



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

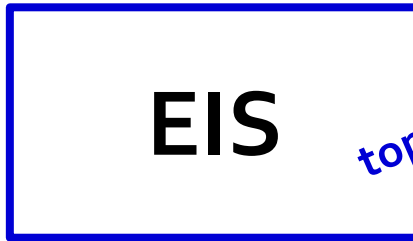
2nd PART *

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:



top management

Executive Information System (BI)



customers

Customer Relationship Management



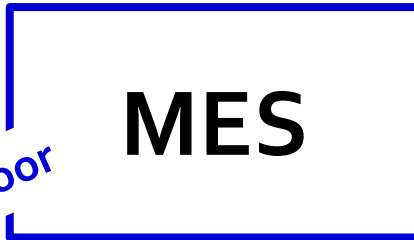
operations

Enterprise Resource management



suppliers

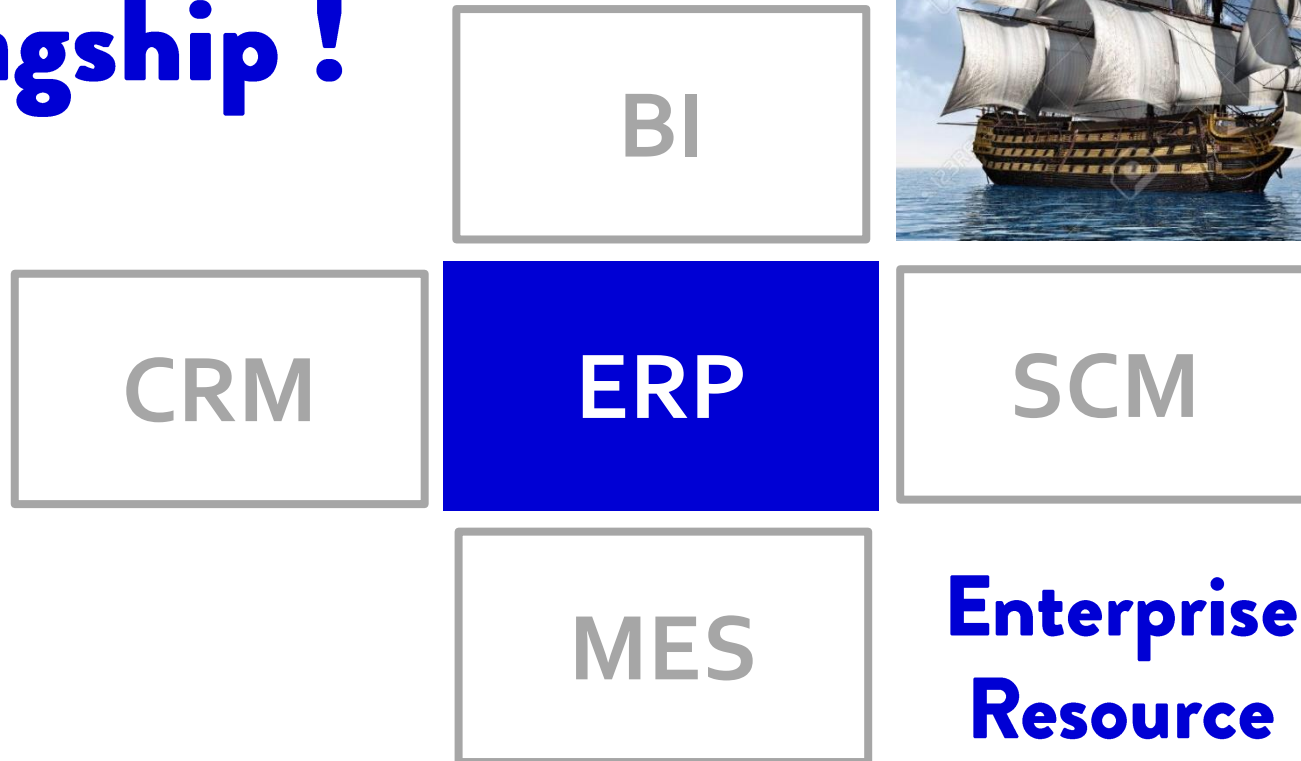
Supply Chain Management



shop-floor

Manufacturing Execution System

**the
flagship !**



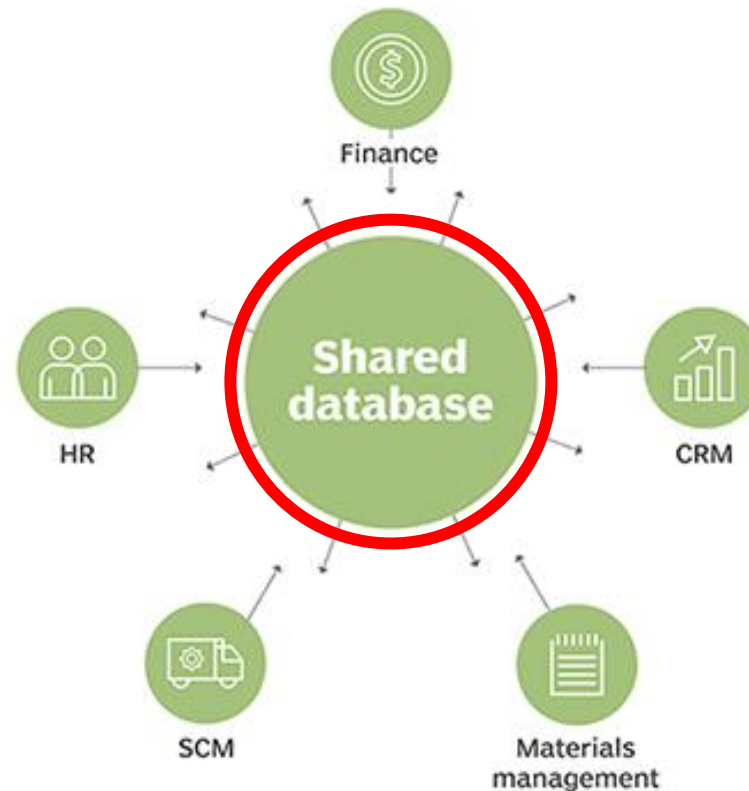
**Enterprise
Resource
Planning**

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

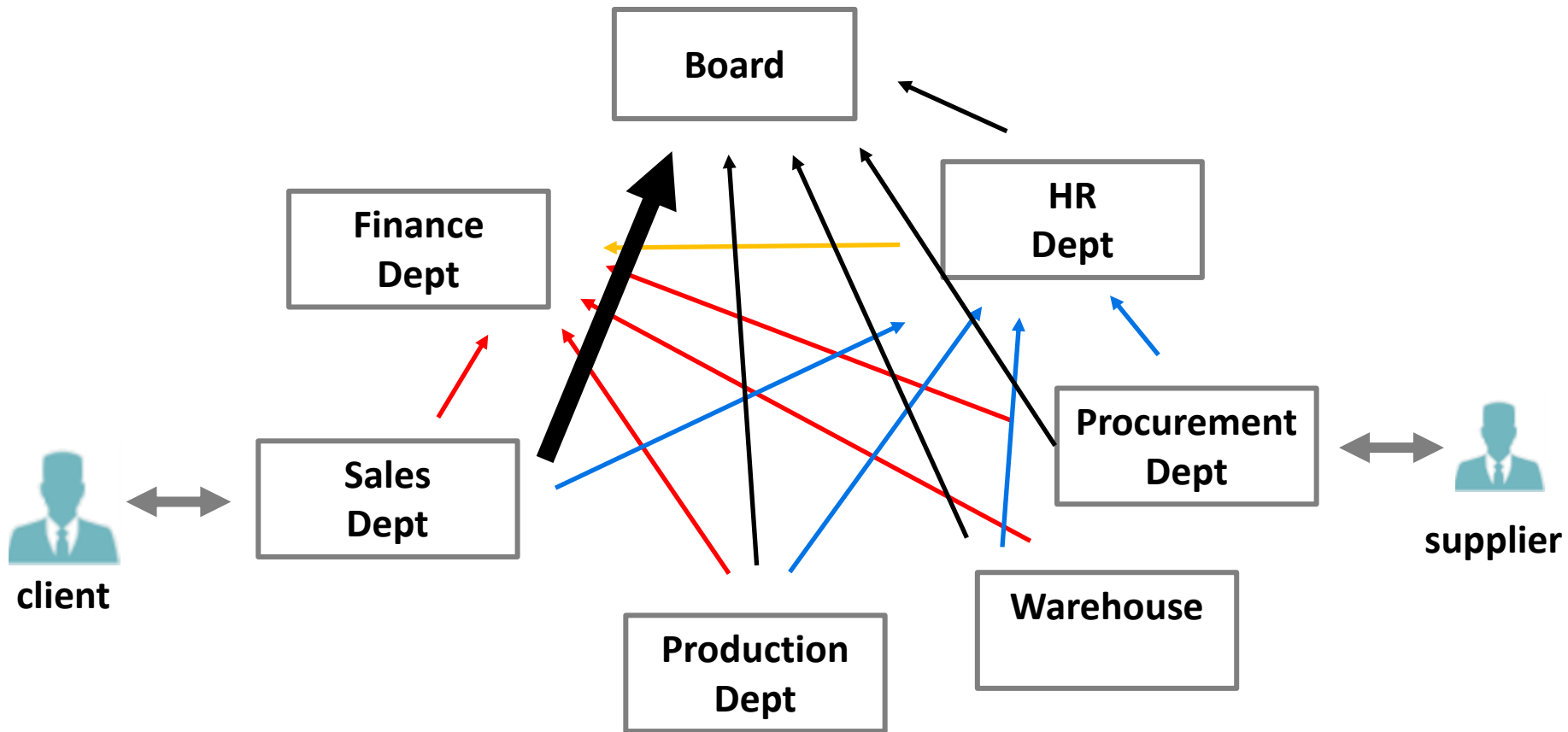
and **the same will** happen in the **INFI project !**

