Bayer Technology Services

An Integrated System Solution for Supply Chain Optimization in the Chemical Process Industry

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FOCAPO 2003
Foundations of Computer-Aided Process Operations

Coral Springs, 12th - 15.th January 2003

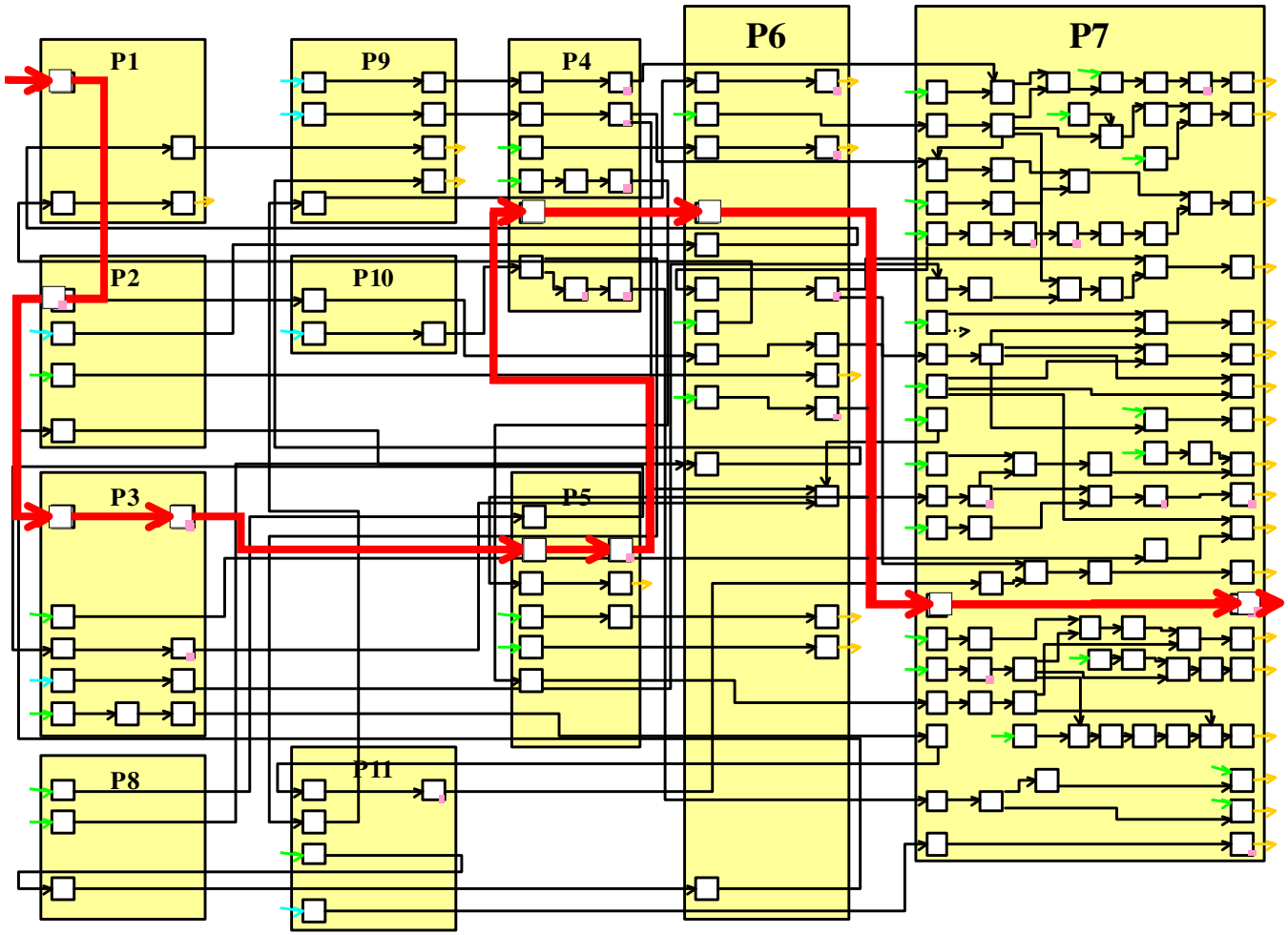
Agenda

- Motivation & Goals
- Scheduling Solution
- Collaborative Planning
- Manual Updates
- Benefits

Motivation: Complex Production

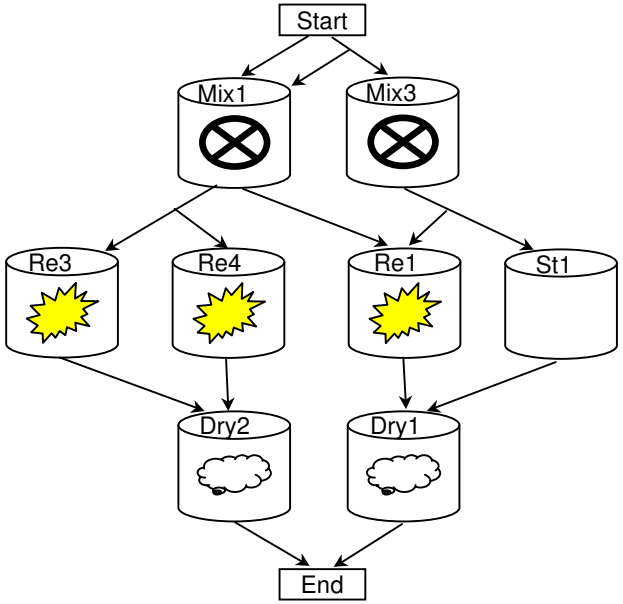
Complexity due to chain production running through multiple plants

