

# Planning an End-to-End Logistics Chain: How can the experience of a leading mining company be applied?

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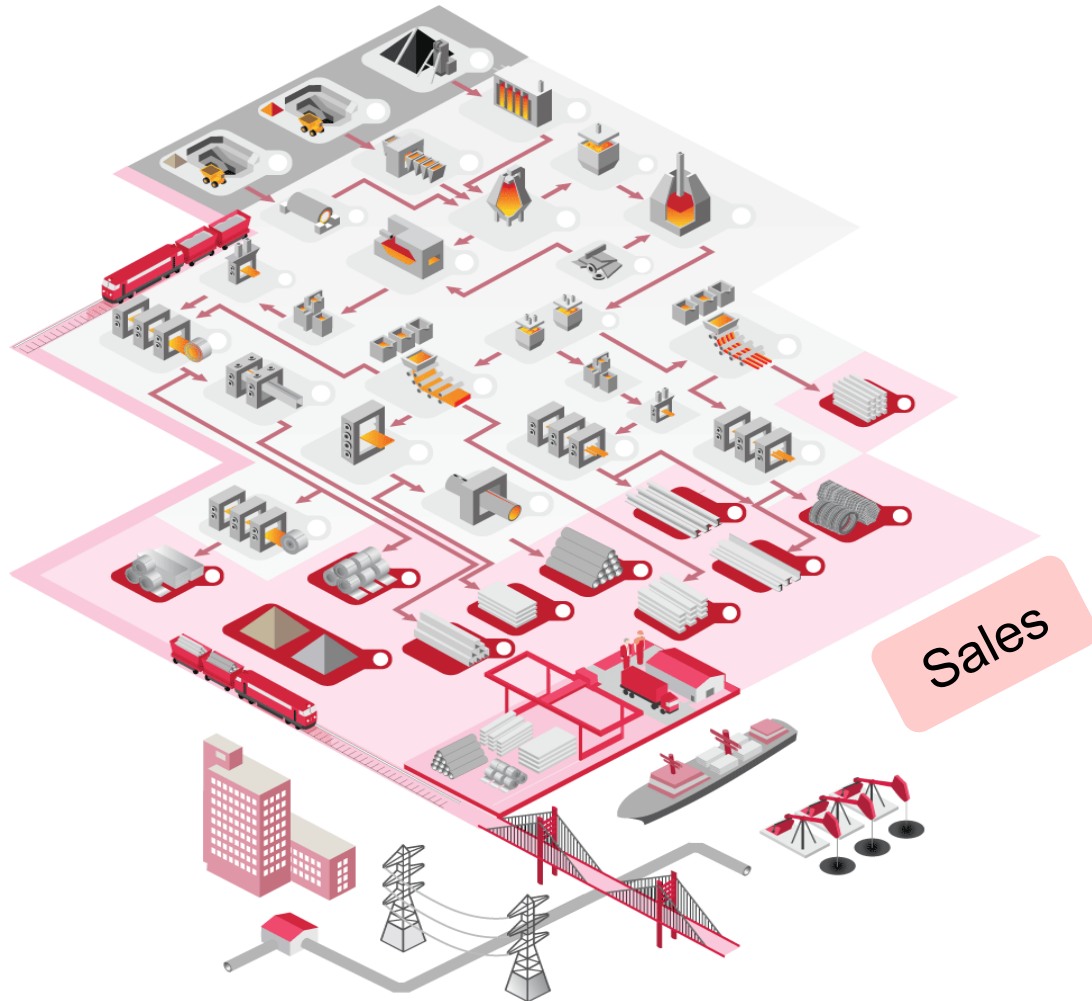


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- i. **Structure of METINVEST – a vertically-integrated group of steel and mining companies**
- ii. Business model of operational planning at Metinvest
- iii. Implementing business model planning in SAB APO Supply Network Planning (SNP)
- iv. Ways to compensate for the functional deficiencies of SAP APO SNP
- v. Implementing local mini projects in SAP APO SNP

# METINVEST – a vertically-integrated group of steel and mining companies



COKING COAL

11.39 MILLION TONS



IRON ORE CONCENTRATE

36.93 MILLION TONS



CAST IRON

11.50 MILLION TONS



STEEL

12.39 MILLION TONS



SEMI-FINISHED PRODUCTS

3.12 MILLION TONS



FLAT SECTION STEEL

5.84 MILLION TONS



ROLLED SECTION STEEL

2.87 MILLION TONS



PIPES

315 THOUSAND TONS

\* Data for 2013

- Coking coal self-sufficiency – 75%
- Blast-furnace coke self-sufficiency – 105%
- Iron ore self-sufficiency – 200%

# Structure of METINVEST process chain



## Mining Division:

- Inguletskiy Iron Ore Enrichment Plant
- Northern Iron Ore Enrichment Plant
- Central Iron Ore Enrichment Plant
- Komsomolskoye Mining Company
- Krasnodon Coal
- United Coal Company