A simplified look at how ERP works

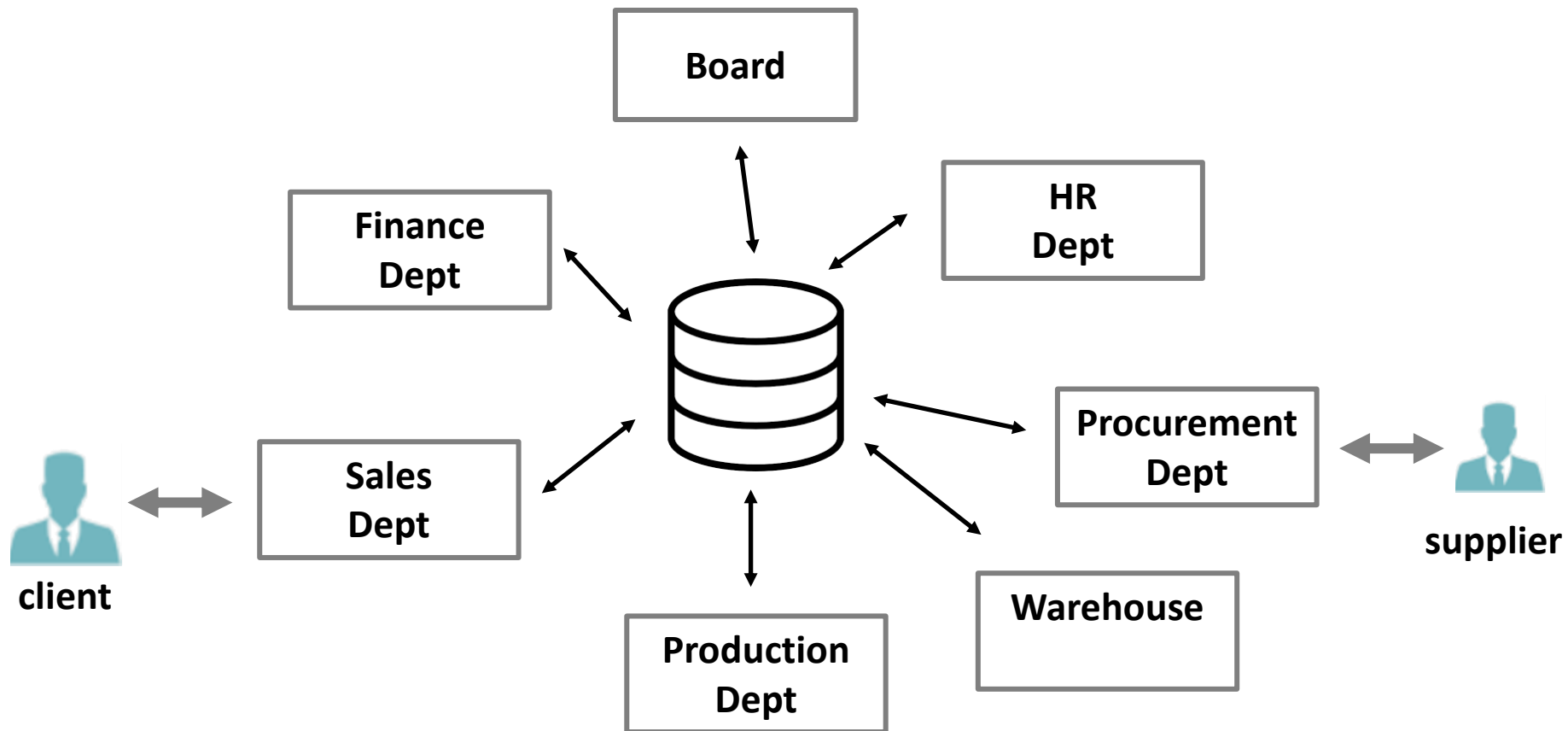
Information is updated in one module, which sends data to a central shared database, which in turn shares the appropriate information with other modules.



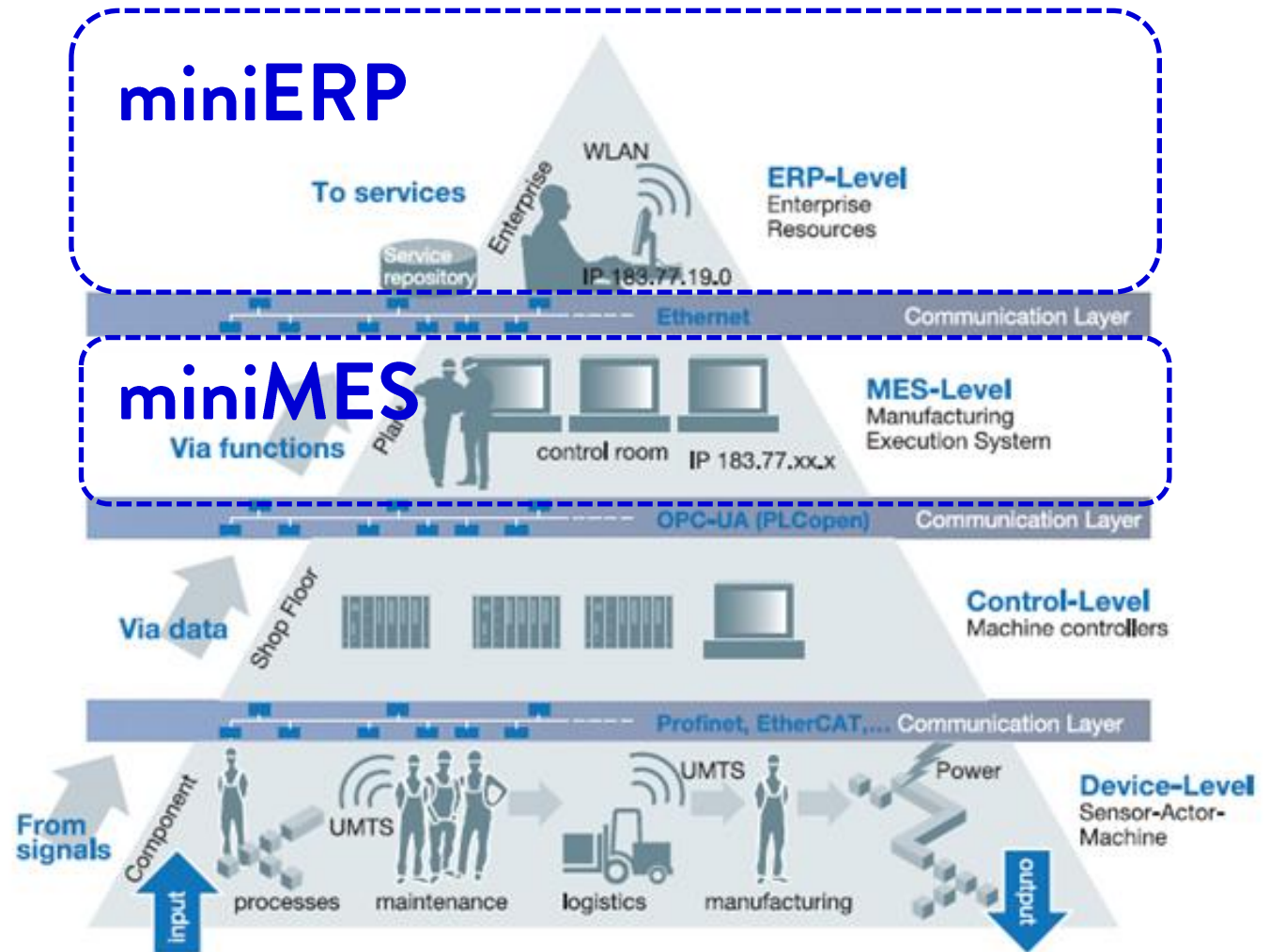
The **advantage of the database integration** became **obvious** from our **analysis of the information flows** inside the company ...