- multi-step, multi-plant chains
- flexible routing network

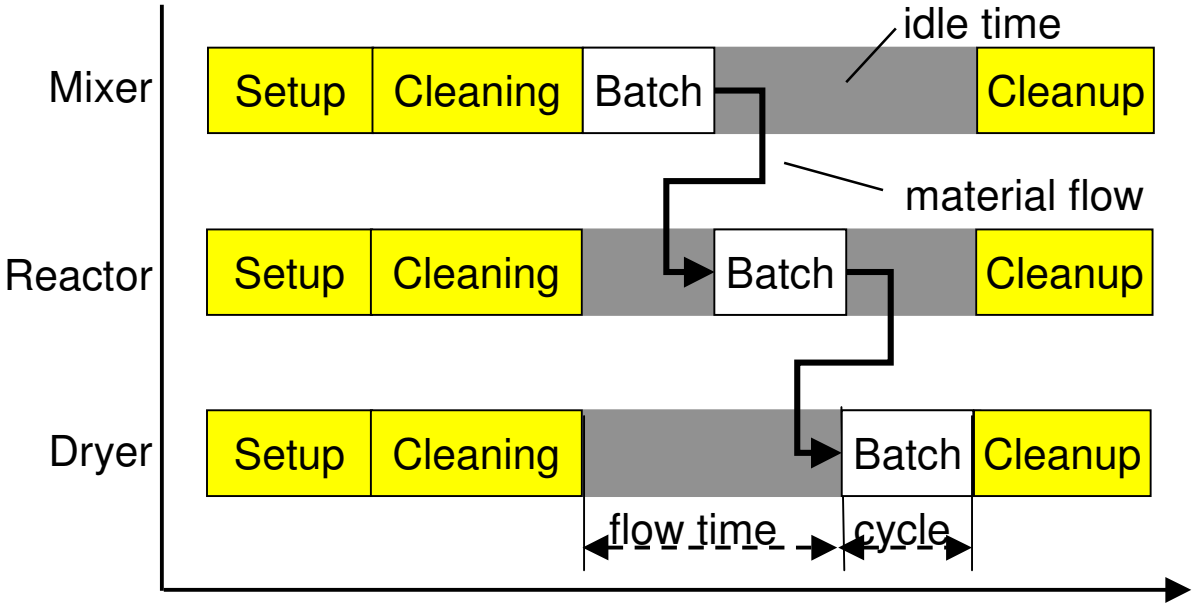


Routing, Campaigns

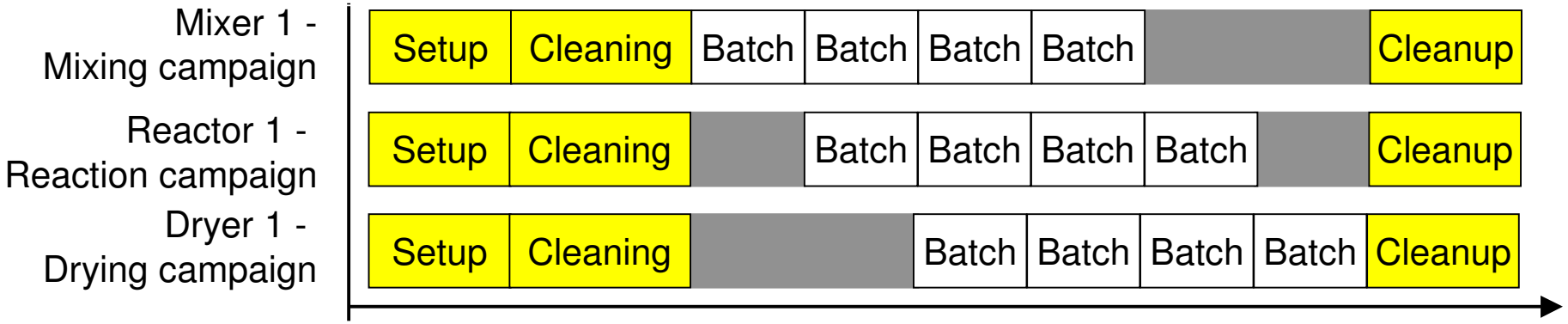
a) Possible routings



b) Material flow through routed facilities

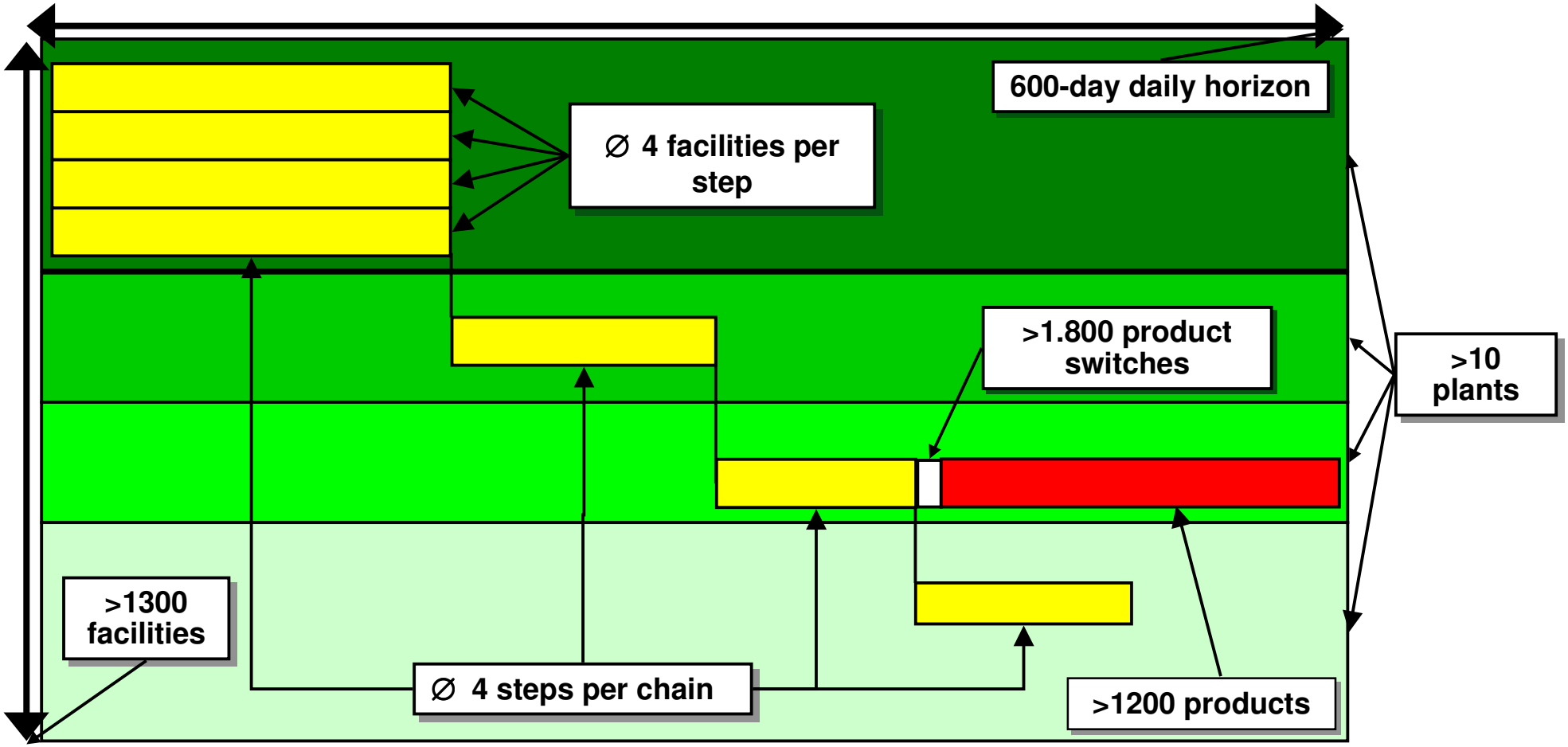


c) Three campaigns on routed facilities



Challenge: Size of Problem

A modeler‘s nightmare: Size and complexity



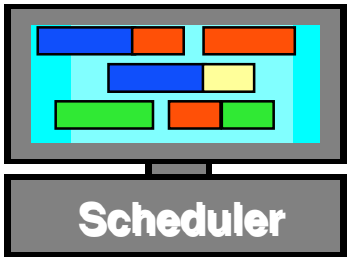
Goals

Optimized overall production plan

- Automated planning for higher capacity utilization

High degree of transparency in planning