## Metallurgical Division:

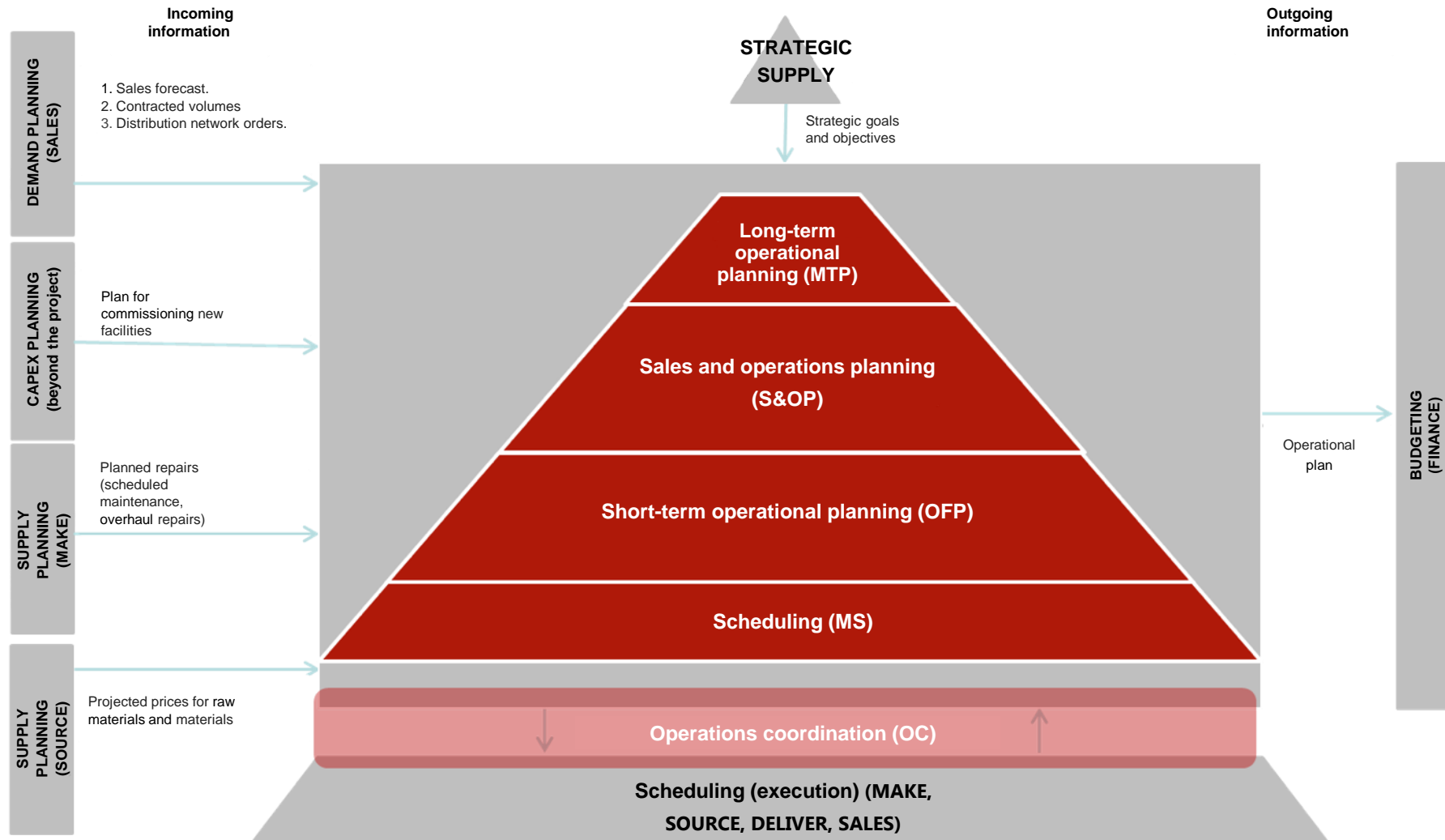
- Azovstal Iron & Steel Works
- Ilyich Iron & Steel Works
- Yenakiieve Iron & Steel Works
- Khartsyzsk Pipe Plant
- Promet Steel
- Ferriera Valsider
- Metinvest Trametel
- Spartan UK
- Metinvest Resource
- Avdiivka Coke Plant
- Inkor & Co.

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# Business model of operational planning



# Elements of the operational planning business model

Target planning levels	Target	Horizon (target)	Horizon (transitional)	Frequency	Detailization	Status of implementation in SAP
Long-term operational planning (MTP)	Map the strategic goals and objectives onto the operational planning level	5 years	3 years	Annually	Product families, 1-2 years with a breakdown by months, 3-5 years with a breakdown by quarters	Not implemented.
Sales and operations planning (S&OP)	Monitor the progress of the mid-term operational plan Optimize the supply chain	15 months	3 months	Monthly/ quarterly (rolling schedule)	Product families, with a breakdown by months	Implemented
Short-term operational planning (OFP)	Optimize the detailed functional plans Prepare data to calculate the forecasted cost	3 months	1 month	Monthly (rolling schedule)	Product details at the level of material master records with a breakdown by months	Implemented
Scheduling (MS)	Optimize performance and prime cost	2 months	1 month	Monthly	Product details at the level of material master records with a breakdown by days	Not implemented.
Operations coordination (OC)	Place orders for production and ensure customer services are provided at the target level Update the operations schedules	2 months	1 month	Weekly	Product details at the level of orders with a breakdown by days	Implemented in part of order placement for production.