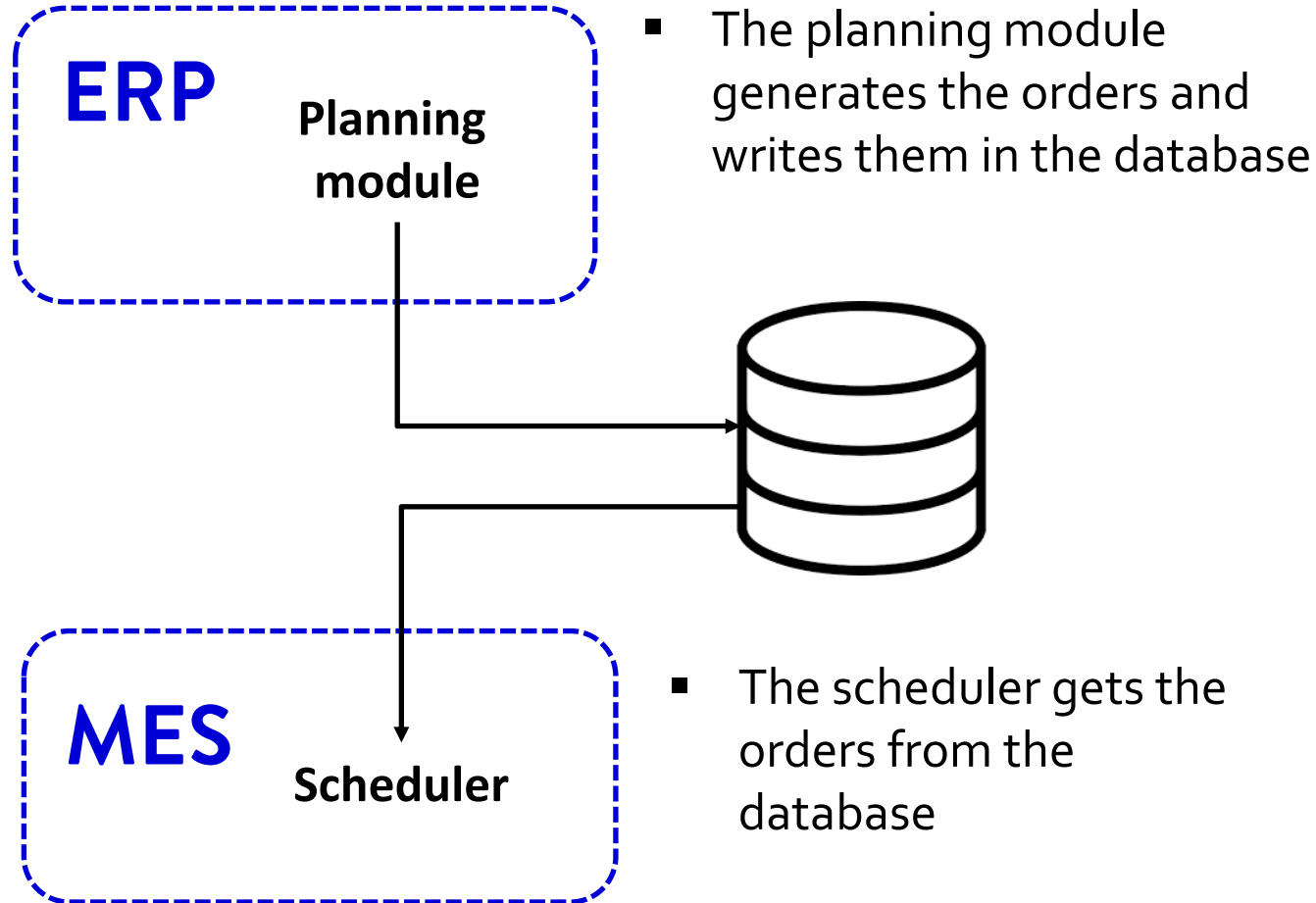
... as they are **much simpler** with an integrated database.



