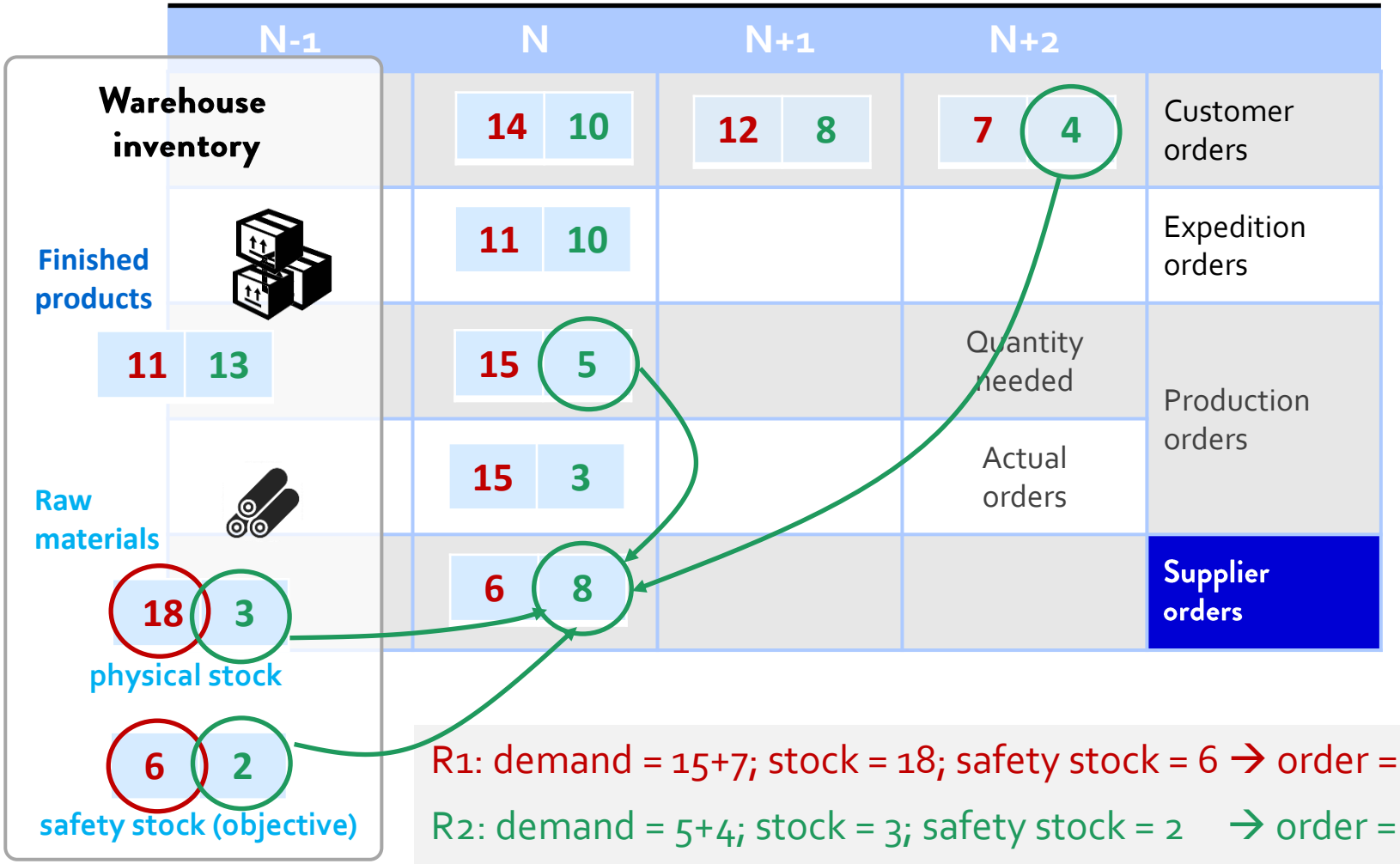
- raw materials ordered at the end of week N-1 will arrive in the plant by the end of week N
- these materials will be used in the production orders executed during week N+1,
- which, in turn, produce the finished products to be expedited to customers in week N+2