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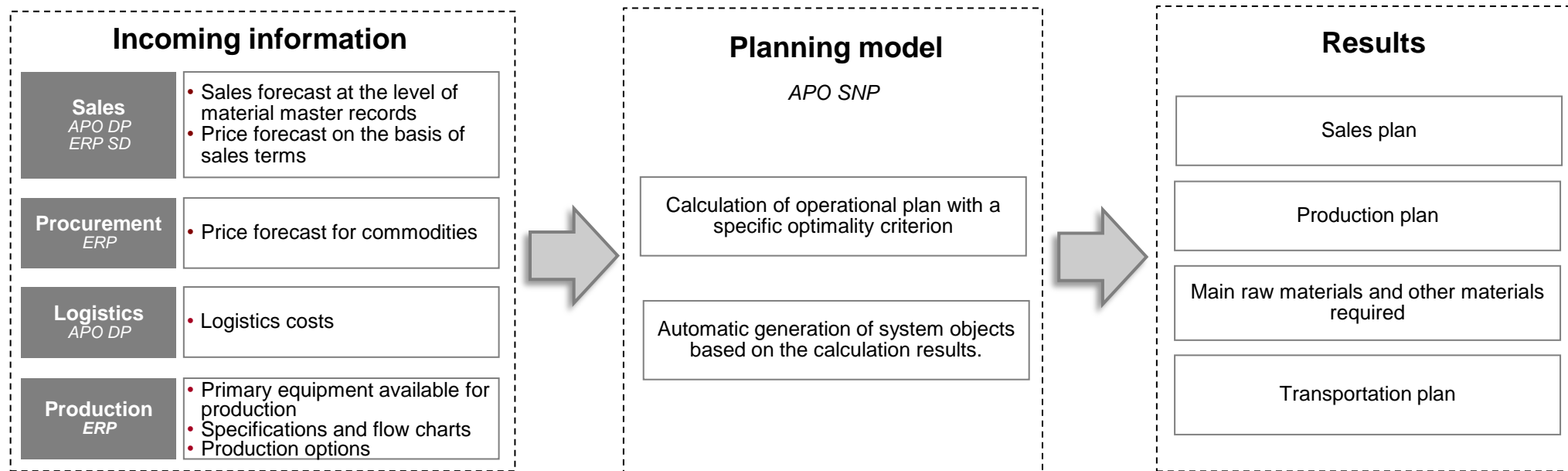
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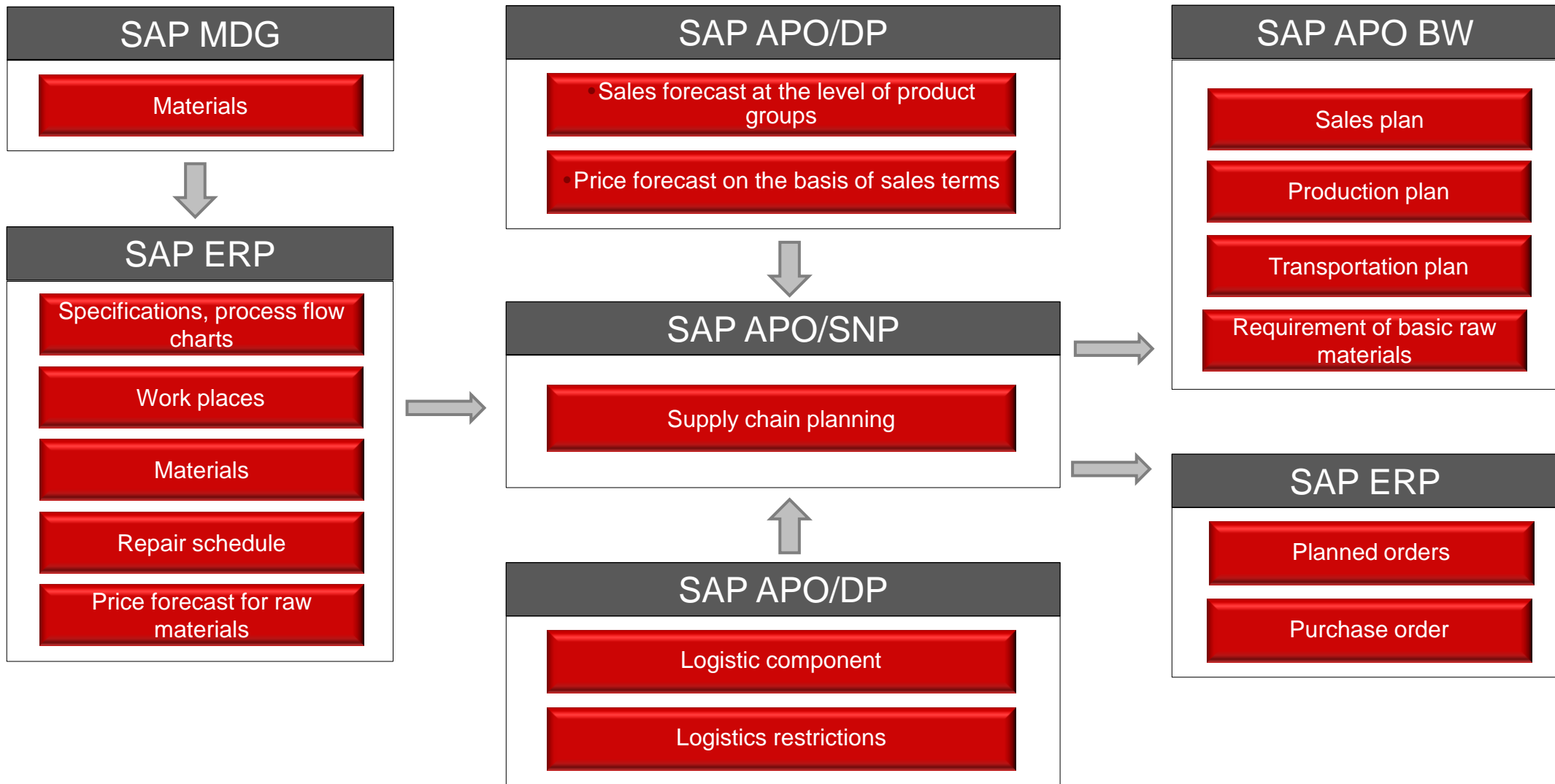
# Data flow in operational planning processes

Operational planning processes are cross-functional and require close cooperation between Sales, Production, Procurement, Logistics and Planning. The chart below shows the data flow for the operational planning processes.

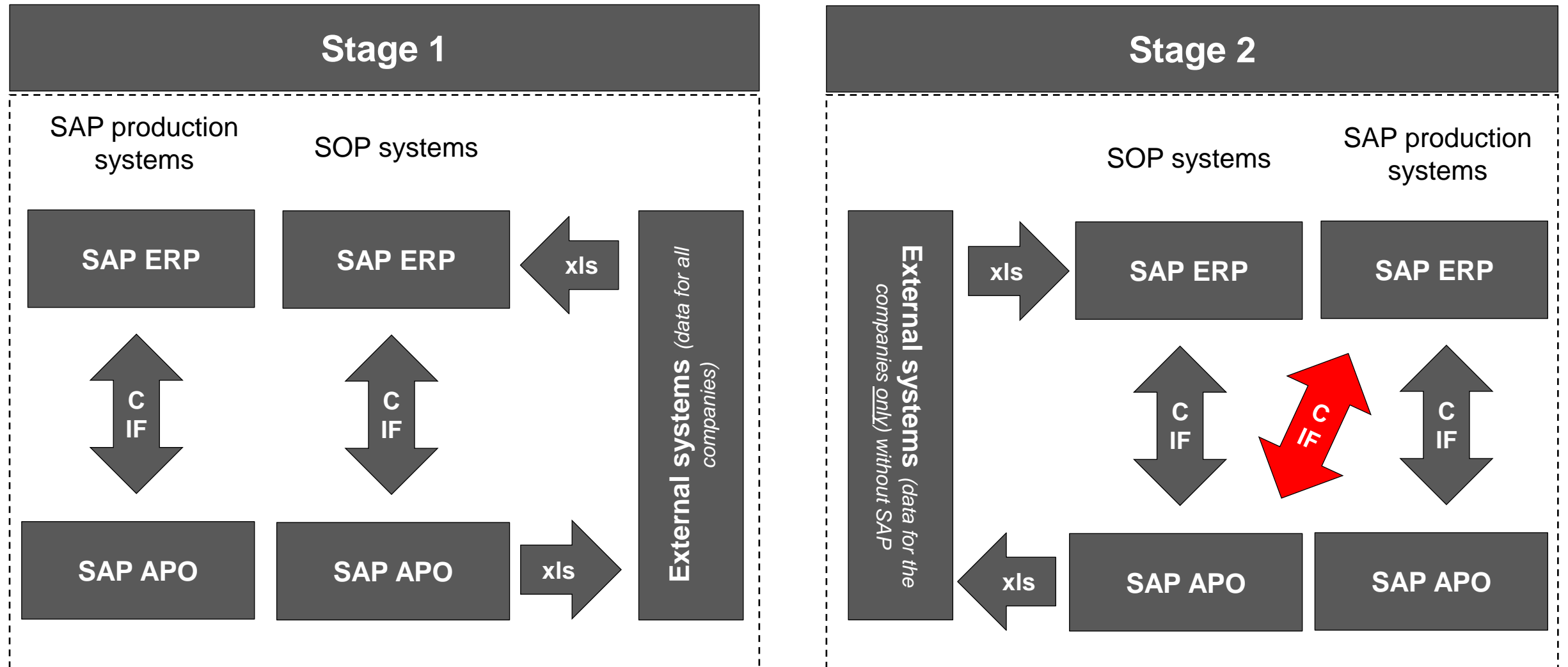


Implementing the operational planning processes in SAP requires integrating the SAP modules into one master module. This makes it possible to create sales forecasts, update the logistics, forecast prices for raw materials, and maintain the master production data