the INFI project

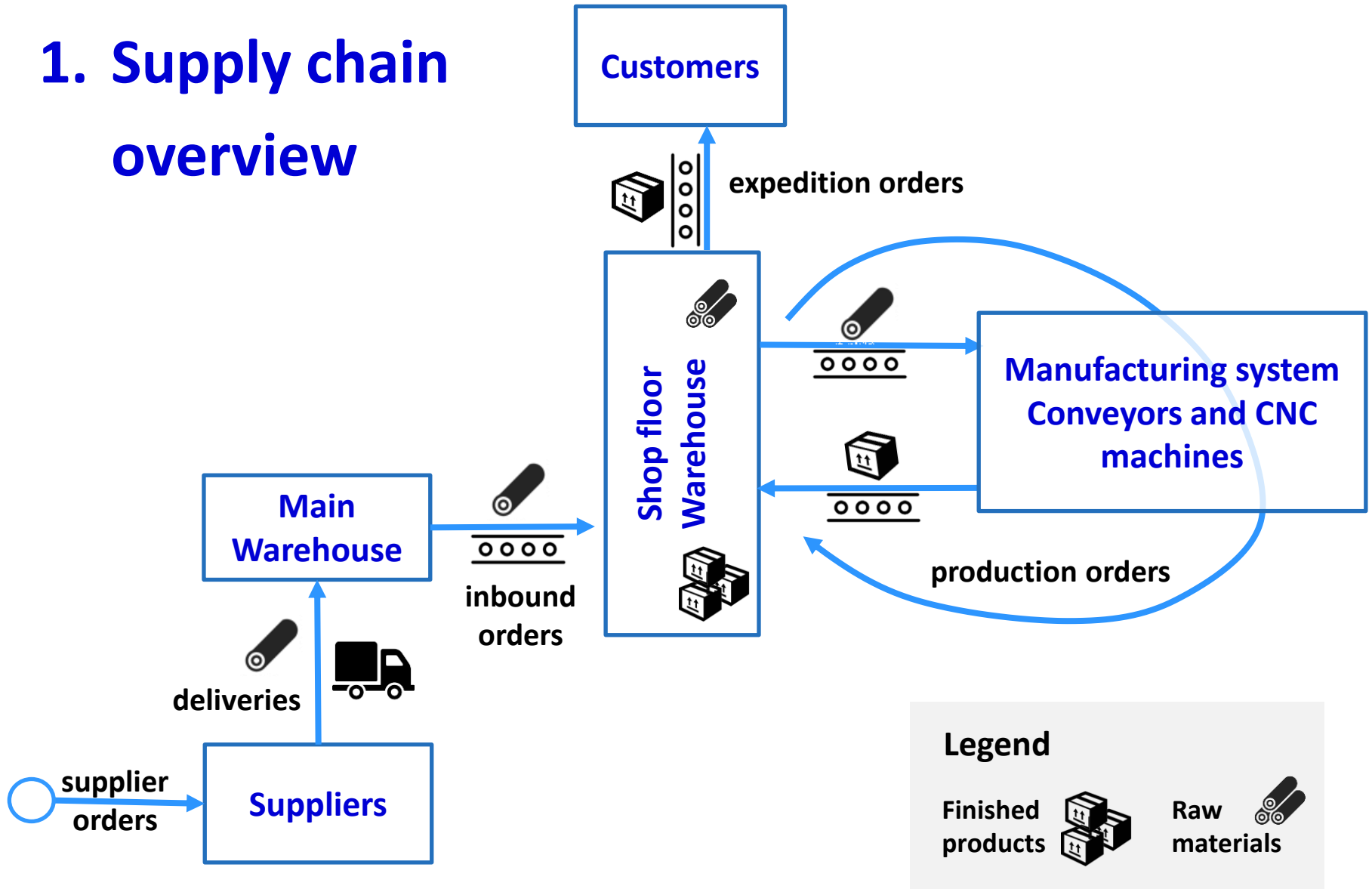


the miniERP and miniMES will communicate via DB

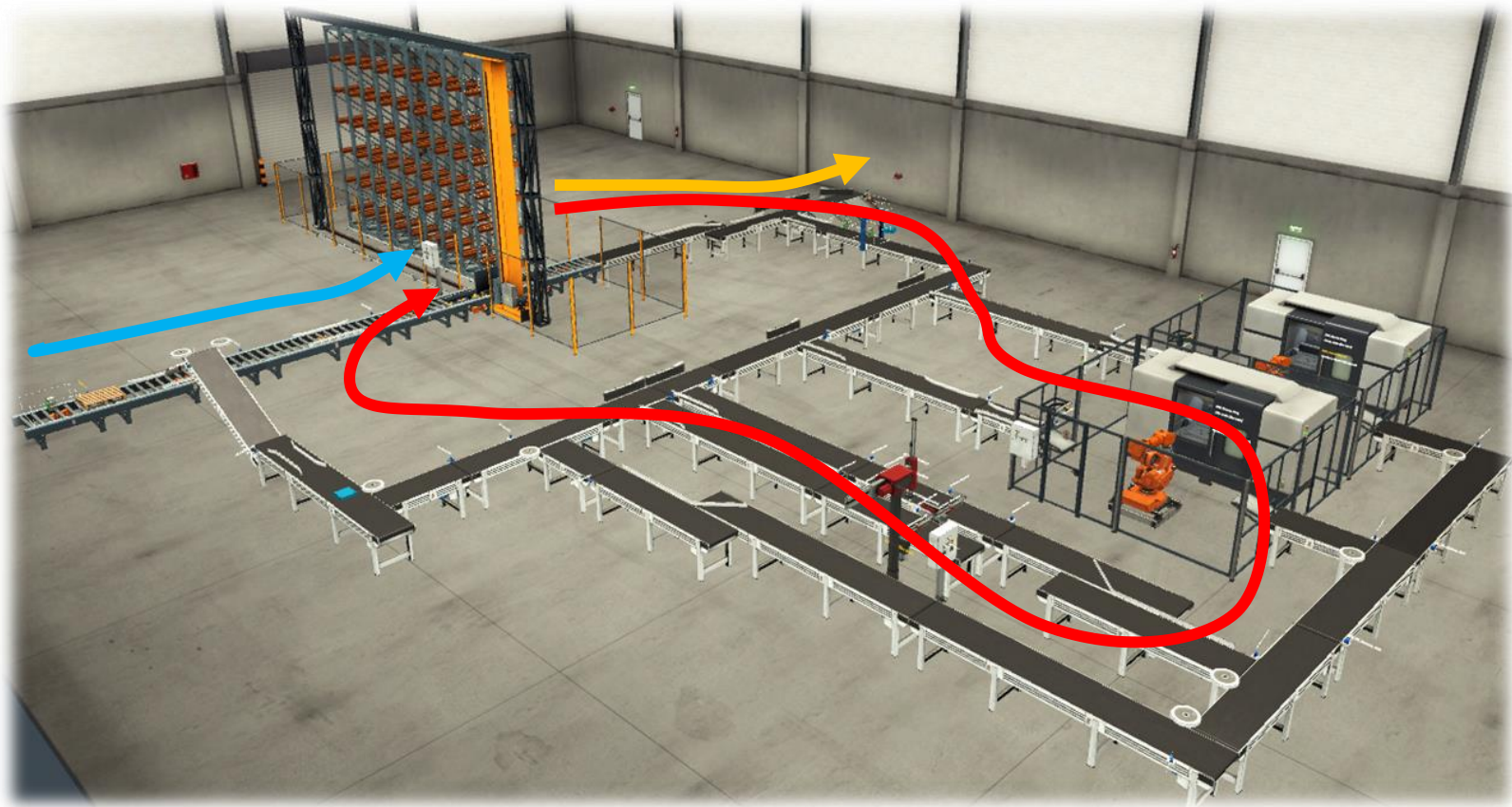


2. Introduction to the planning module

1. Supply chain overview



Shop-floor and Warehouse

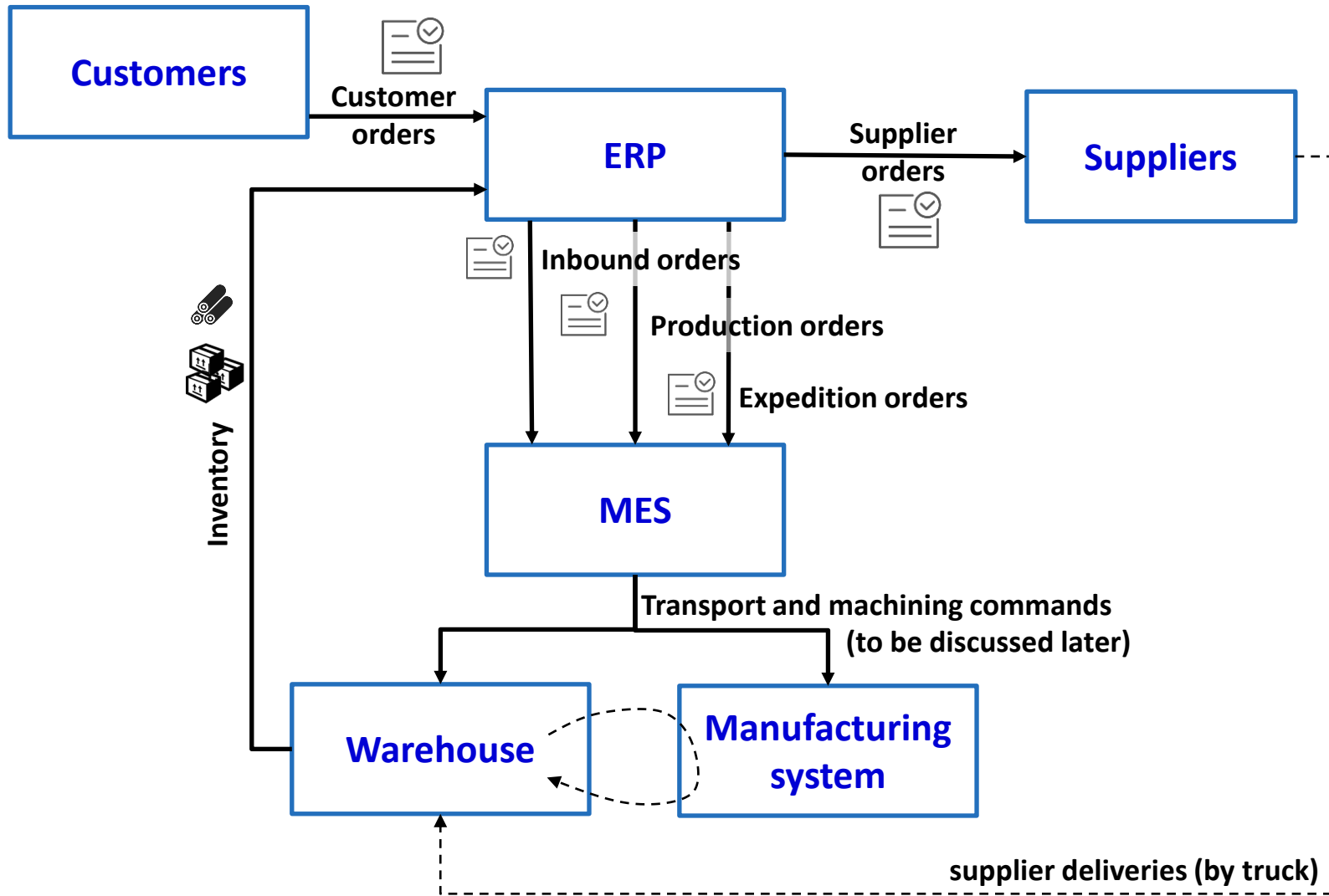


Inbound orders

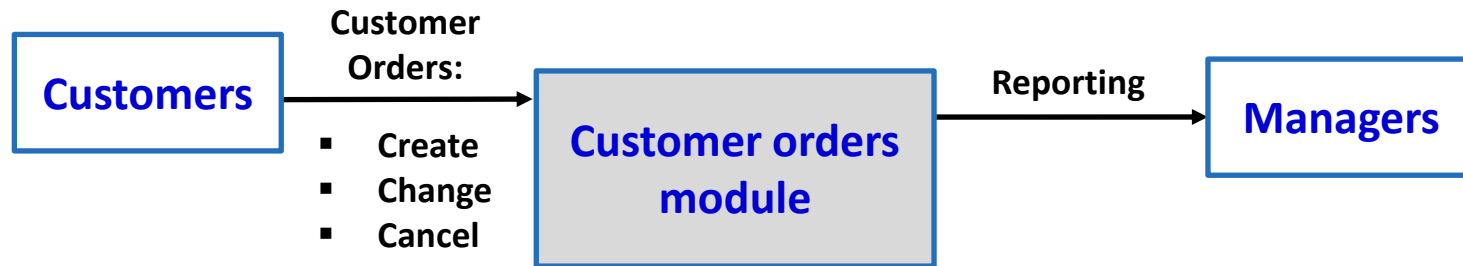
Production orders

Expedition orders

2. Overview of the management system



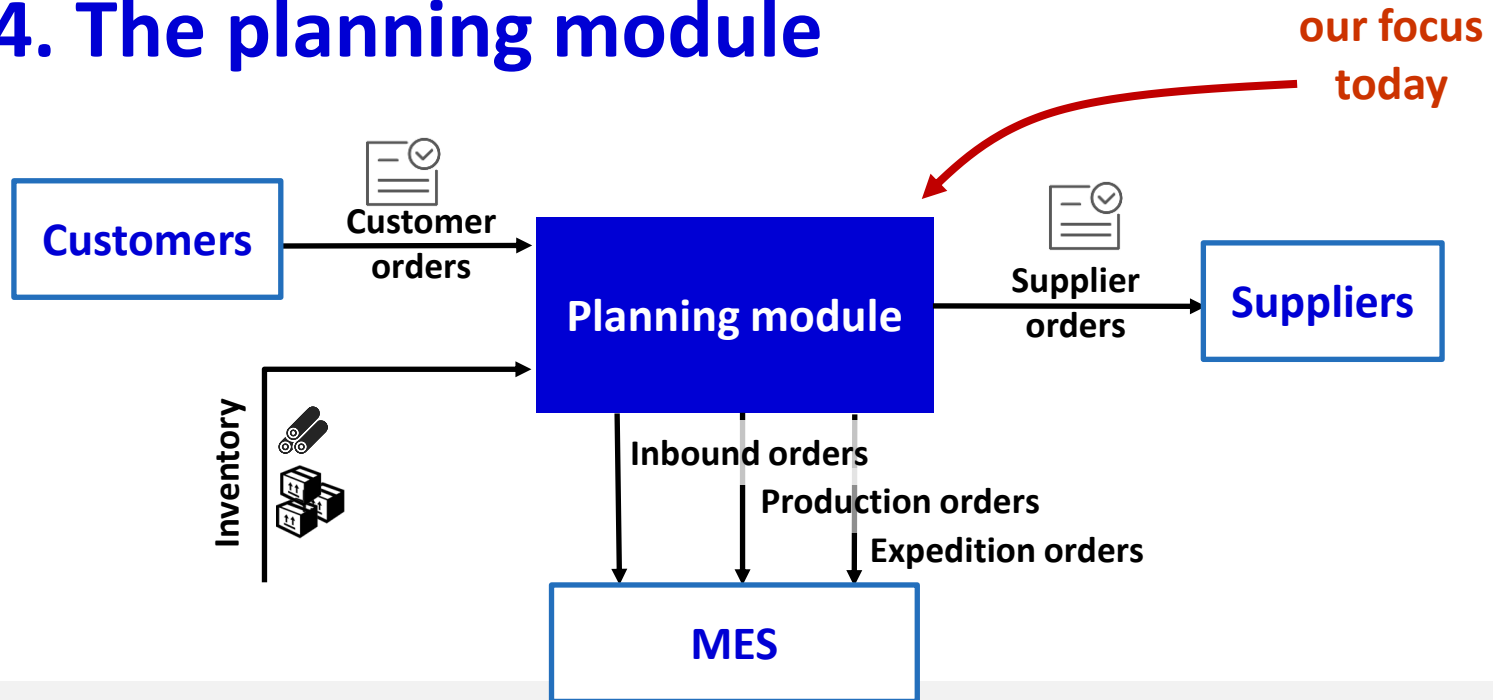
3. The customer orders module



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

Main menu

Client order management

Production planning

Expedition orders

Invoicing

close

Order management

Nr	Product	Qt	Client	Status
1	BA	5	Digicert	Confirmed
2	BV	7	Xplus	Registered
3	BV	2	Arxa	Planned
4	BA	5	Dreamo	Canceled