Suppliers orders planning



R1: demand = 15+7; stock = 18; safety stock = 6 → order = 10

Suppliers orders planning

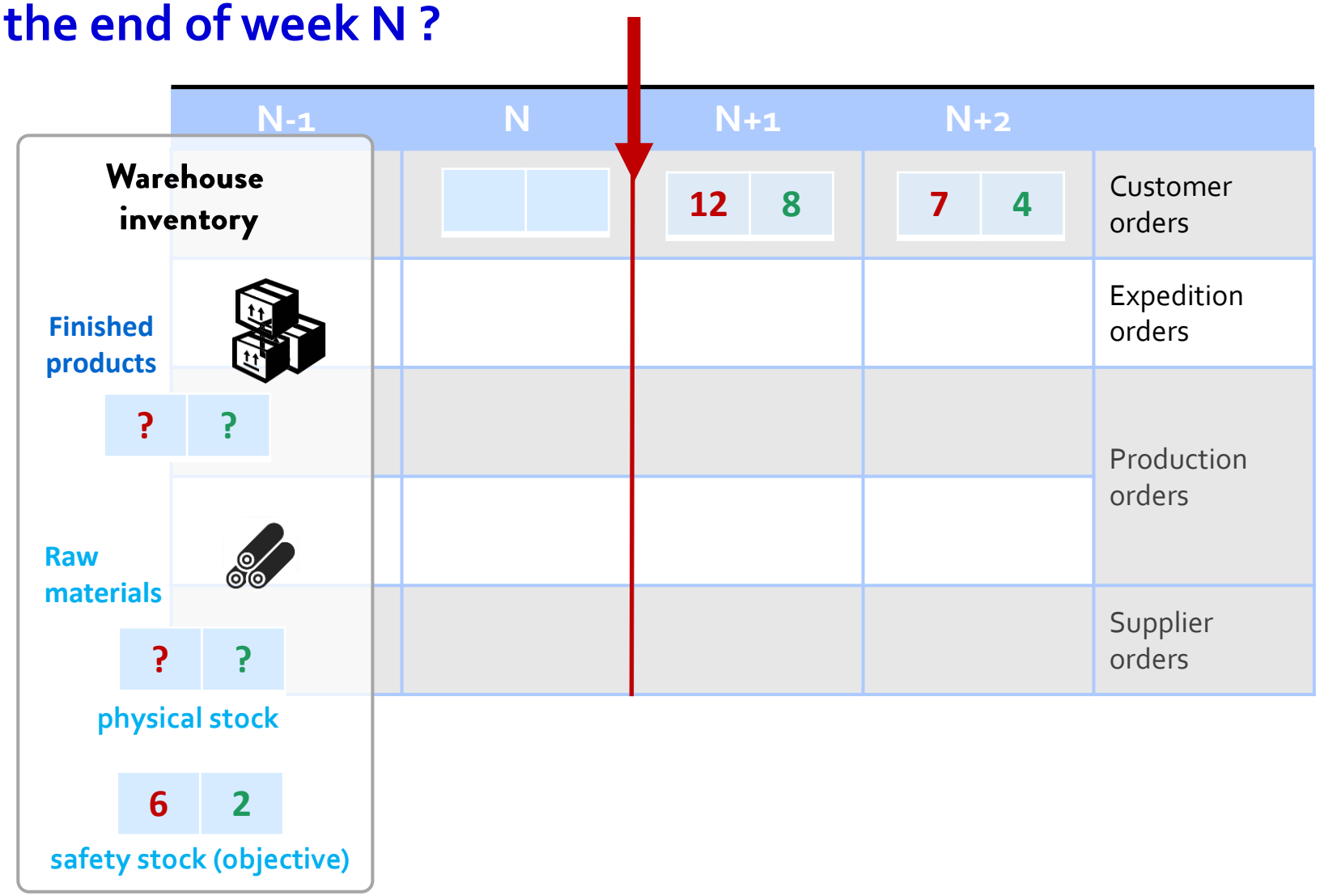


R1: demand = 15+7; stock = 18; safety stock = 6 → order = 10

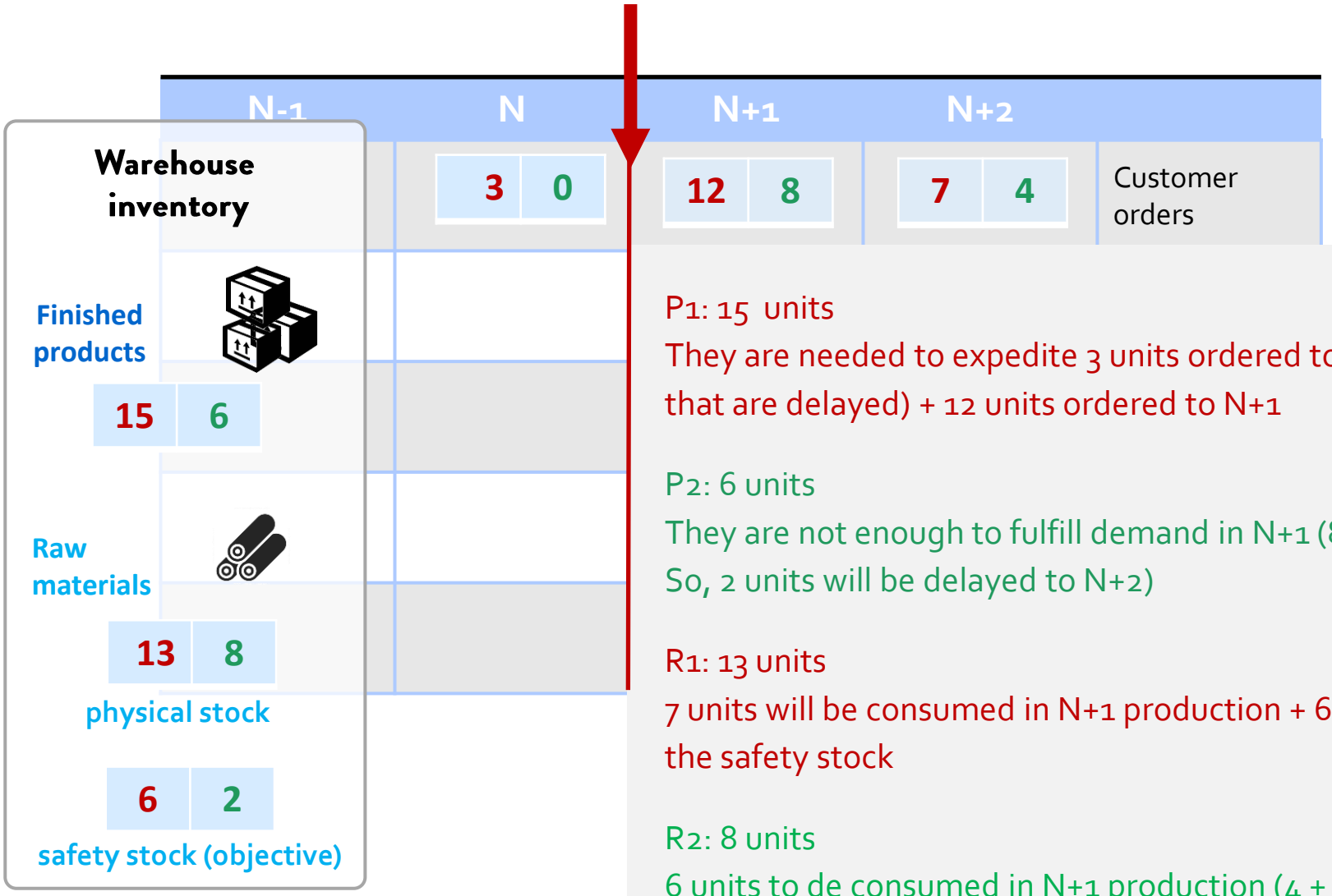
R2: demand = 5+4; stock = 3; safety stock = 2 → order = 8