# Technical architecture of the operational planning solution (I)

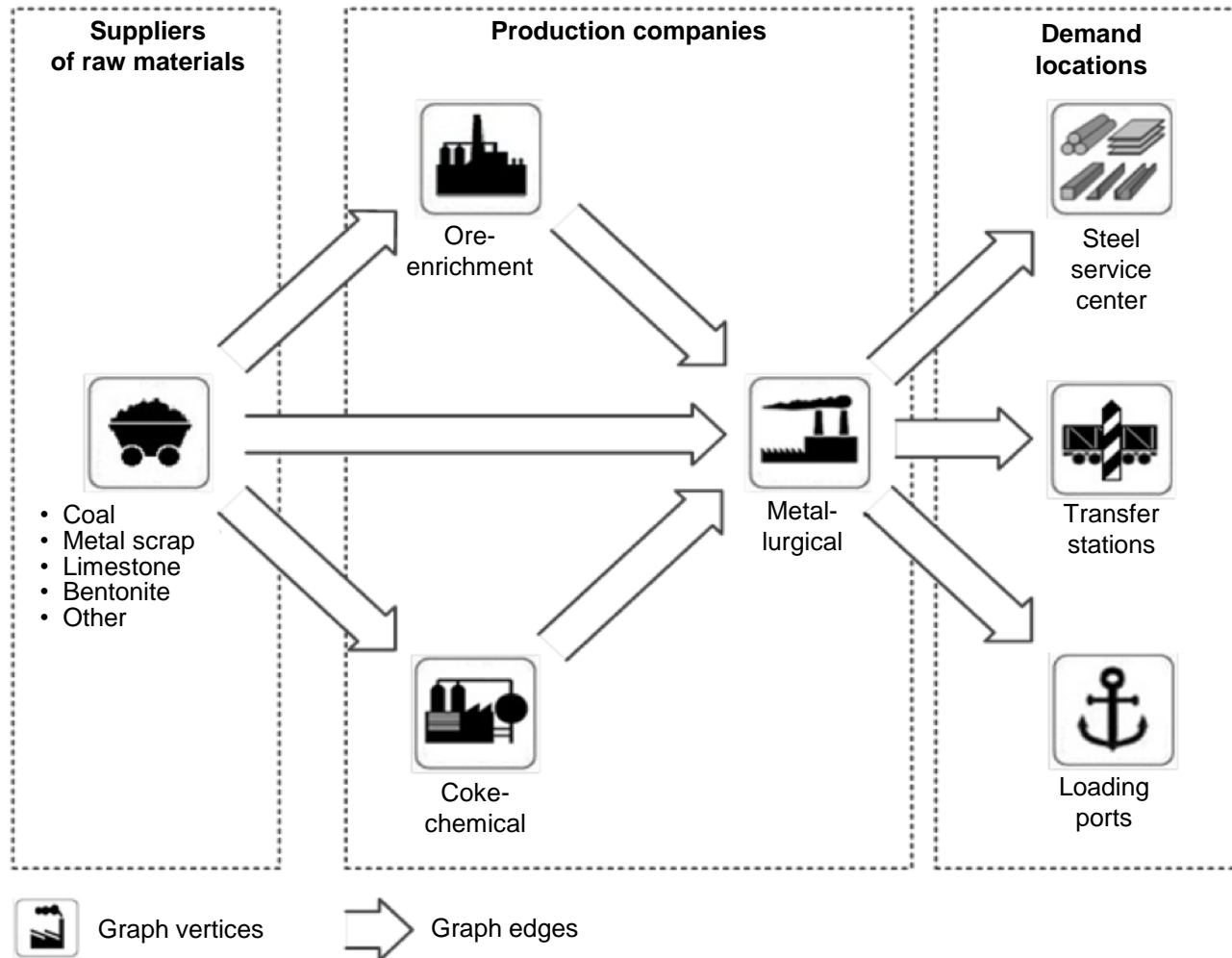


# Technical architecture of the operational planning solution (II)



# Structure of the supply chain planning model (I)

At the level of the Company's logistics chain

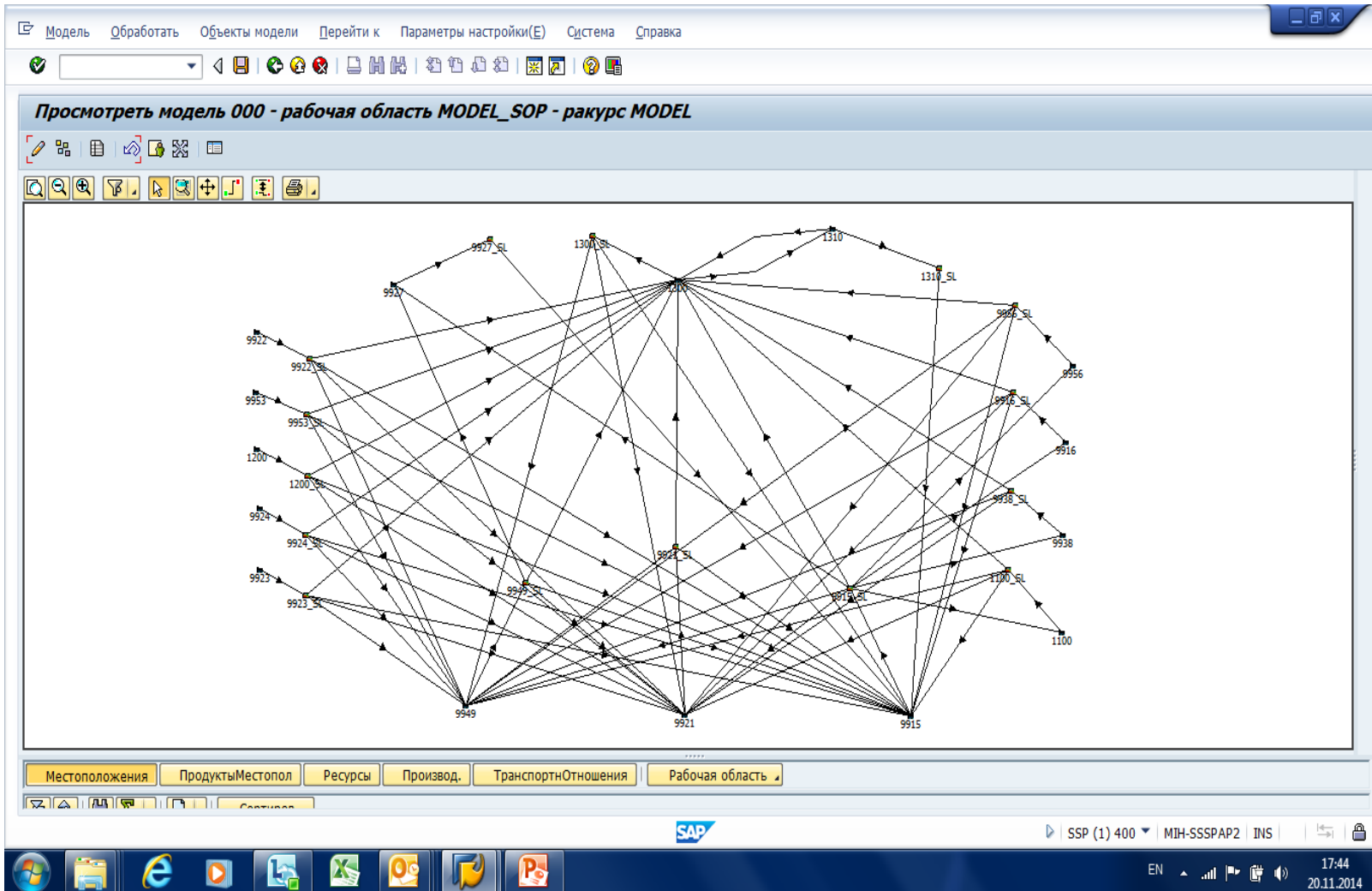


The key link in the architecture of the planning processes implementation in SAP is the supply chain planning model. The supply chain planning model is a graph where the vertices are the suppliers, manufacturers, terminals