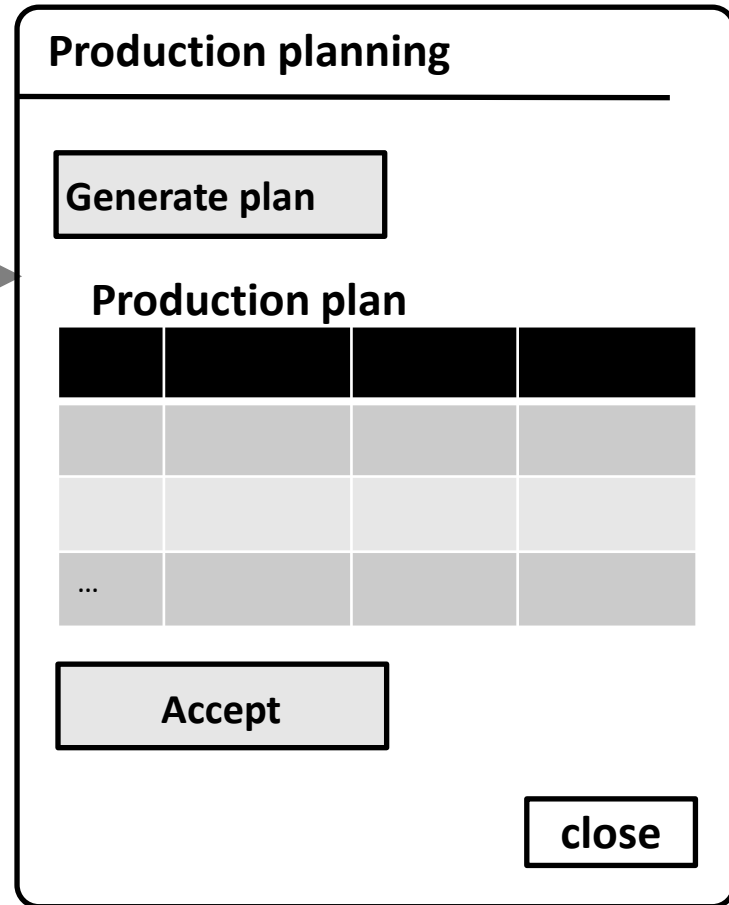
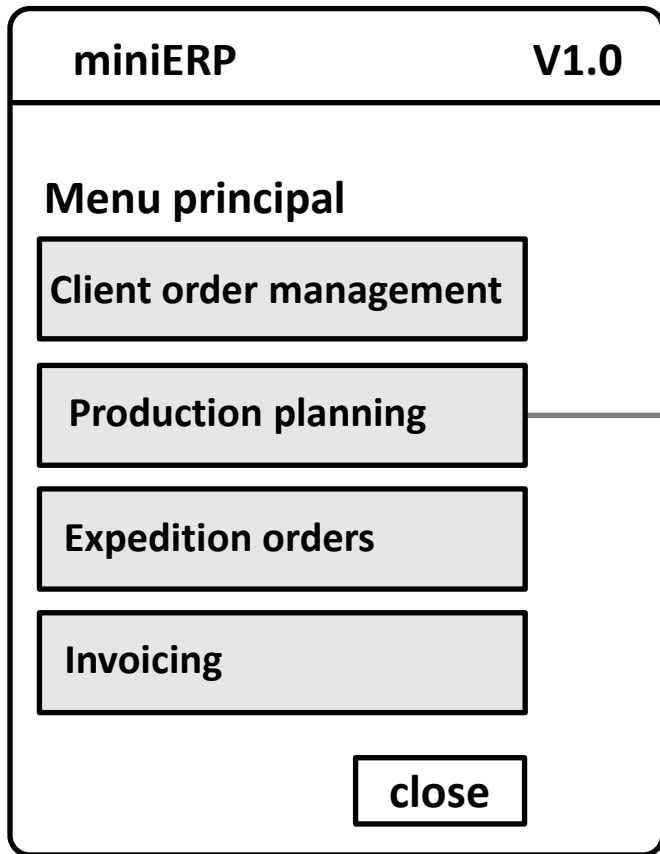
New order

New order

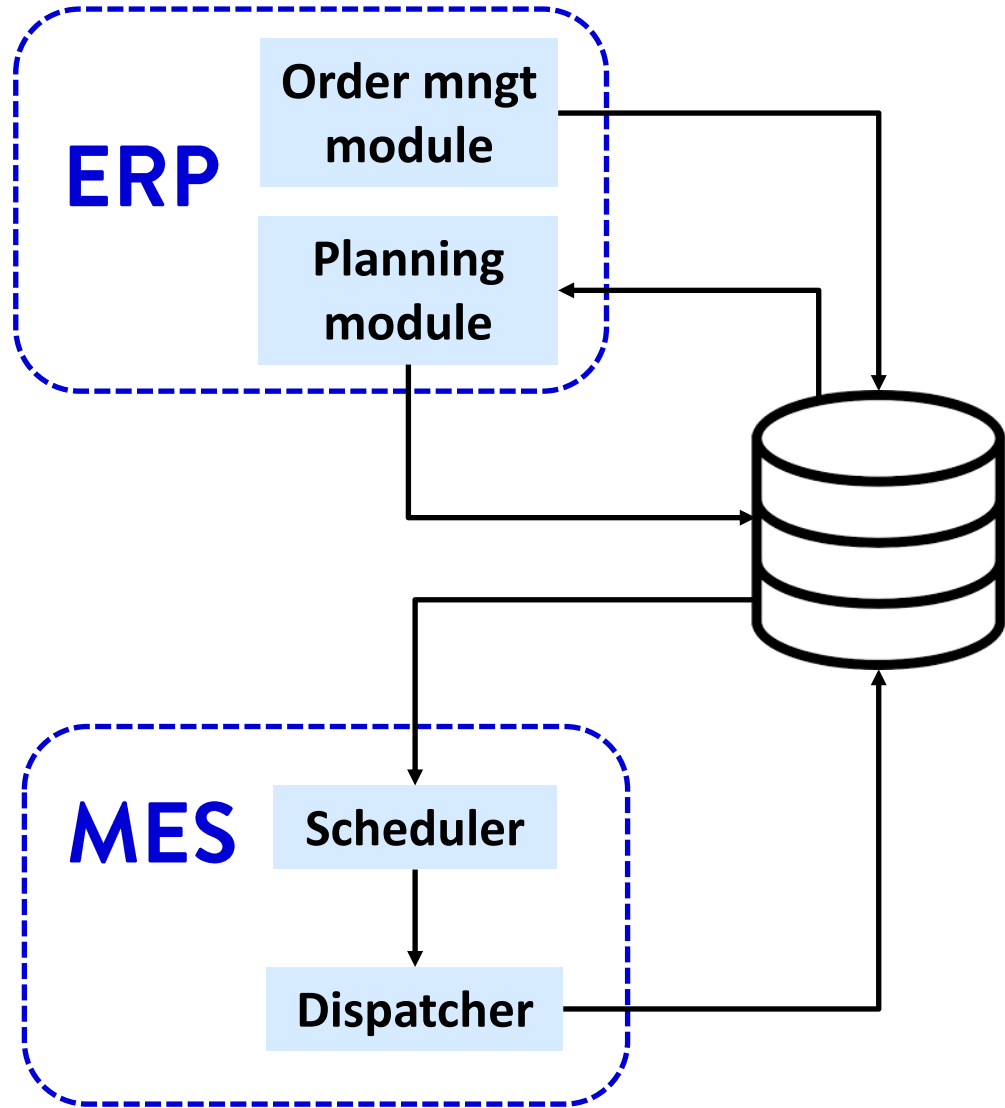
Product

Quantity

Client



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

1. Analysis of the **planning module**
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today



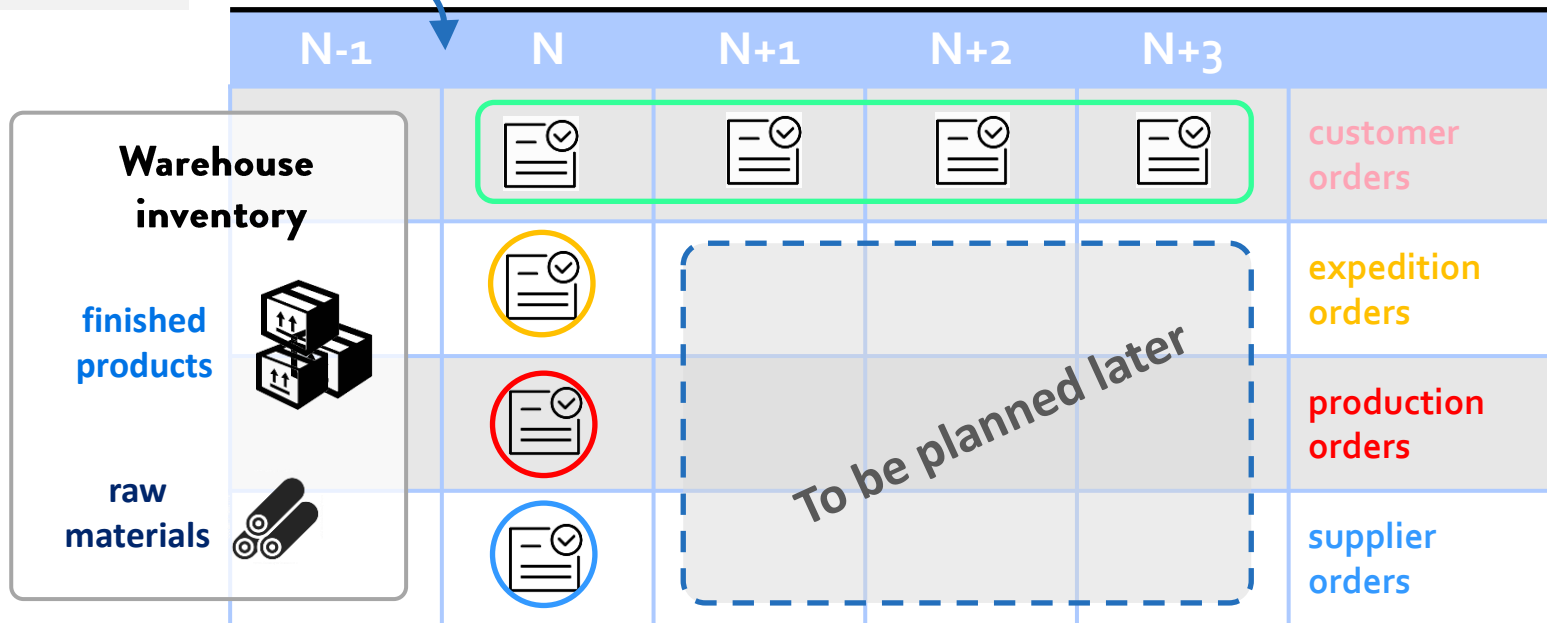
let's go, we have a lot to do 😊 !