- Forecasting, orders, queries and problems regarding chains

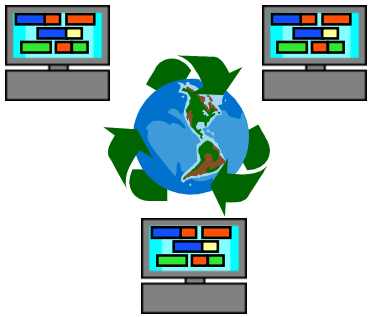


Support conflict resolution

- Manual interaction with simulations, scenarios

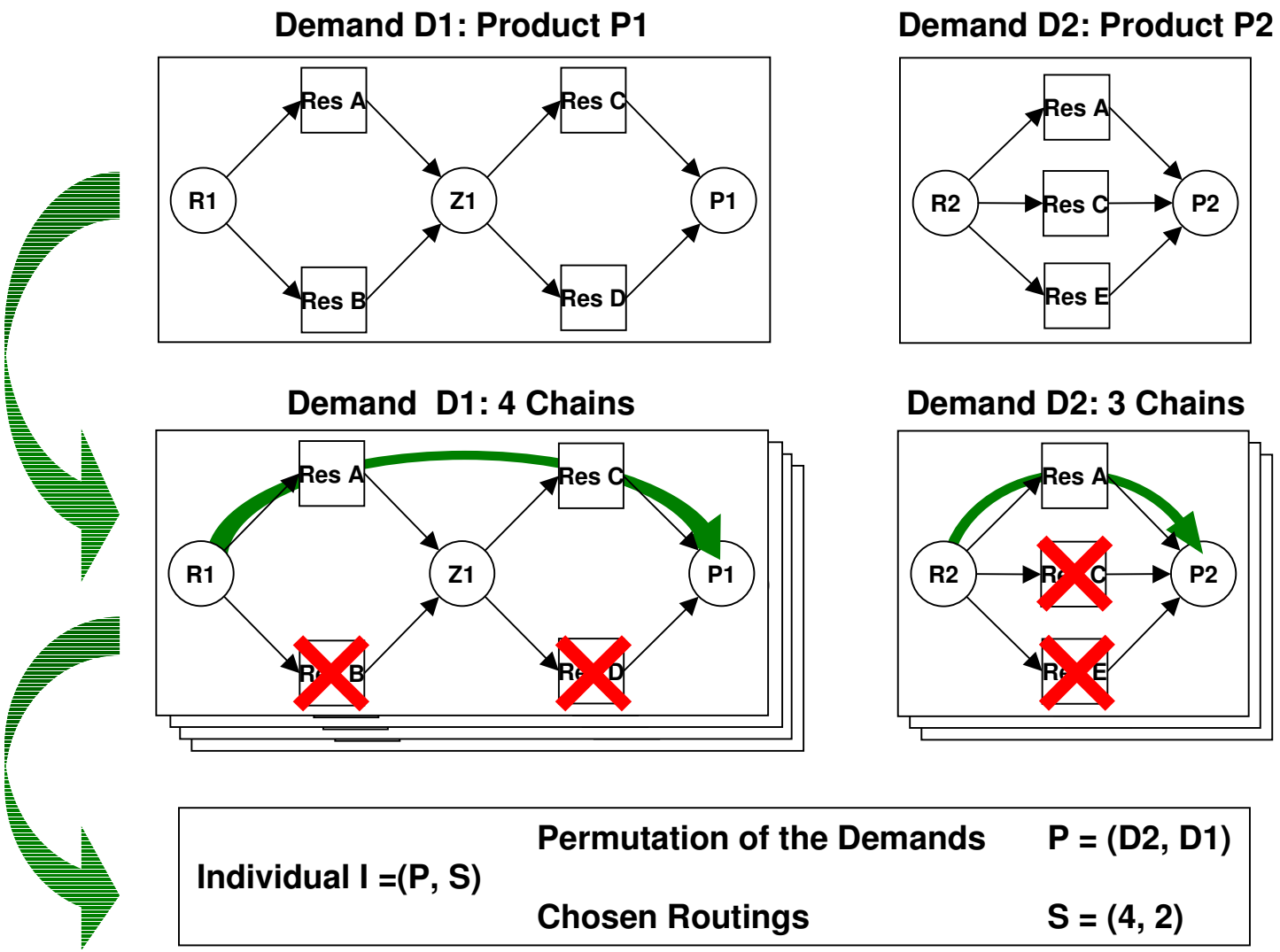
Higher degree of customer satisfaction

- Minimized due date violations through ATP/CTP



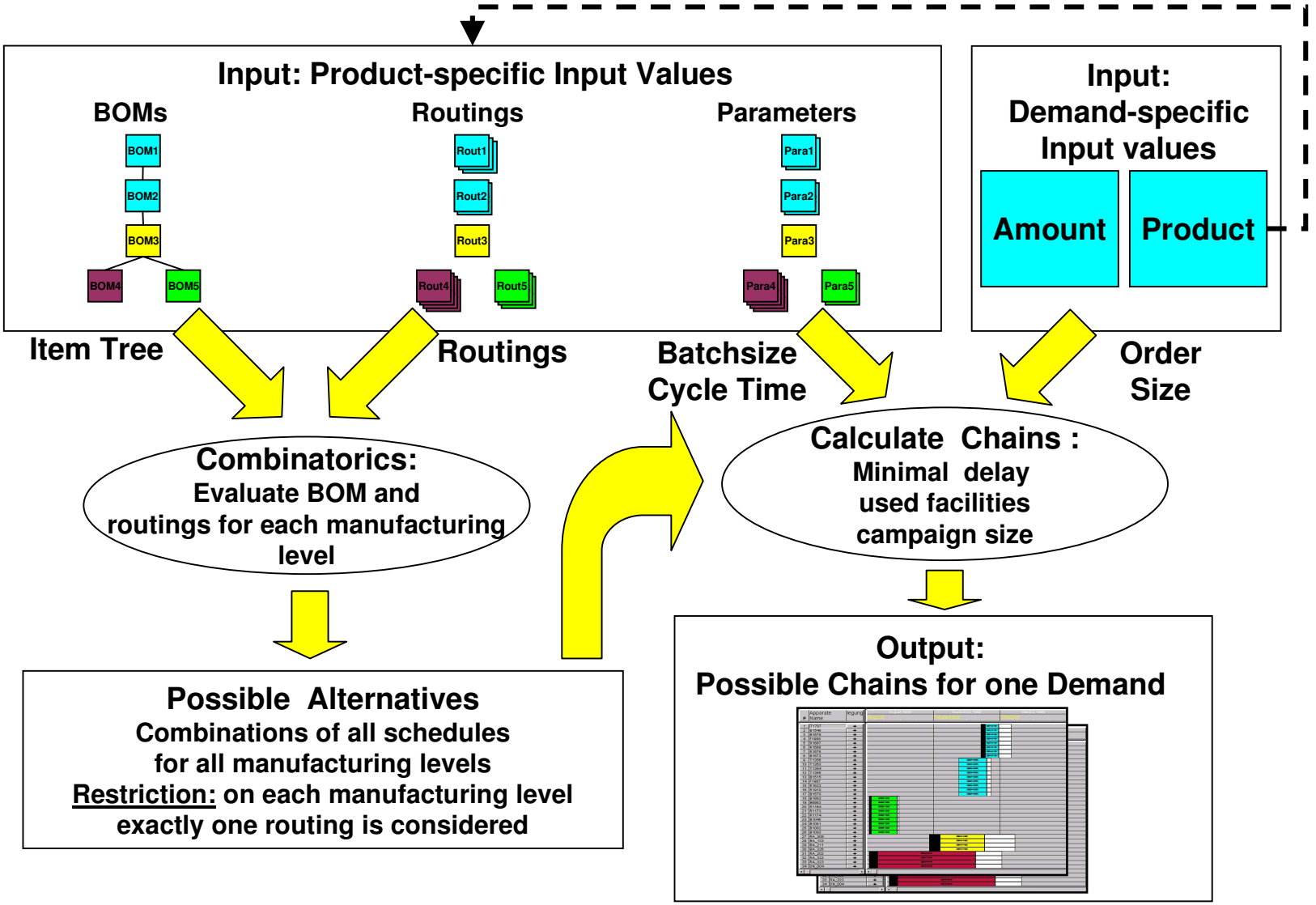
Transparency

Definition of an Individual, Example

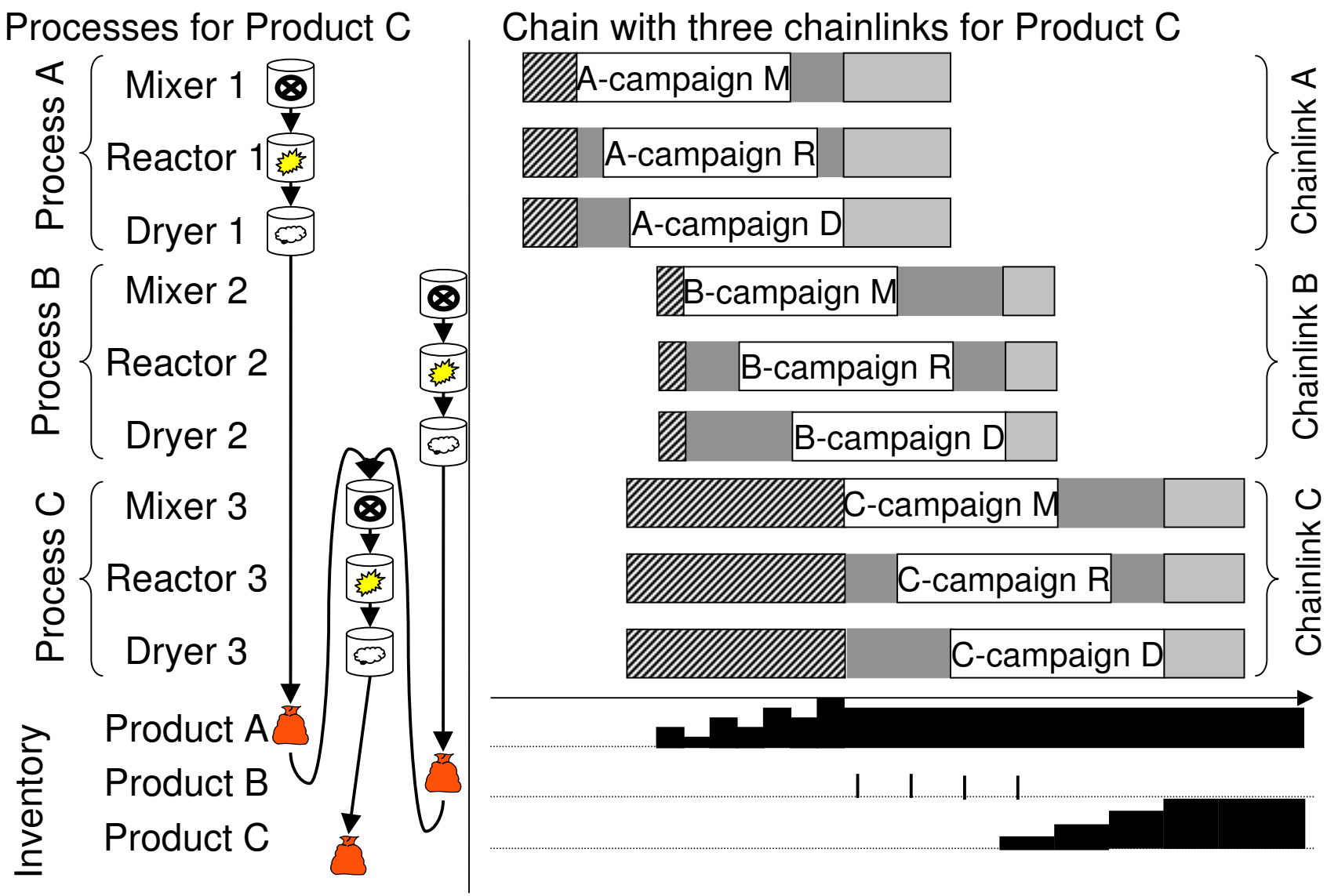


Individual I =(P, S)	Permutation of the Demands	P = (D2, D1)
	Chosen Routings	S = (4, 2)