and demand locations. The graph edges are transport relations showing the traffic flow routes

The capacity of graph vertices representing the production companies is planned using the production planning models.

# Structure of the supply chain planning model (II)

## Reflection of the model in SAP APO



The structure of the Metinvest supply chain planning model is rather complicated.

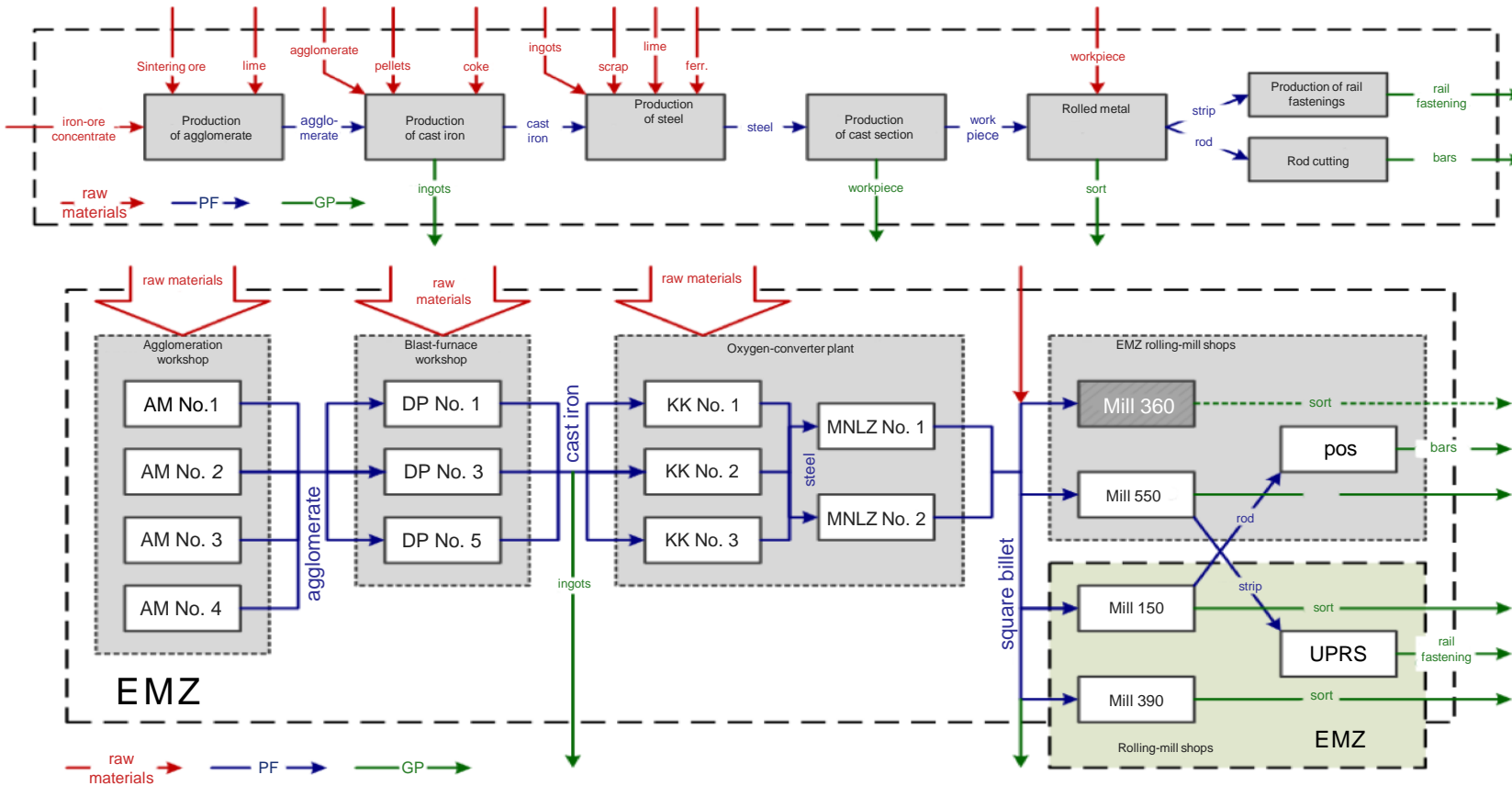
The supply routes are numerous and long and the cooperation between the companies is very complex.