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

week	N-1	N	N+1	N+2	N+3
Customer orders					
Expedition orders					
Production orders					
Supplier orders					

- 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

week	N	N+1	N+2	N+3
Customer orders				
Expedition orders				
Production orders				
Supplier orders				

The diagram illustrates the flow of orders over time. Customer orders are received in week N and are planned as expedition orders in week N. These expedition orders are then planned as production orders in week N+1, which are further planned as supplier orders in week N+2. The flow is indicated by dashed arrows pointing from the bottom row (Supplier orders) to the middle row (Production orders) and then to the top row (Customer orders). A red circle highlights the expedition order in week N, and a green circle highlights the customer order in week N. A dashed blue box encloses the expedition orders from week N to week N+3.

- 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)

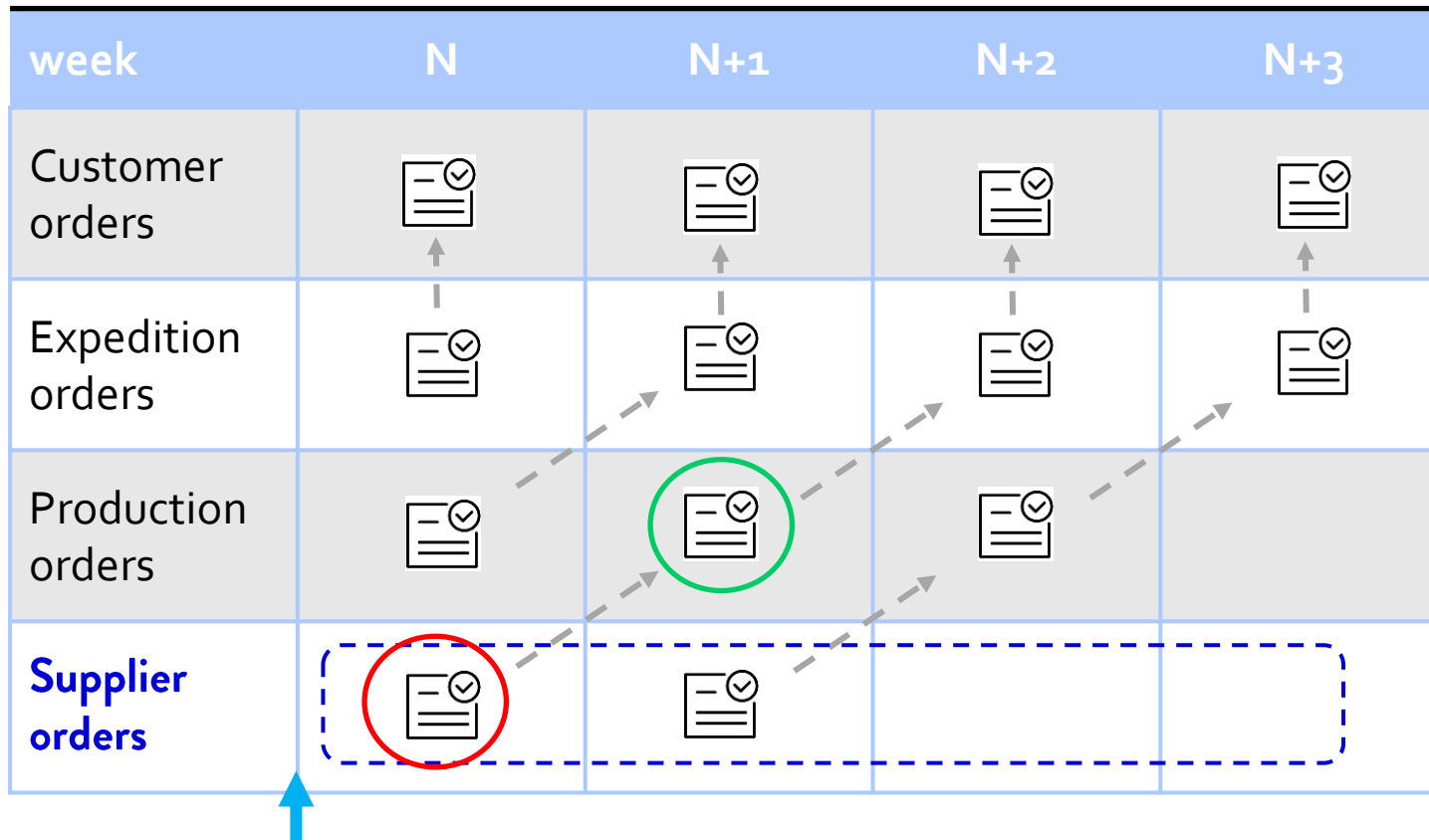
Production order planning

week	N	N+1	N+2	N+3
Customer orders				
Expedition orders				
Production orders				
Supplier orders				

Diagram illustrating the production order planning process across four weeks (N, N+1, N+2, N+3). The process involves Customer orders, Expedition orders, Production orders, and Supplier orders. The Production orders row is highlighted with a dashed blue box, and the Production order for week N is circled in red. The Expedition order for week N+1 is circled in green. Dashed arrows indicate the flow of information from Supplier orders to Production orders, and from Production orders to Expedition orders, and finally to Customer orders.