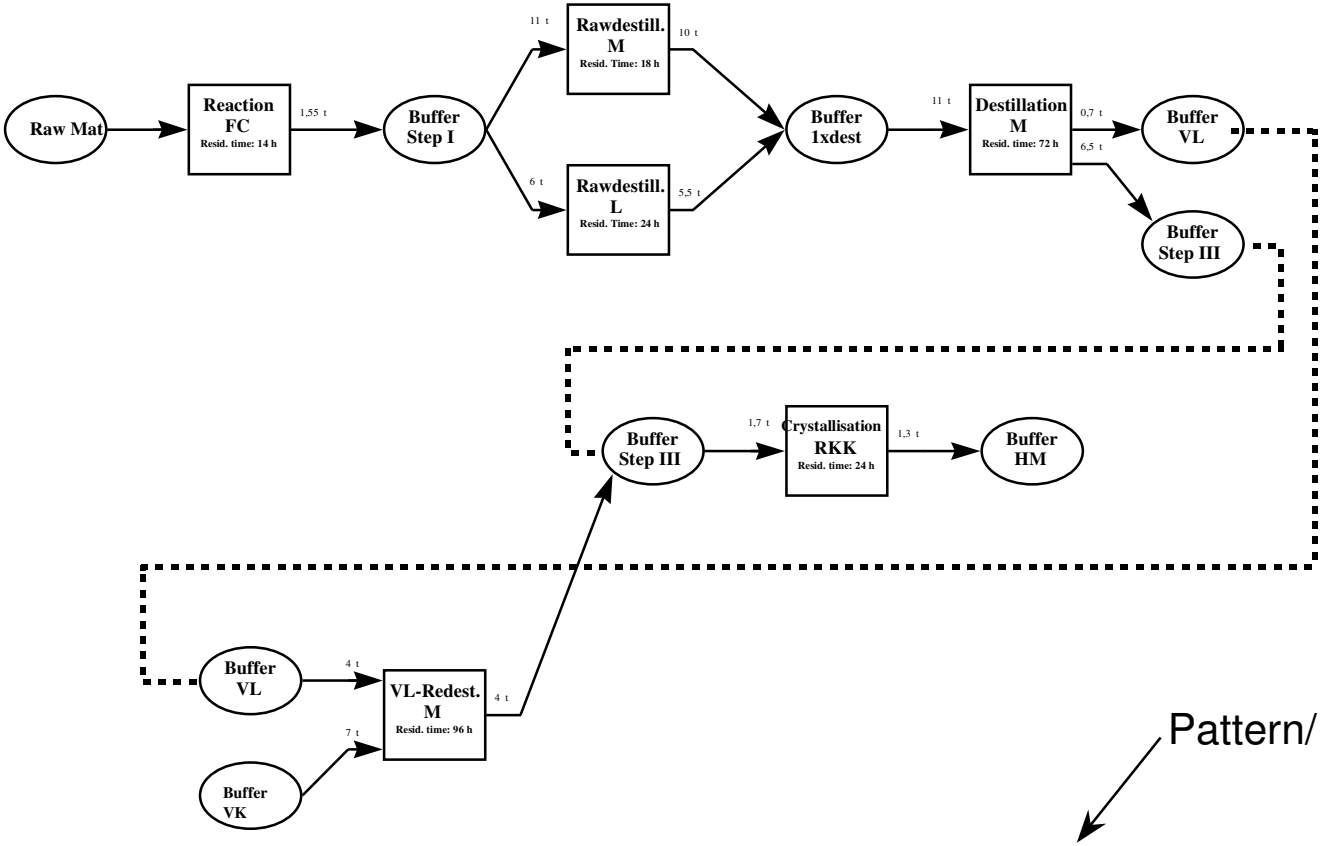
Chain Computation



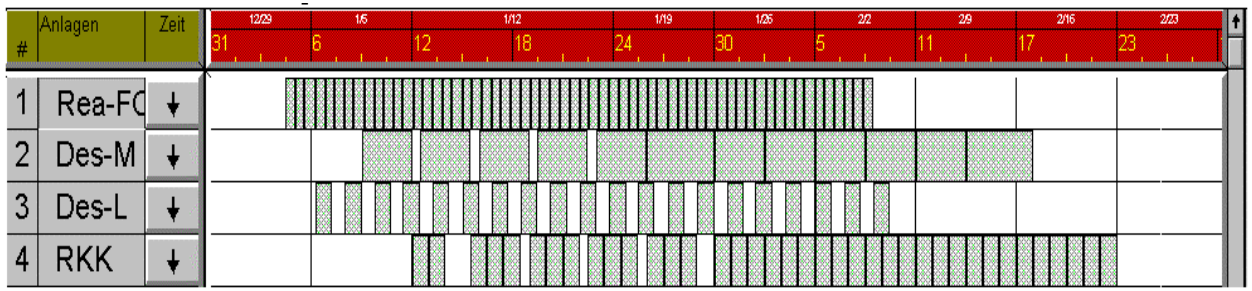
Chain Generation



Product (only one facility per synthesis step)