### Model scale:

- 14 assets of both divisions
- 394 demand locations
- 1,116 transport routes

# Structure of the supply chain planning model (III)

## At the asset production level



The key elements of the production planning models are:

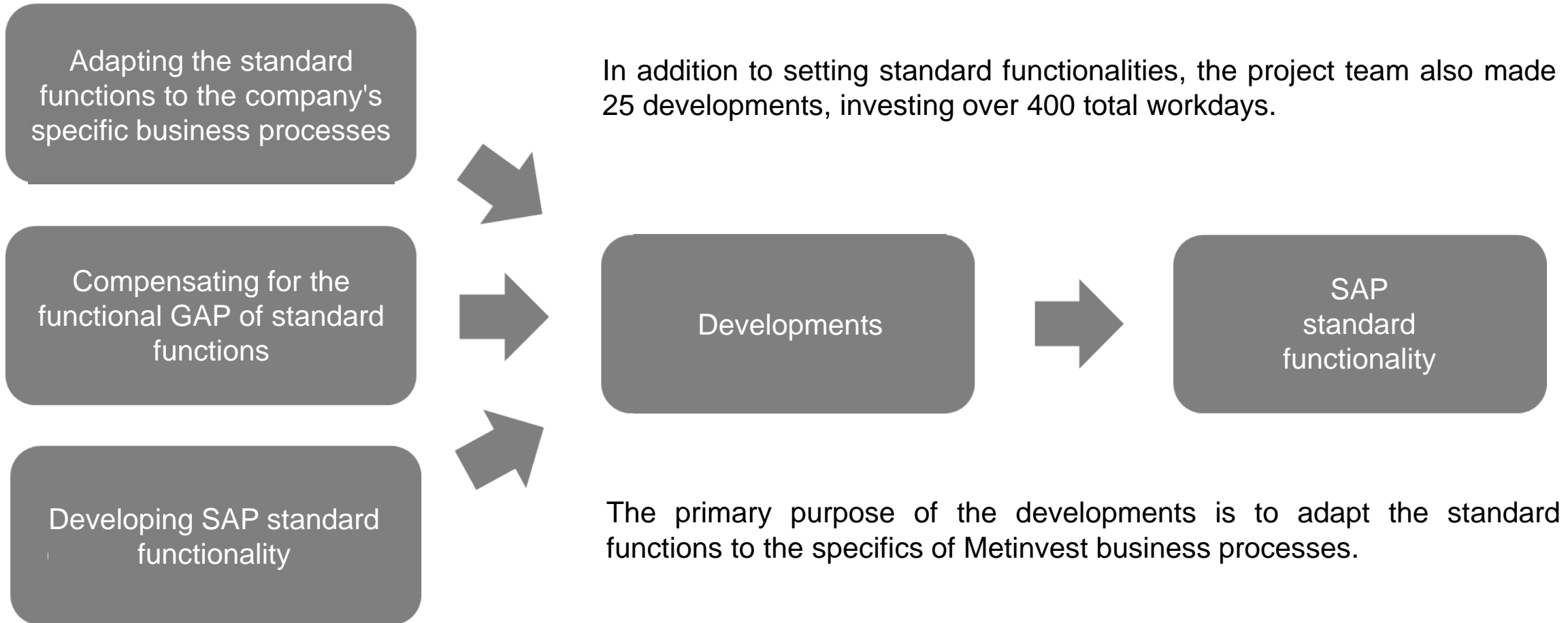
- the company's basic production units (work places)
- the list of materials produced (material master records) for each production unit
- master production data (specifications, process flow charts) for each material.

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# Using developments to compensate for the functional deficiencies of SAP (I)





# Using developments to compensate for the functional deficiencies of SAP (II)

The operational plans are calculated using SAP APO SNP functionality with a criterion of maximum marginal profits. There are two possible options for implementing this criterion:

## **Option No. 1**

*(Sale Price - Specific Variable s/s) \* Production Volume = Marginal Profit*

With this option, the variable cost must be calculated outside the system and then the results are uploaded directly to the planning model.

## **Option No. 2**

*Gross Income - Gross Variable Costs = Marginal Profit*

This option is based on consumption indices across the entire process chain that are in the companies' ERP system and the projected prices for the basic raw materials and other materials. The advantage of this option is that costs can be planned for the long-term taking into account the production options and the price forecast.

To implement SAP APO SNP, the project team chose Option No. 2, because the key requirement for implementing SAP into the operational planning was to take into account the price forecast for basic raw materials in the optimization procedures with an appropriate cost differentiation subject to a particular production process chart. During the implementation process, the project team realized a serious drawback of SAP APO/SNP was that it lacked standard functionality that could be used for Option No. 2 to calculate the prime cost based on the operational plan and to create reports describing the economic component of the target indicators. This made it impossible to interpret the planning results.

# Using developments to compensate for the functional deficiencies of SAP (III)

Папка планирования: OFP ИНТЕРАКТИВНОЕ ПЛАНИРОВАНИЕ / OFP ПЛАН [Live]

АРО - местоположение: 1300 / Енакиевский МЗ | АРО - продукт: 24.11.513000.00009 / Швеллер 10П СтЗпс м

Выделенные объекты

Номер продукта	Тип	Местопол.	Название продукта
07.10.100000.00040		1300	Окатыш железоруд.неофлюс.0.12 F
07.10.100000.00043		1300	Руда железная 0-20 Fe60 Яковлев

Профиль выбора

- MARTYNCAN00U
  - MIH\_CC

Папка планиров./раку...

- Z\_FC\_OFF
- Z\_FC\_OFF\_GDD
- Z\_FC\_SOP
- Z\_MIH\_DP
- Z\_MIH\_MS
- Z\_MIH\_MTP
- Z\_MIH\_OC
- Z\_MIH\_OFF
  - OFP CAP
  - OFP PLAN
- Z\_MIH\_SOP
- Z\_PLN\_MS
- Z\_PLN\_MTP
- Z\_PLN\_OC

Описание

- OFP ПРОВЕРКА МОЩН...
- OFP ПЛАН

SNP PLAN

Еди.	01.05.2015	01.06.2015	01.07.2015
Сырье химическое	USD 188,20		
Топливо технологическое	USD 9,64		
Уголь	USD		
Ферросплавы	USD 9 057,93		
Флюсо-доломитная продукция	USD 2 019,56		
Электроэнергия	USD 14 165,36		
транспортные затраты	USD		
Промышленные услуги сторонние	USD		
Услуги по транспортировке запасов	USD 278,13		
Налог за пользование недрами	USD 680,19		
Прочие затраты	USD 8 490,64		
Отходы, полупная продукция, брак	USD -57 424,...		
Склад	USD		
Общая сумма затрат	USD 289 318,11		
Общая сумма затрат альтернативная	USD		
Общая сумма затрат индивидуальная	USD		
Общая стоимость за ед.	USD 296,74		
Индивидуальная стоимость за ед.	USD		
Альтернативная стоимость за ед.	USD		
Общее поступление	USD 975,00		

статьи затрат

всего затрат, \$

себестоимость, \$/T

объем реализации, T

To compensate for the identified functional deficiencies in calculating the variable prime cost in SAP APO/SNP, the project team experts developed an add-in to SAP standard functionality. With this development, the variable part of the prime cost could be calculated with a breakdown by cost elements.