- 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

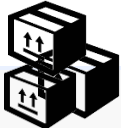


4.1. Week N planning

Expedition orders planning

Assume that we "are" here

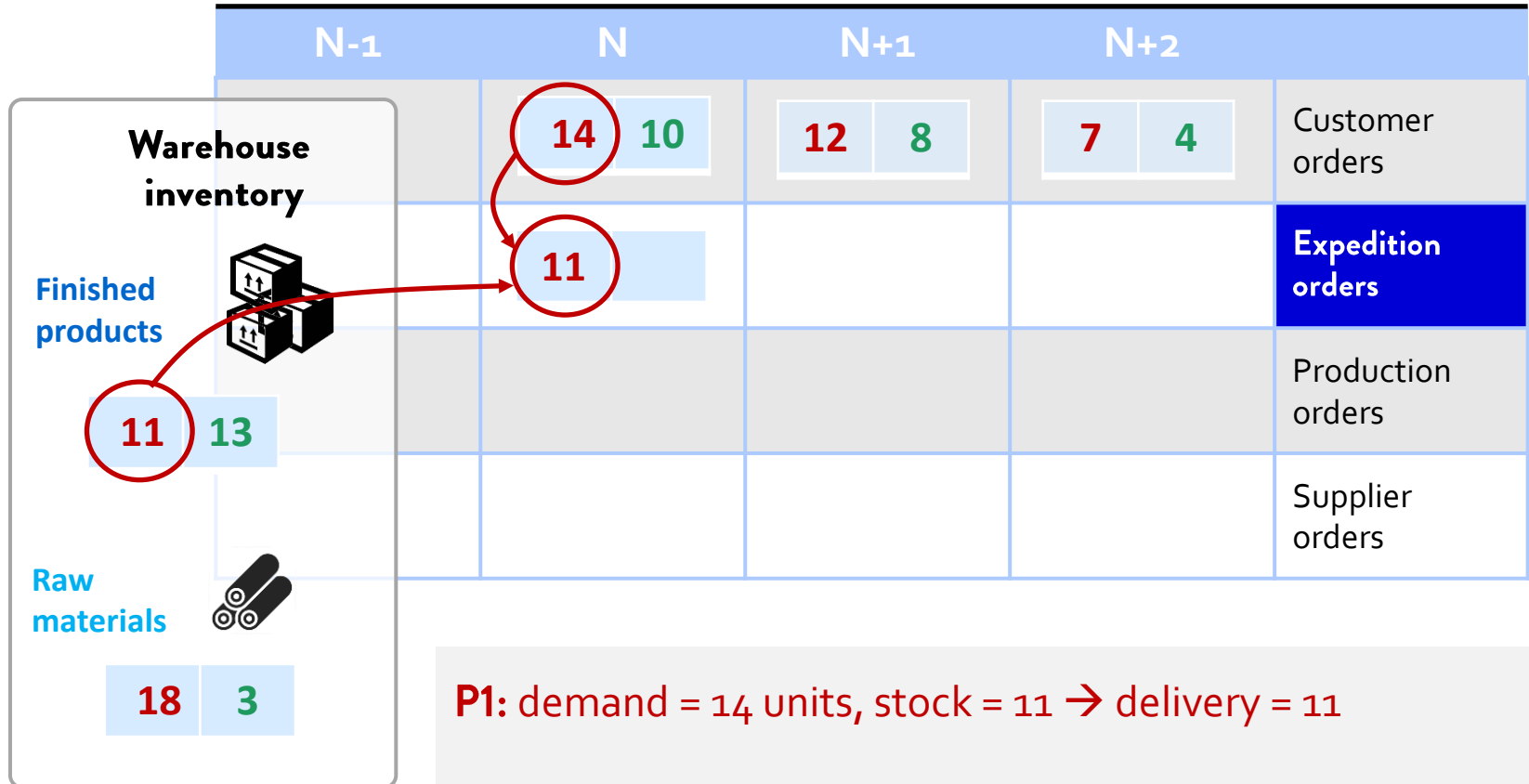
Quantities for product type **P1**

Quantities for product type **P2**

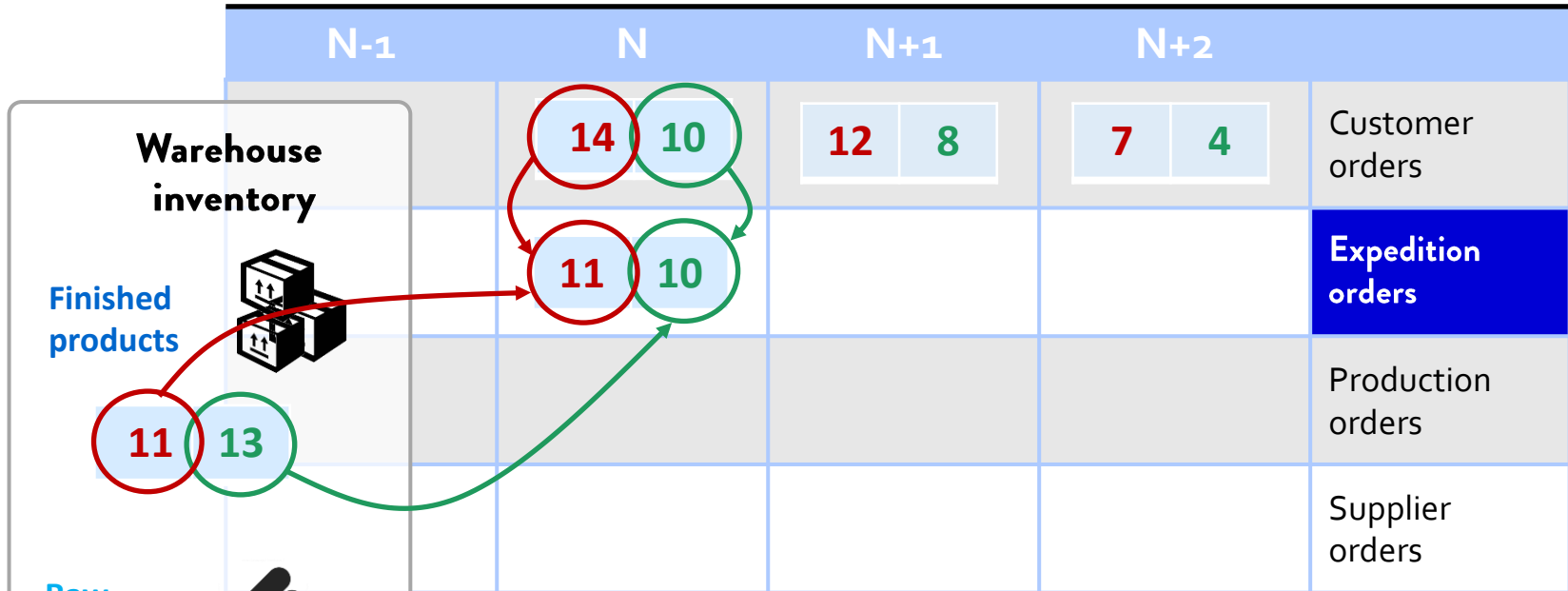
		N-1	N	N+1	N+2	
Warehouse inventory  Finished products  Raw materials 	Finished products 11 13		14 10	12 8	7 4	Customer orders
	Raw materials 18 3		?? ??			Expedition orders
						Production orders
						Supplier orders

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

Expedition orders planning



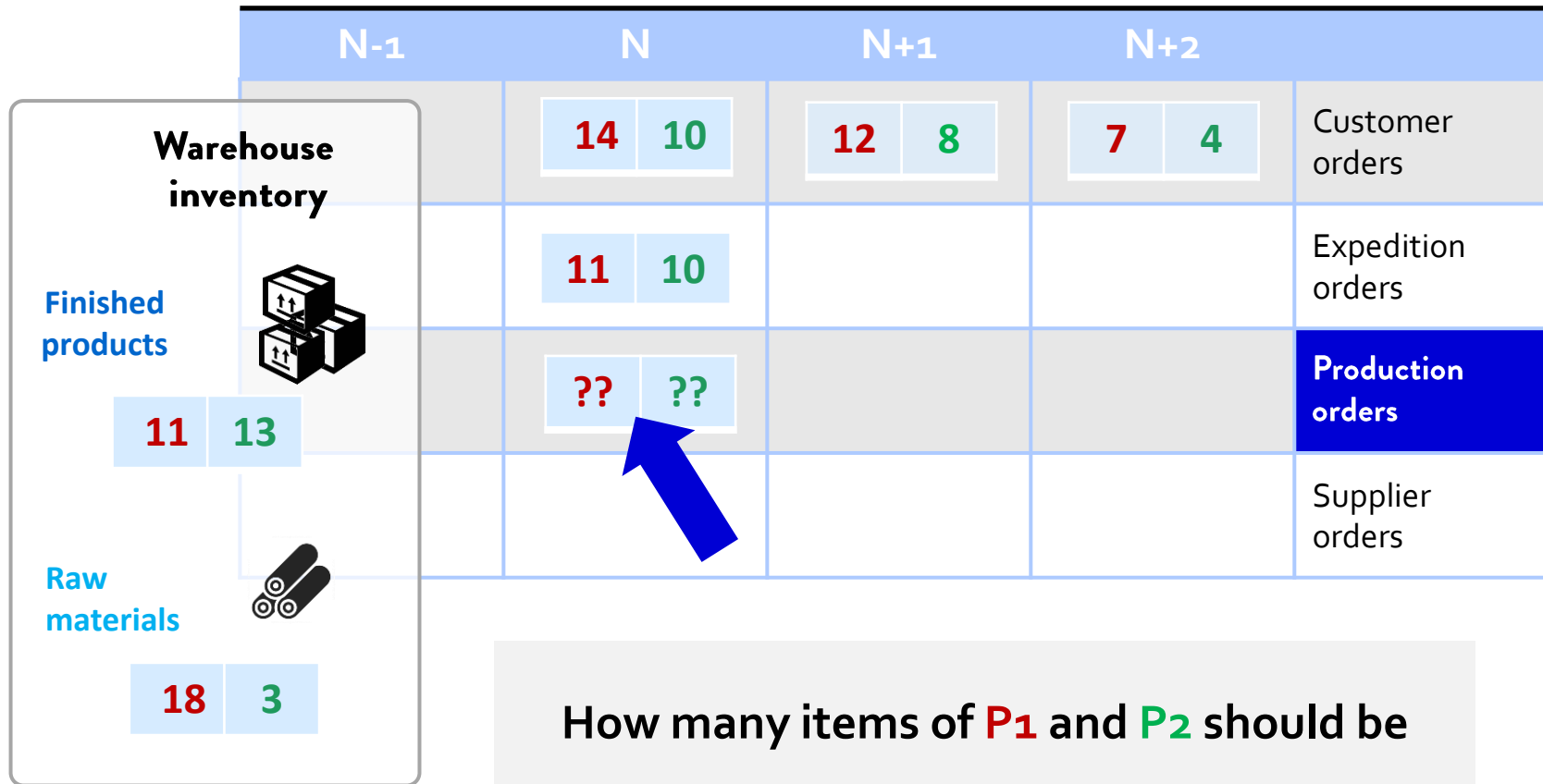
Expedition orders planning



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

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

Production orders planning



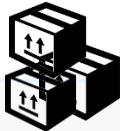
Production orders planning

		N-1	N	N+1	
Warehouse inventory			14 10	12 8	Customer orders
Finished products			11 10		Expedition orders
11 13			?? ??	1 st step	Quantity needed
Raw materials			?? ??	2 nd step	Actual orders
18 3					Supplier orders

Two steps procedure:

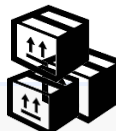

- 1st: calculate the **quantity needed** by product type knowing demand (i.e., customer orders)
- 2nd: plan the **orders that can actually be produced** taken into account the raw materials

Production orders planning | 1st step. Quantity needed

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



Production orders planning | 1st step. Quantity needed

		N-1	N	N+1	
Warehouse inventory Finished products  Raw materials 	Customer orders		14 10	12 8	
	Expedition orders		11 10		
	Quantity needed		15		
	Actual orders				
	Supplier orders				
		11 13			
		18 3			

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

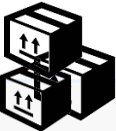

Production orders planning | 1st step. Quantity needed

		N-1	N	N+1	
Warehouse inventory Finished products  Raw materials 	Customer orders		14 10	12 8	
	Expedition orders		11 10		
	Quantity needed		15 5		
	Actual orders				
	Supplier orders				

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			
Warehouse inventory Finished products  Raw materials 	Finished products 11 13		14 10	12 8		Customer orders	
			11 10			Expedition orders	
			15 5			Quantity needed	Production orders
			?? ??			Actual orders	
	Raw materials 18 3						Supplier orders



Production orders planning | 2nd step. Actual orders



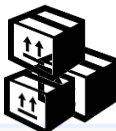

		N-1	N	N+1		
Warehouse inventory			14 10	12 8		Customer orders
Finished products			11 10			Expedition orders
	11 13		15 5		Quantity needed	Production orders
Raw materials			15 3		Actual orders	
	18 3					Supplier orders

Diagram illustrating the calculation of actual orders based on inventory levels and requirements across periods N-1, N, and N+1. The table shows inventory levels for Finished products and Raw materials, and the resulting Quantity needed and Actual orders for Production orders, and Supplier 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
Raw materials			15 3			Actual orders
	18 3		?? ??			Supplier orders
	6 2 safety stock					

Note: A blue arrow points from the 'Raw materials' row at week N to the 'Supplier orders' row at week N.

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

Suppliers orders planning

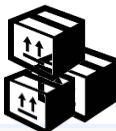



	N-1	N	N+1	N+2	
Warehouse inventory					
Finished products 		14 10	12 8	7 4	Customer orders
		11 10		E E	Expedition orders
11 13		15 5			Quantity needed
			P P		Actual orders
Raw materials 		15 3			
18 3		S S			Supplier orders

Diagram illustrating the flow of information and materials between weeks N-1, N, N+1, and N+2. The table shows inventory levels, customer orders, expedition orders, quantity needed, actual orders, and supplier orders. A green arrow points from the raw materials inventory at week N-1 to the supplier orders at week N. An orange arrow points from the supplier orders at week N to the actual orders at week N+1. A blue arrow points from the actual orders at week N+1 to the quantity needed at week N+2. A red arrow points from the quantity needed at week N+2 to the expedition orders at week N+2.