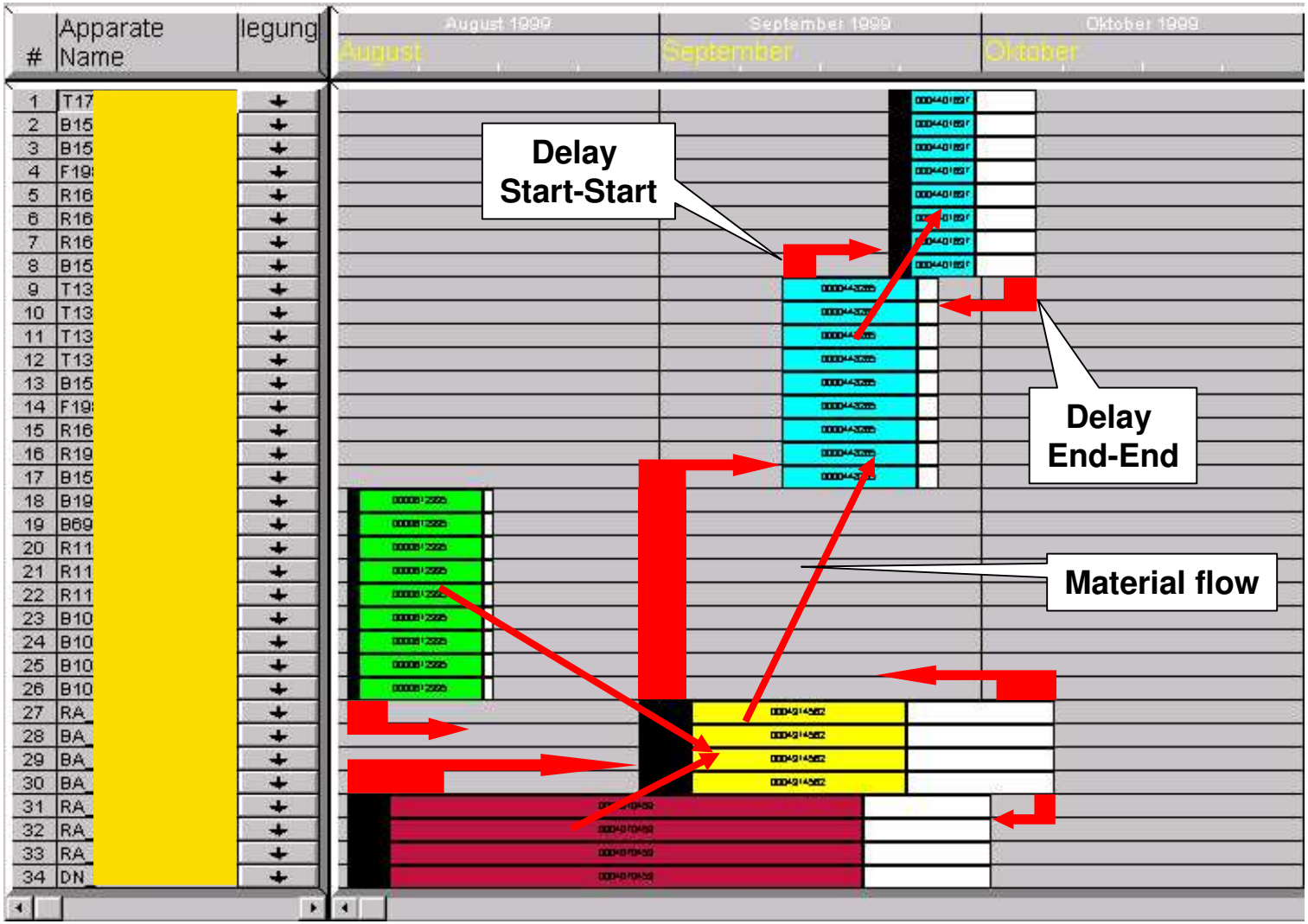


Pattern/ Chain

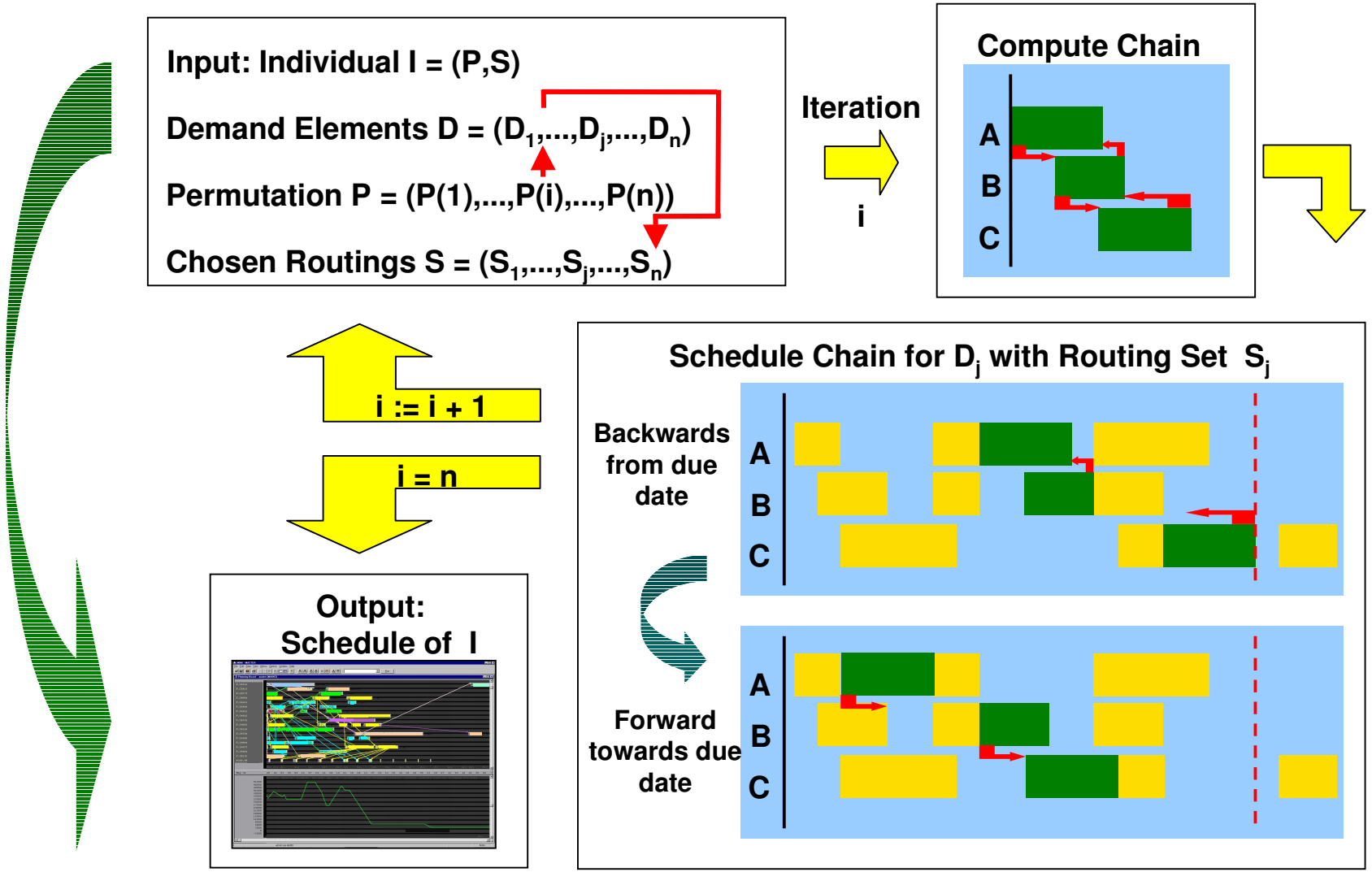


45 t
60 reactions
20 raw destillations
10 redestillations
2 redestillatins
38 crystallisations