4.2. Week N+1 planning

According to week N's plan, what is the **expected situation at the end of week N ?**



Expected situation at the end of week N:



P1: 15 units
They are needed to expedite 3 units ordered to N (and that are delayed) + 12 units ordered to N+1

P2: 6 units
They are not enough to fulfill demand in N+1 (8 units). So, 2 units will be delayed to N+2)

R1: 13 units
7 units will be consumed in N+1 production + 6 units for the safety stock

R2: 8 units
6 units to de consumed in N+1 production (4 + 2 delayed) + 2 safety stock

- However, the **actual situation** at the end of week N **is different** from what could be expected from the plan.

- The differences come from the fact that:

  1. **New orders** arrived from customers
  2. Some product didn´t pass **quality control** and were discarded
  3. Supplier **missed some** material **deliveries**

- As so, the **actual situation** in the plant is shown in the **next slide** …

Actual situation at the end of week N:

	N-1	N	N+1	N+2	N+3	
Warehouse inventory		3 0	12 ~~8~~	~~7~~ ~~4~~	4 8	Customer orders
			9	9 7		Expedition orders
Finished products						Production orders
~~15~~ ~~6~~ / 15 6						
Raw materials						Supplier orders
physical stock ~~13~~ ~~8~~ / 13 8						
safety stock 6 2						

assuming that we are now at the end of week N and the situation is the above one:

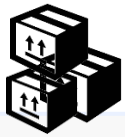
prepare the plan for week N+1

assuming we are **now at the end of week N** with this situation :

	N-1	N	N+1	N+2	N+3	
Customer orders		3 0	12 ~~8~~ 9	~~7~~ ~~4~~ 9 7	4 8	Customer orders
Expedition orders		?	?			Expedition orders
Production orders		?	?			Production orders
		?	?			
Supplier orders		?	?			Supplier orders

Warehouse inventory

Finished products



~~15~~ ~~6~~
15 6

Raw materials

physical stock

~~13~~ ~~8~~
13 8

safety stock

6 2

prepare the plan for week N+1

5. The good and bad news

The bad news:

- Production planning in the real world (equipment failures, unreliable suppliers, quality issues) is quite complex and you have to develop the planning module in 2nd part of the project

The good news:

- You just have to implement a much simplified version of the planning algorithm

(but you should be aware of the planning complexities, that is why we did this introductory exercise !)

Annex.

1. Week N plan

N-1	N	N+1	N+2		
	14 10	12 8	7 4		Customer orders
					Expedition orders
				Quantity needed	Production orders
				Actual orders	
					Supplier orders

Warehouse inventory

Finished products

11 13

Raw materials

18 3

6 2

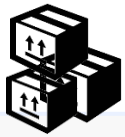
safety stock

2. Week N+1 plan

	N-1	N	N+1	N+2	N+3	
		3 0	12 9	9 7	4 8	Customer orders
						Expedition orders
						Production orders
						Supplier orders

Warehouse inventory

Finished products



~~15~~ ~~6~~

15 6

Raw materials

physical stock: ~~13~~ ~~8~~ / 13 8

safety stock: 6 2

thank you !