# Integrating SAP with alternative software to compensate for the functional deficiencies of SAP (I)

Production planning in standard SAP functionality involves choosing the most suitable production option from among the variety of alternatives in the system. A production option is a combination of the specification and the process flow chart. The specification is a list of materials required to manufacture a product, and the process flow chart specifies the time needed to make a given product.

**Просмотр Специфика Материала: общий обзор позиций**

Материал: 24.11.217000.00006 Блюм 09Г2С 3 мера  
 Завод: 9915 ПАО "МК Азовсталь"  
 Альтернатива: 1 Блюм 09Г2С 3 из полновесных слитков

Поз.	ТП	Компонент	Название компонента	Инд. ф...	Количество	ЕИ
0010	L	24.11.211100.00002	Слиток 09Г2С С8		1,218,000	КГ
0030	L	38.11.580000.00034	Обрезь стальная вид №7 ДСТУ 4121-200..		196,929-	КГ
0040	L	PLN_A00047	Потребление газа коксового		109,100	М3
0050	L	PLN_A00048	ОчищДом.газСтрансп		130,100	М3
0060	L	PLN_A00045	Эл-энерг с транс-кой		28,200	КВЧ
0070	L	PLN_A00058	Расход воды морской		12,600	М3
0080	L	PLN_A00029	Подача воды техничес		0,850	М3
0090	L	COST_BLOOM	Cost_Bloom		1,000	T

**Единичная техкарта: Просмотреть: обзор операций**

Материал: 24.11.217000.00006 Блюм 09Г2С 3 мера СчГрТехкр30  
 Последов.: 0

ЕИ	Оп...	Пд...	Рабоче...	З-д	Уп...	Ключ о...	Описание	И...	В...	К...	О...	З...	В...	П...	БазисКолич	Е...	Время нал...	Е...	В..	Машинное время	Единица
	0010		45451010	9915	PP01		Нагрев металла (обжимной цех)								1,000	T	0,000			0,268	МИН
	0020		45452020	9915	PP01		Прокат металла на стане 1200								1,000	T	0,000			0,188	МИН

As the practice of using SAP shows, this mechanism:

- is efficient for planning steelmaking and rolling capacities of iron and steel companies;
- has significant limitations for planning agglomeration and blast-furnace process stages of iron and steel companies
- is not applicable for planning the production of coke companies

To cover the functional deficiencies in terms of coke production planning, the SAP project team developed an optimization model that can be used to calculate the optimum coal charge for coking with a charge/coke cost minimization criterion.

# Integrating SAP with alternative software to compensate for the functional deficiencies of SAP (II)

**Model purpose:** ensure that an optimum coal charge for coke production is automatically calculated that meets all formal restrictions with set optimality criteria

## Target model function:

The model for planning the demand of coke companies for coal is a two-criteria task:

**Criterion 1:** minimizing the cost of charge coal (*or*) minimizing the cost of blast-furnace coke

**Criterion 2:** minimizing the excessive stock balances of coal

## Addressed task classes:

In the process of planning the optimum coal charge, the following classes of optimization tasks are addressed:

- **"Mixing Task"** – finding the optimum mixture of coal concentrates
- **"Transport Task 1"** – optimization of coal supplies from the suppliers to coke companies
- **"Transport Task 2"** – optimization of furnace coke supplies from coke companies to iron and steel companies

## Mathematical methods used:

- linear programming method
- integer programming method

## Benefits of the mathematical model:

- The optimum solution can be obtained
- A balanced plan can be calculated for all formal restrictions for one iteration
- More than one optimality criterion can be taken into account
- Online calculation and re-calculation is fast
- What IF analysis can be used
- Model is very flexible with regard to changes in input parameters
- The interface is convenient and user-friendly
- The model can be further improved

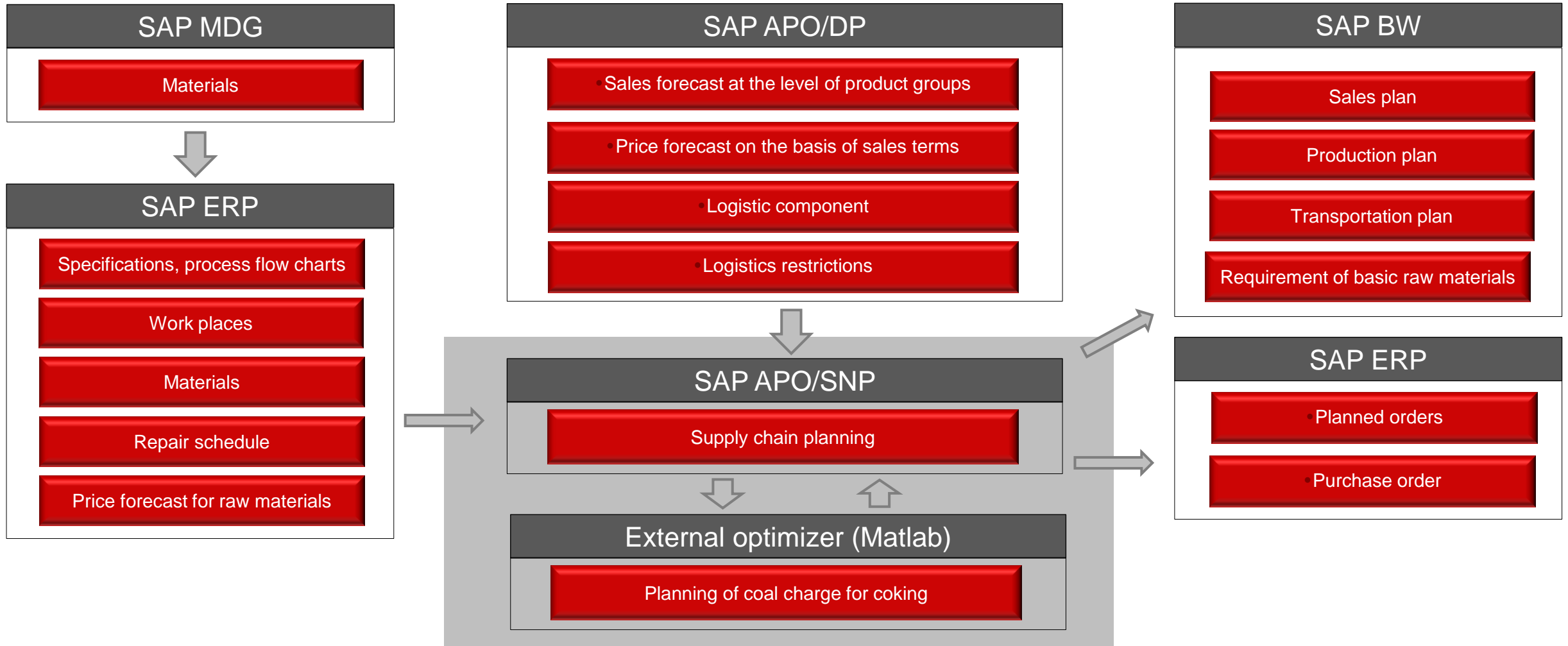
## Software used:

- model matrix generation: **MS-Excel / Matlab**
- finding an optimum solution: **Matlab / Tomlab**

## Model dimension:

- number of variables: **8120**
  - number of restrictions: **7808**
- including:
- 100 coal suppliers/brands
  - 2 brands of furnace coke for each coke company
  - 6 coke companies (*including the 4 coke sections of Avdiivka Coke Plant*)
  - 4 iron and steel companies
  - 32 "coke companies → iron and steel companies" transport routes
  - 800 "coal suppliers → coal companies" transport routes

# Integrating SAP with alternative software to compensate for the functional deficiencies of SAP (III)



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# Optimizing the costs of metal scrap transportation

The task is to satisfy the demand of iron and steel companies for metal scrap and to minimize the transportation costs.

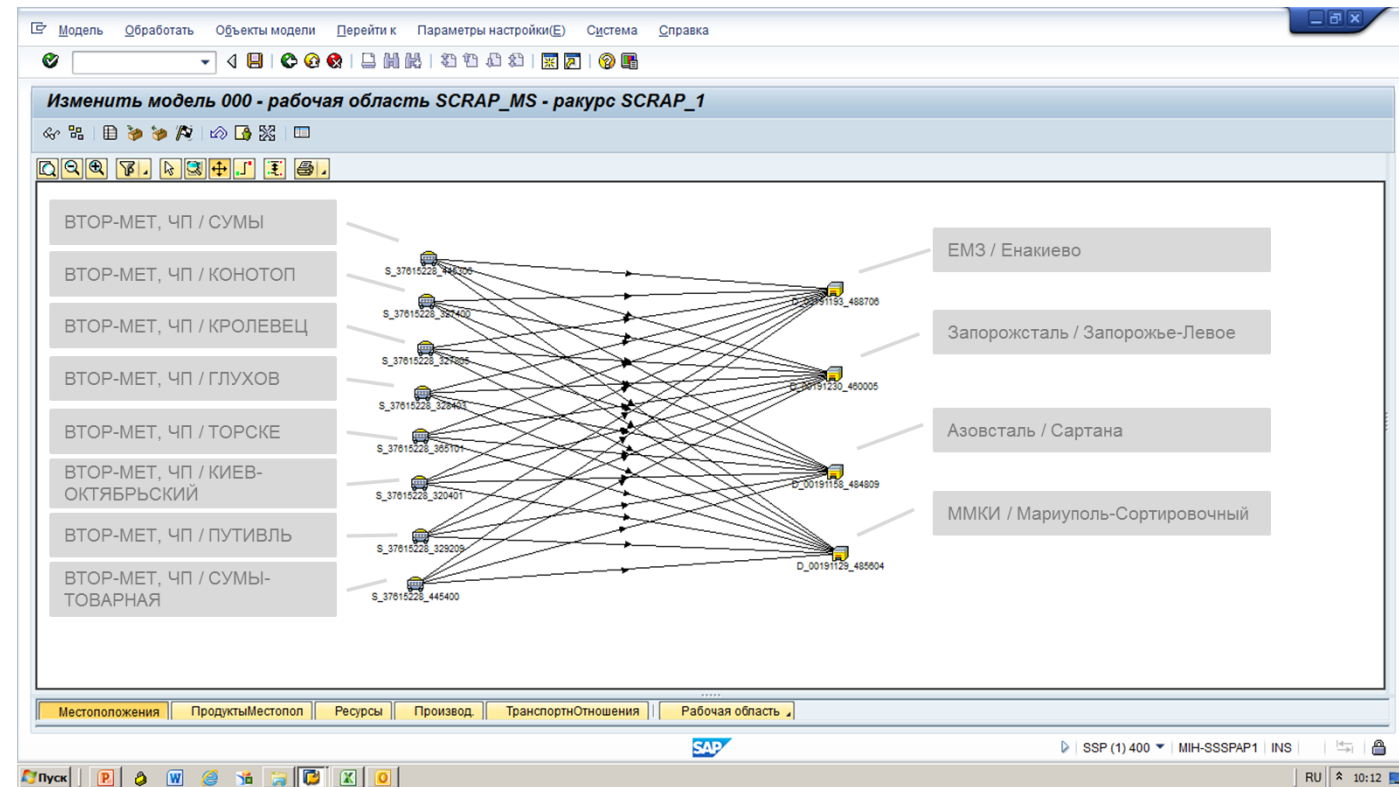
To solve the task, SAP APO SNP functionality is used.

The structure of the metal scrap supply model in SAP includes:

- 685 Locations (Supplier / Shipment Stations)
- 74 Suppliers
- 300 Shipment stations
- 4 Consumers
- 4 Receipt stations
- Transport relations =  $685 \times 4 = 2740$

The architecture of the SAP functionality integration with the METINVEST-RESOURCE accounting system (1C) was determined:

- Scrap metal availability data was transferred from supplies from 1C to SAP (the integration interface was developed and tested).
- Planning results were transferred from SAP to 1C (the integration interface is being fine tuned)



Using SAP functionality, the costs for metal scrap transportation were reduced by 3.7%.