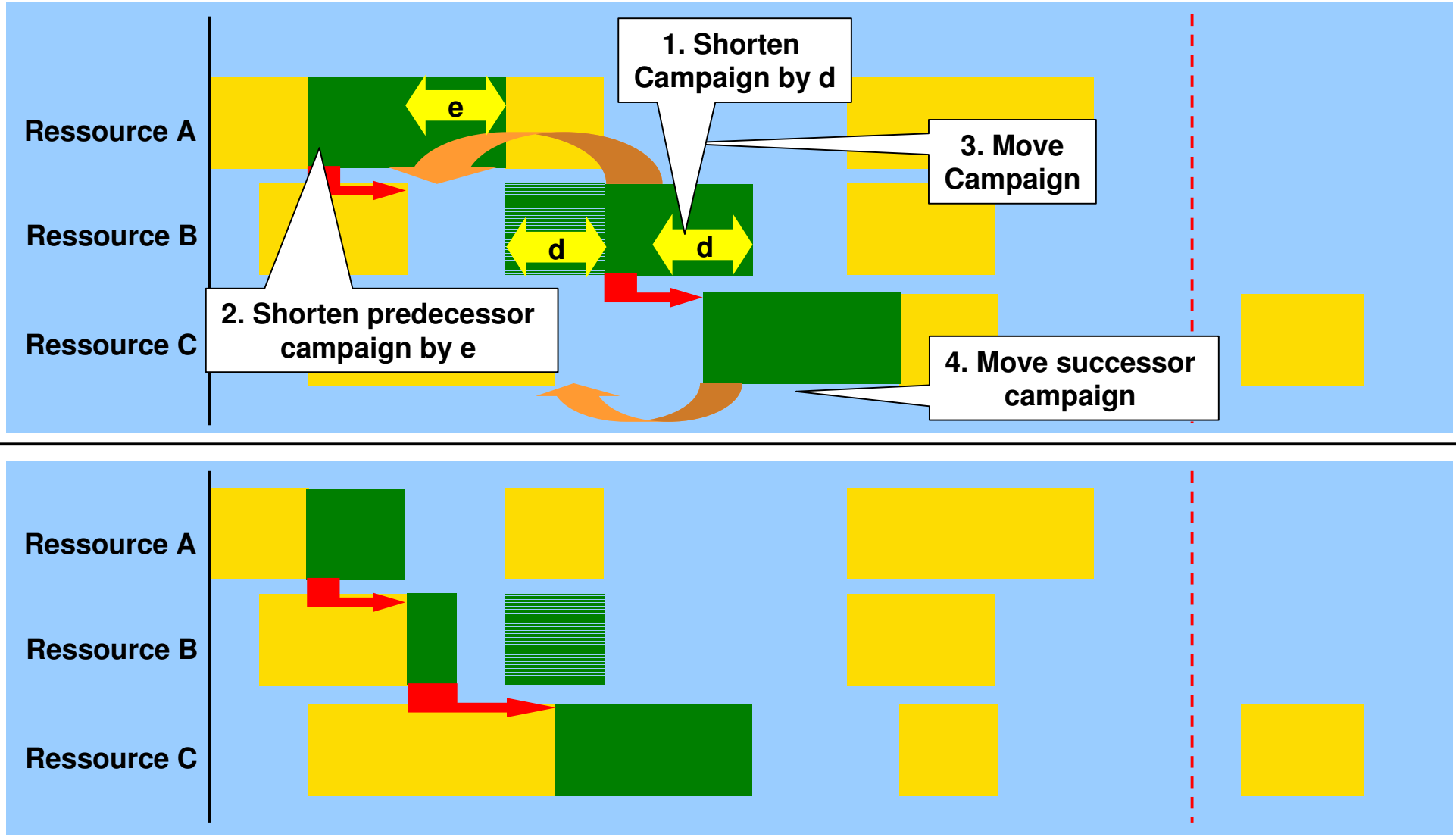
Example of a generated Chain



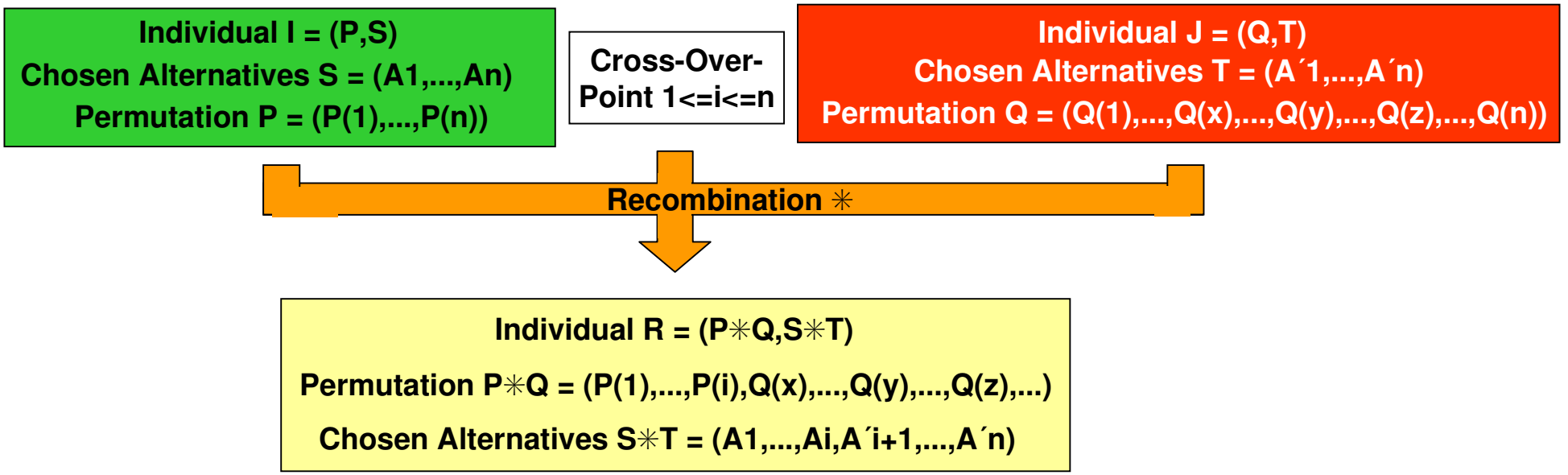
Chain Scheduling



Schedule Improvement



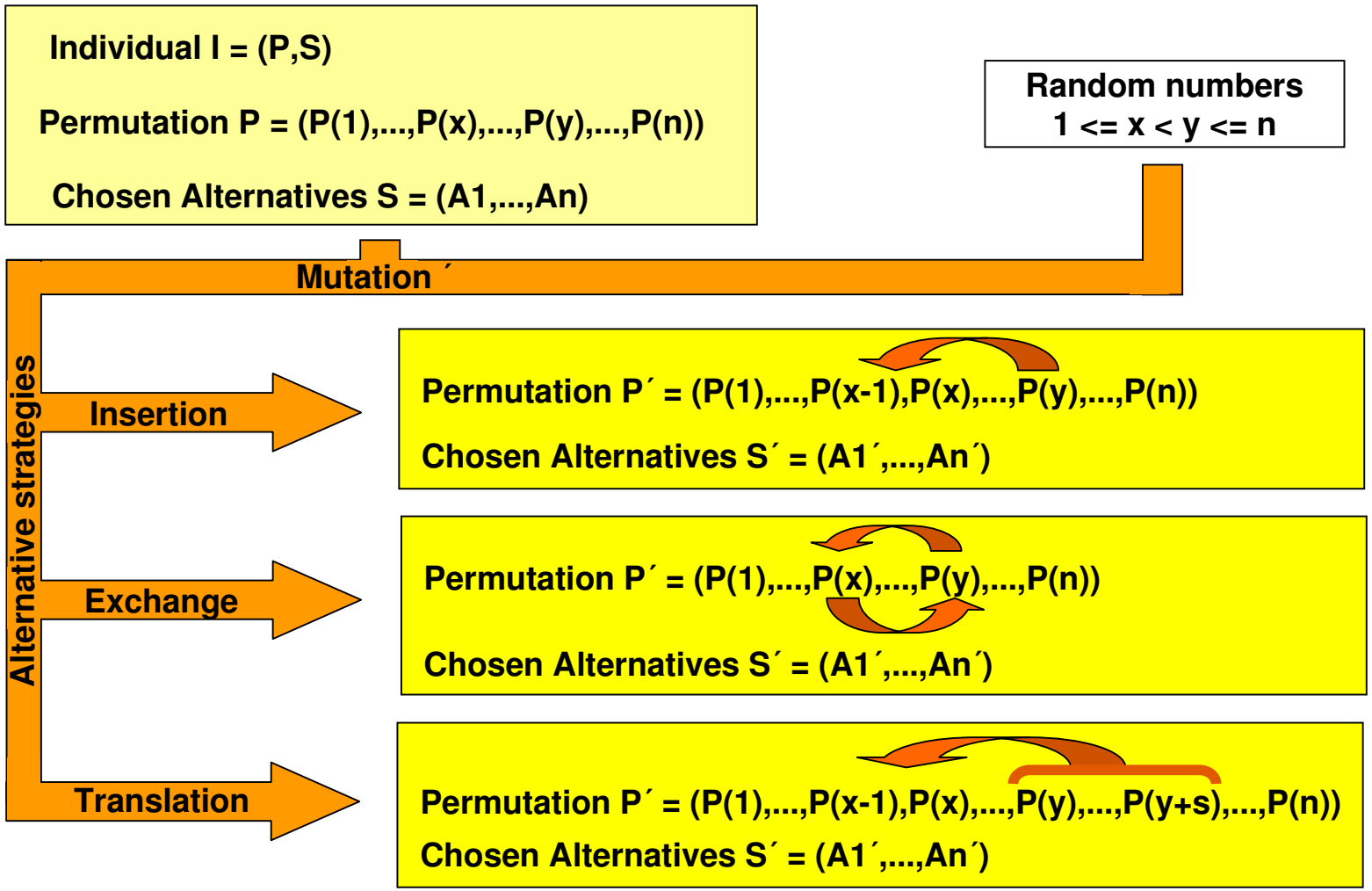
Generating New Individuals by Recombination



$$P{\ast}Q(j) = \begin{cases} P(j) & : j < i+1 \\ Q(k) \text{ with } k = \min\{x \mid 1<=x<=n,\ Q(x)<>P{\ast}\ Q(l) \text{ für } 1<=l<j\} & : \text{else} \end{cases}$$

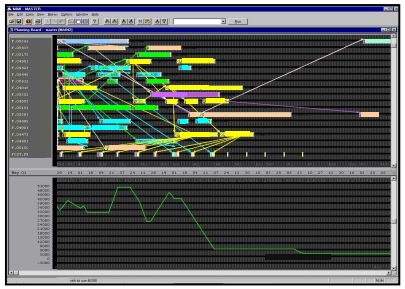
$$S{\ast}T(j) = \begin{cases} S(j) & : j < i+1 \\ T(j) & : \text{else} \end{cases}$$

Modifying a generated Individual by Mutation



Evaluation of the Individuals by Obtained Schedules

Input: computed schedule of Individual I = (P,S)



Input: Quality Criteria
Storage costs
set up & cleaning costs
due date violations

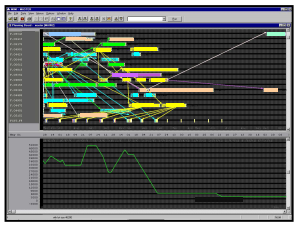
Corresponding:

Individual I = (P,S)

Schedu-

ling

Schedule of I



Evaluation of a Schedule

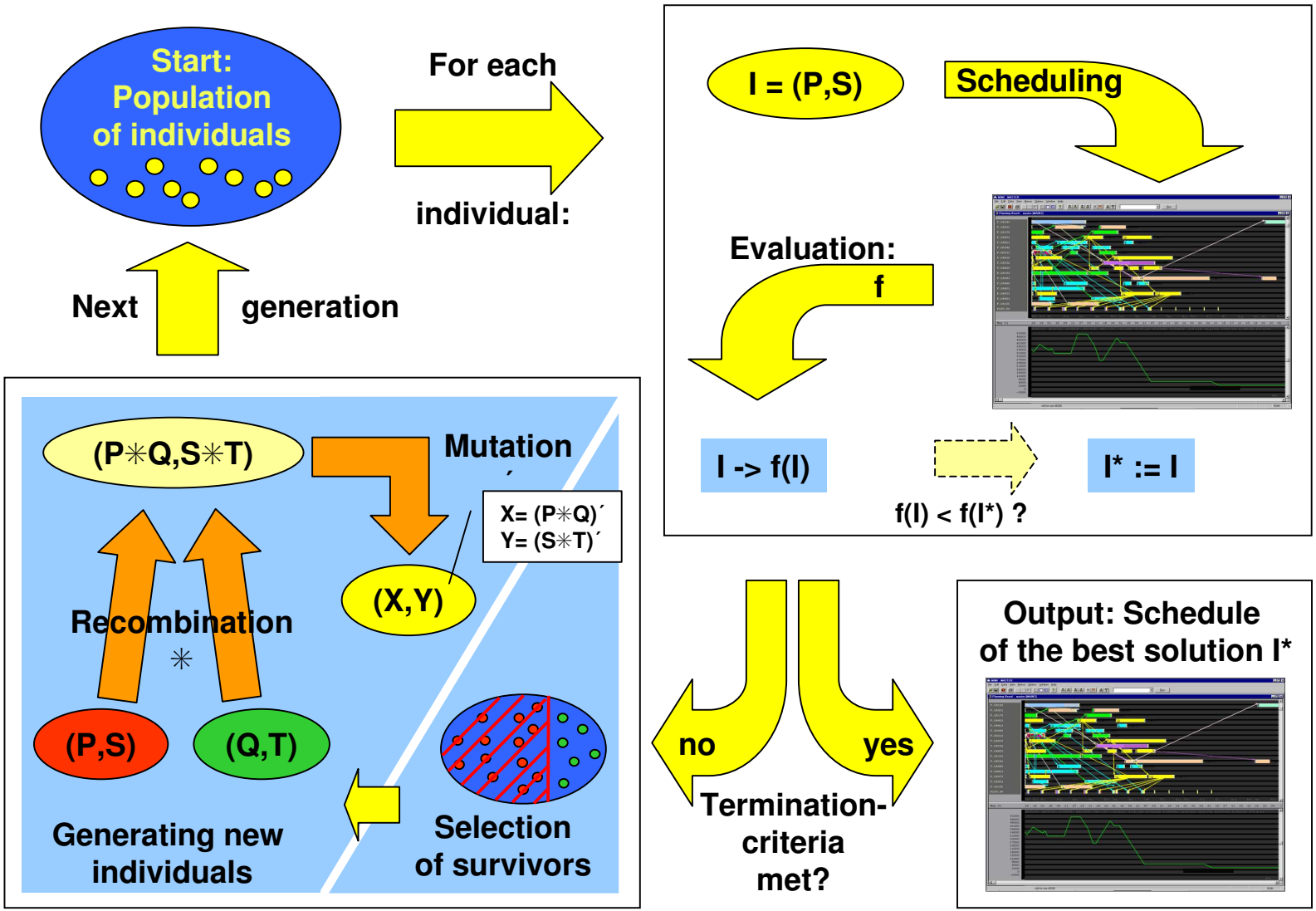
of Individual I by

defined Quality Criteria

Output: real number f(I)
Quality value of the schedule of Individual I

Output:
Real-valued objective function
f: I -> f(I)
defined on the Set of all Individuals I = (P,S)