Keep in mind that:

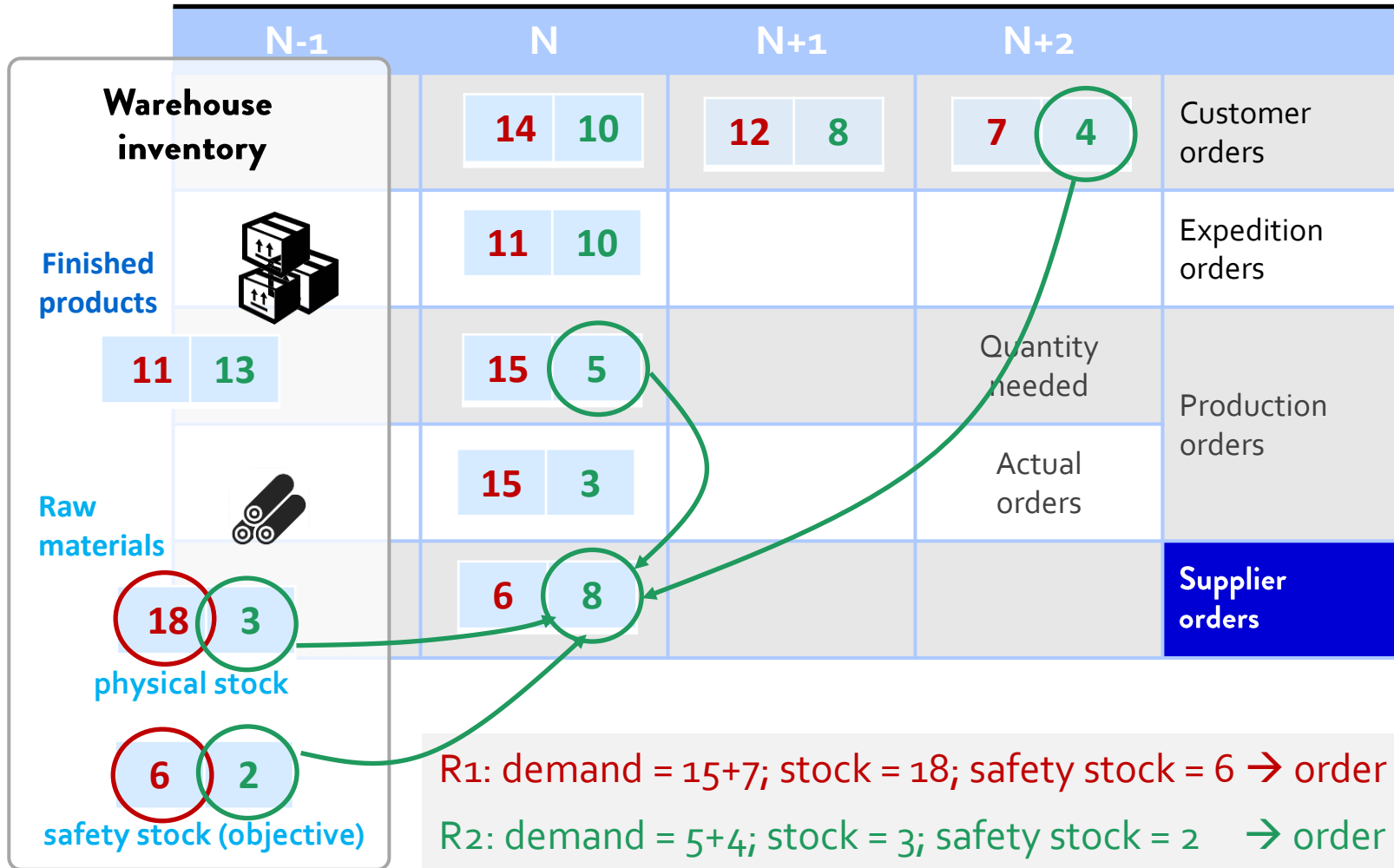
- raw materials ordered at the **end of week N-1** will arrive in the plant **by the end of week N**
- these materials will be used in the **production orders executed during week N+1**,
- which, in turn, produce the finished products to be **expedited to customers in week N+2**

Suppliers orders planning

		N-1	N	N+1	N+2	
Warehouse inventory Finished products  Raw materials  physical stock safety stock (objective)	Warehouse inventory		14 10	12 8	7 4	Customer orders
	Finished products		11 10			Expedition orders
	Raw materials	11 13	15 5			Quantity needed
	physical stock	18 3	15 3			Actual orders
	safety stock (objective)	6 2	10 8			Supplier orders

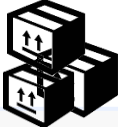

R1: demand = 15+7; stock = 18; safety stock = 6 → order = 10

Suppliers orders planning

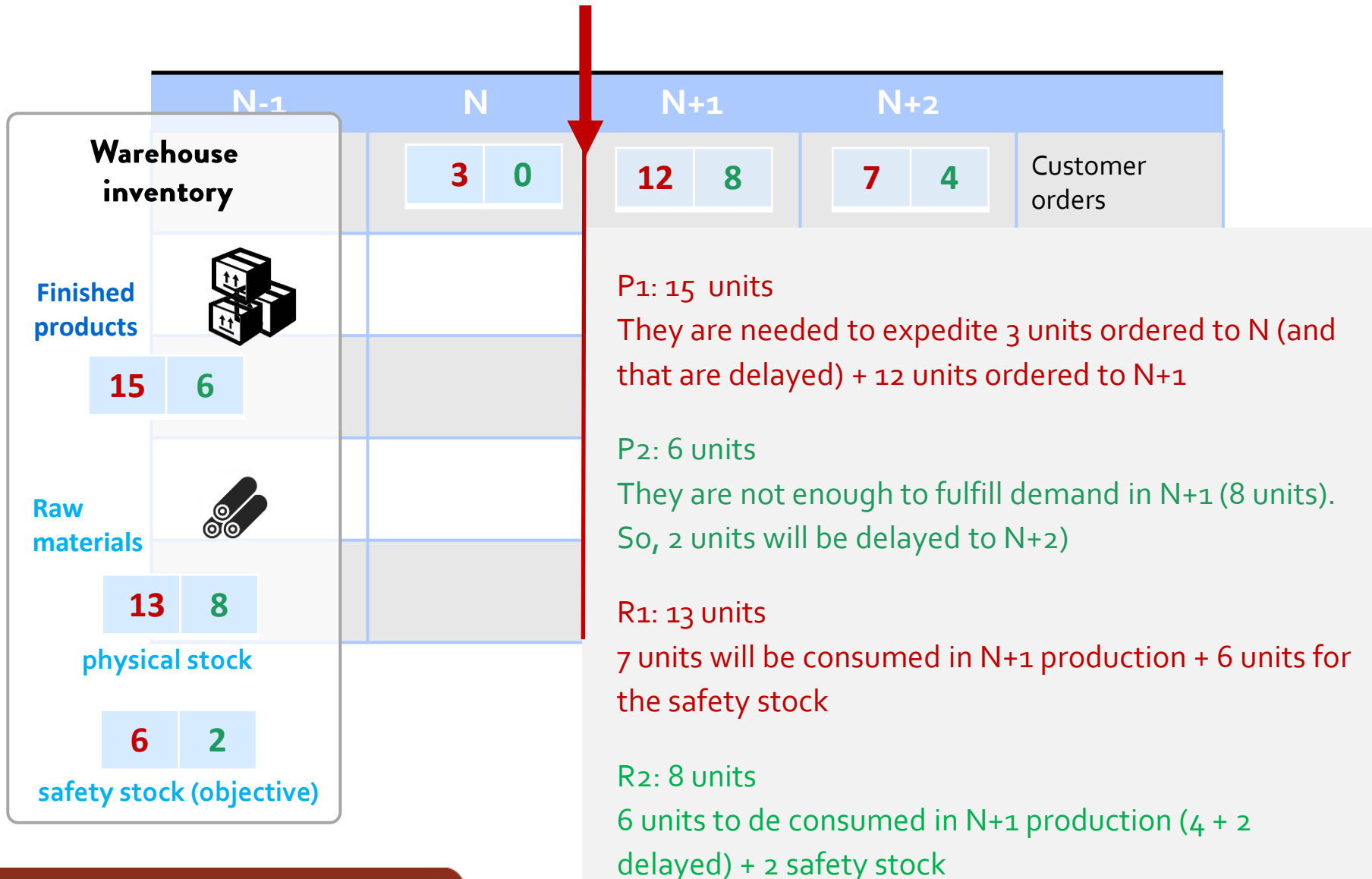


4.2. Week N+1 planning

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

		N-1	N	N+1	N+2	
Warehouse inventory Finished products  ? ? Raw materials  ? ? physical stock 6 2 safety stock (objective)	Customer orders			12 8	7 4	
	Expedition orders					
	Production orders					
	Supplier orders					

Expected situation at the end of week N:





- 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 7		Expedition orders
Finished products 							Production orders
Raw materials 							Supplier orders
physical stock							
safety stock							

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	
Warehouse inventory			3 0	12 -8	-7 -4	4 8	Customer orders
Finished products 			?	?			Expedition orders
			?	?			Production orders
Raw materials 			?	?			
physical stock			?	?			Supplier orders
safety stock							

Warehouse inventory						
	15	6				
	15	6				
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

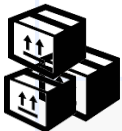

The good news:

- 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		
Warehouse inventory Finished products  11 13 Raw materials  18 3 6 2 safety stock			14 10	12 8	7 4		Customer orders
							Expedition orders
						Quantity needed	Production orders
						Actual orders	
							Supplier orders

2. Week N+1 plan

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



thank you !