EvoPlan Algorithm



Optimizer EvoPlan

Target function:

$$f = \min \sum$$

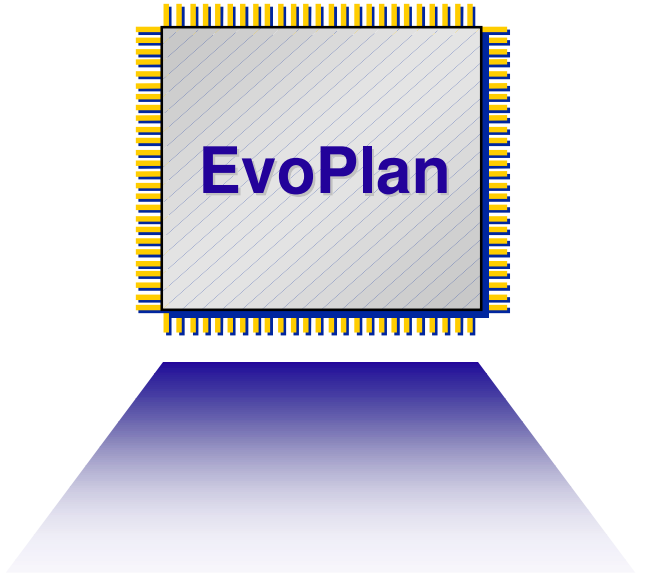
- Warehouse costs
- Penalties for due date violations
- Setup and cleanup costs

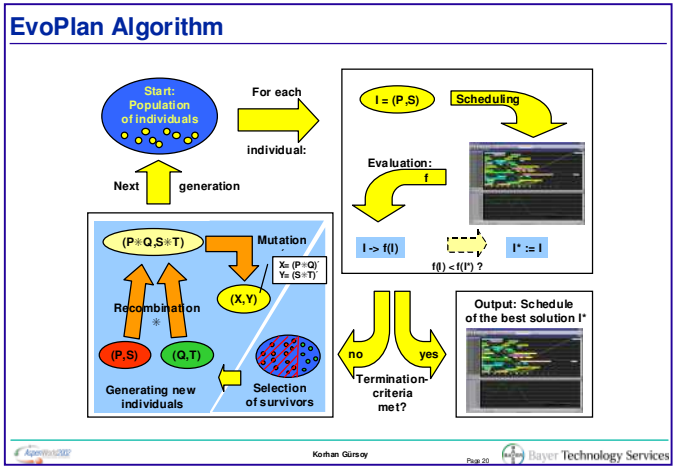
Model constraints:

- Resource priorities
- Max. and min. lot sizes
- Frozen activities
- Shutdown and breakdowns
- Initial inventories

Optimization based on:

- Genetic algorithms





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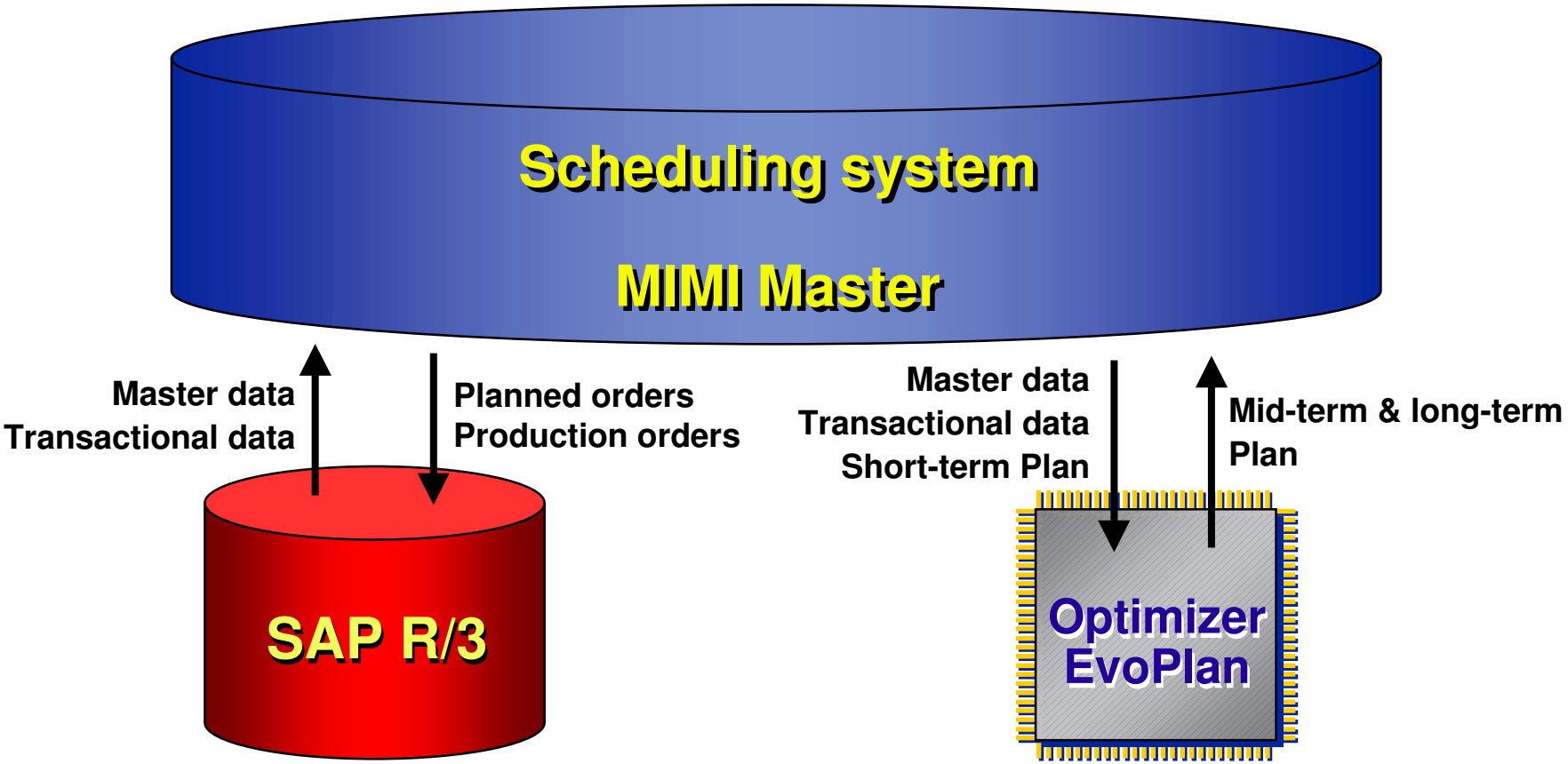
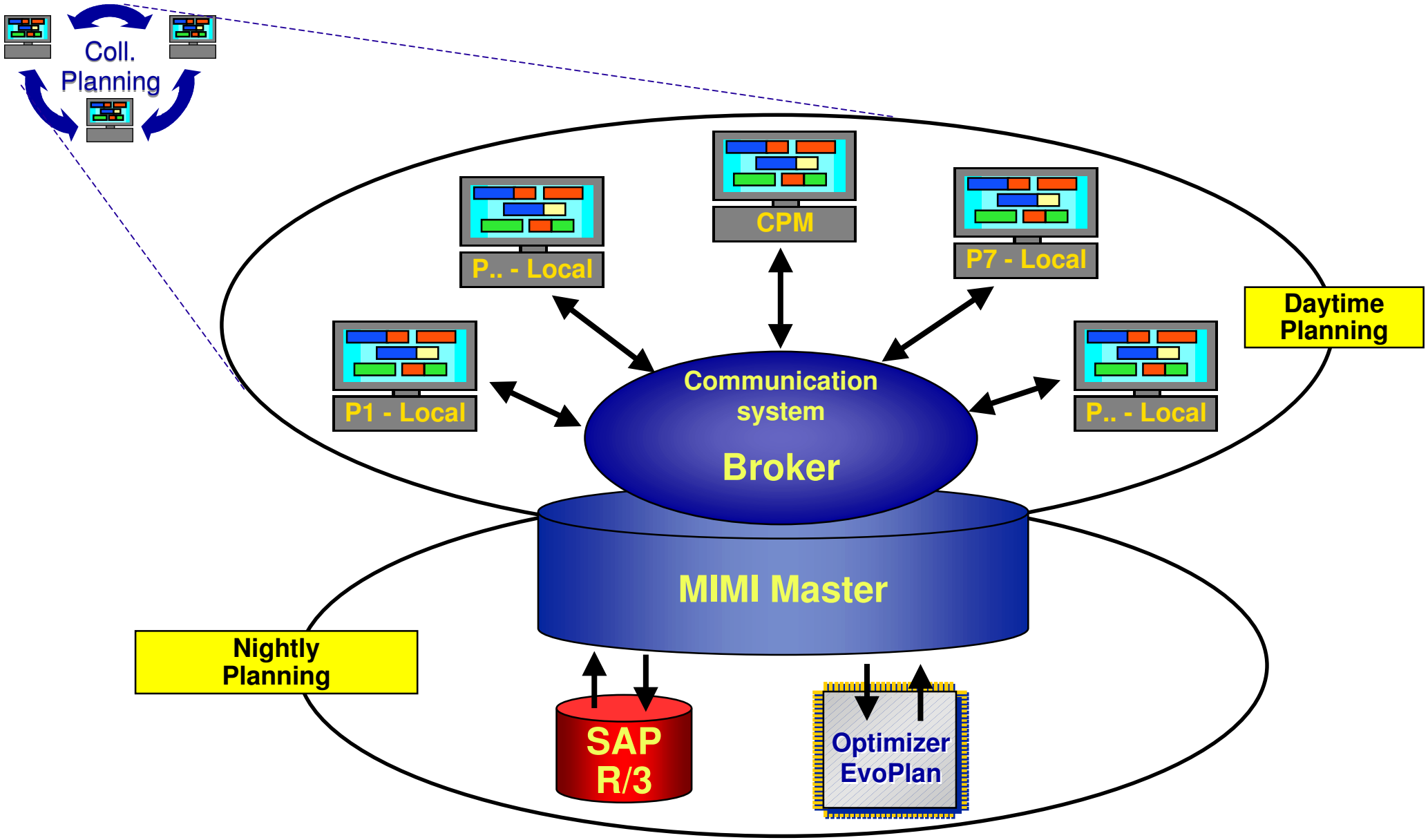
SAP + MIMI + EvoPlan



Collaborative Planning



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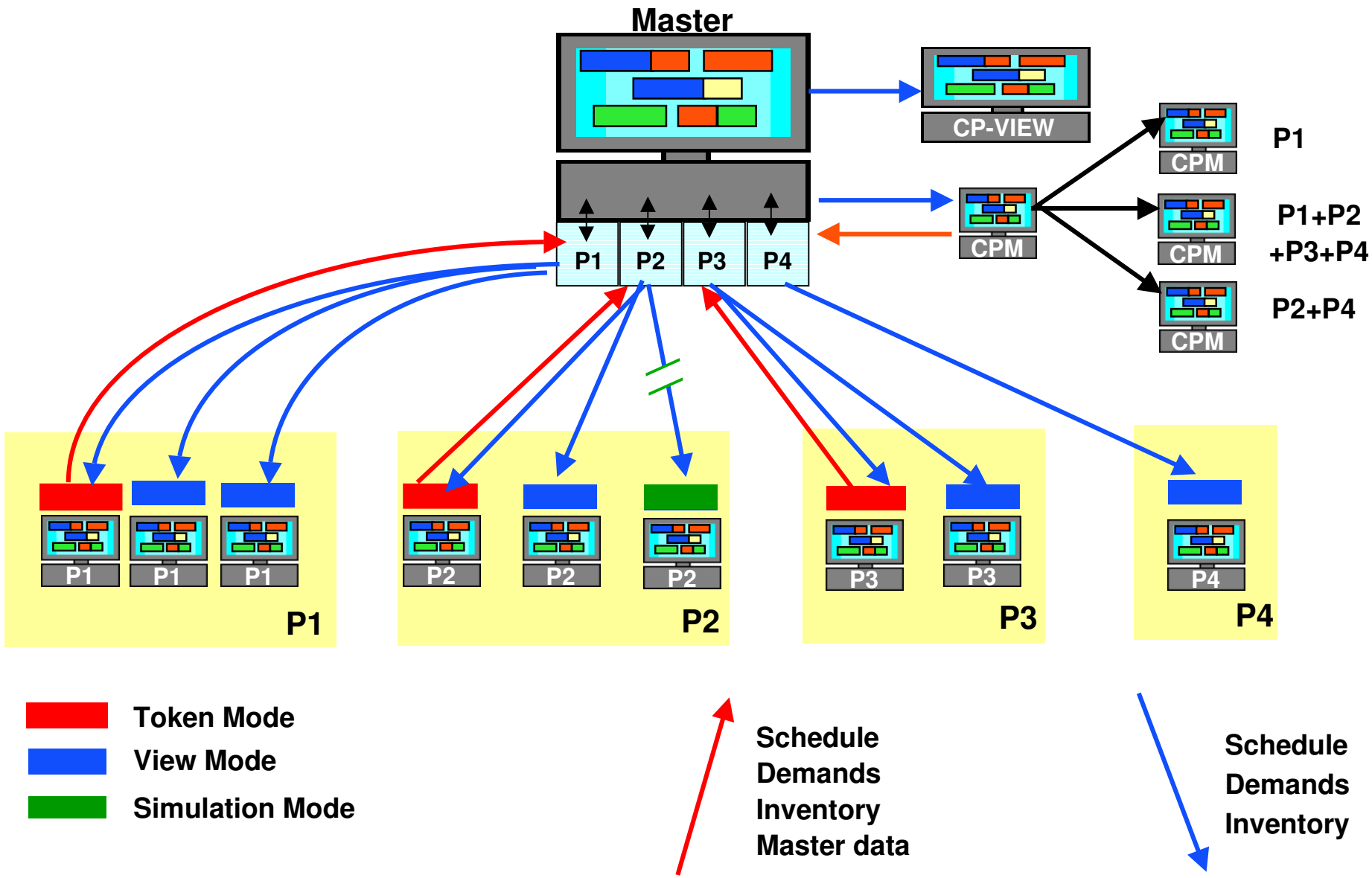
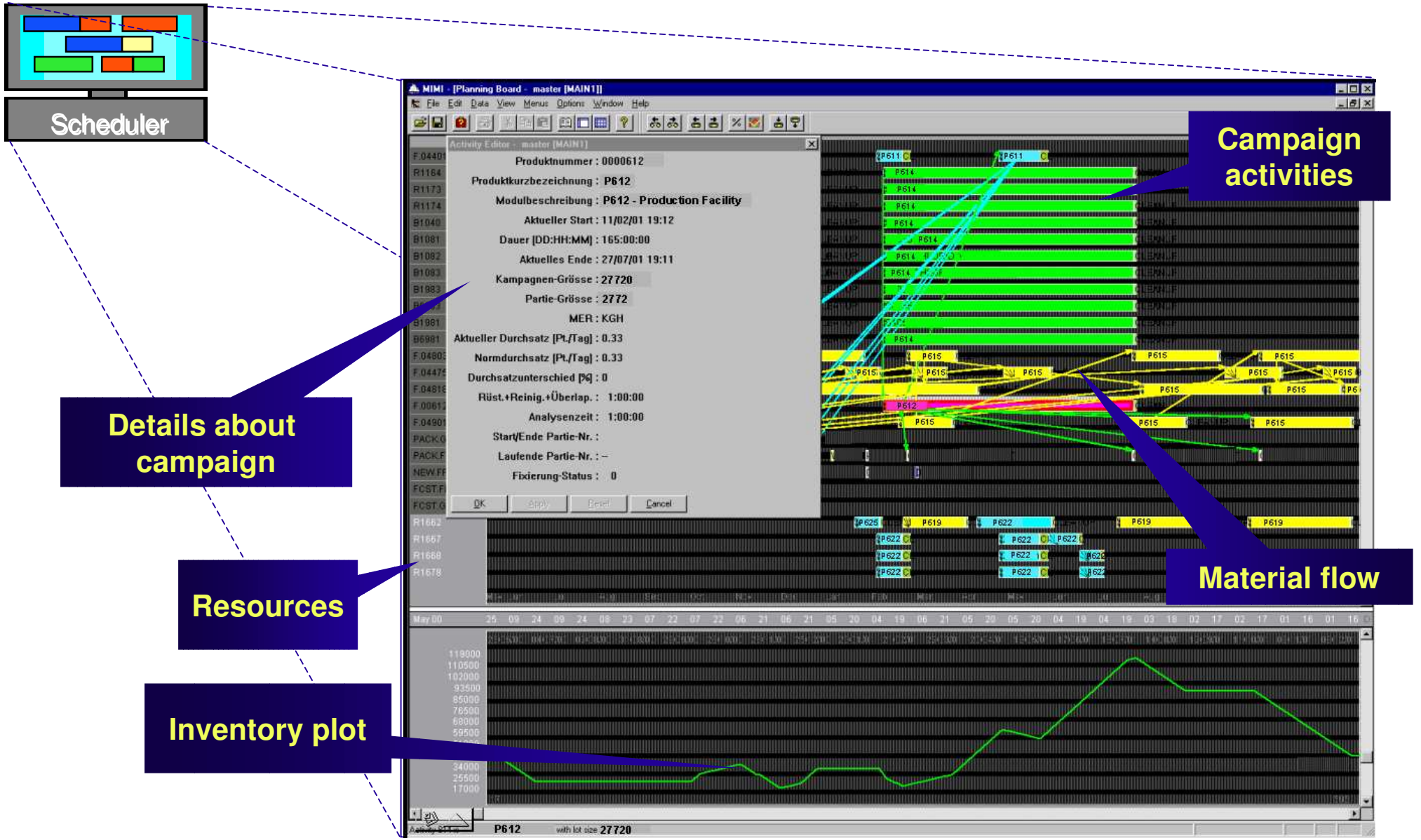
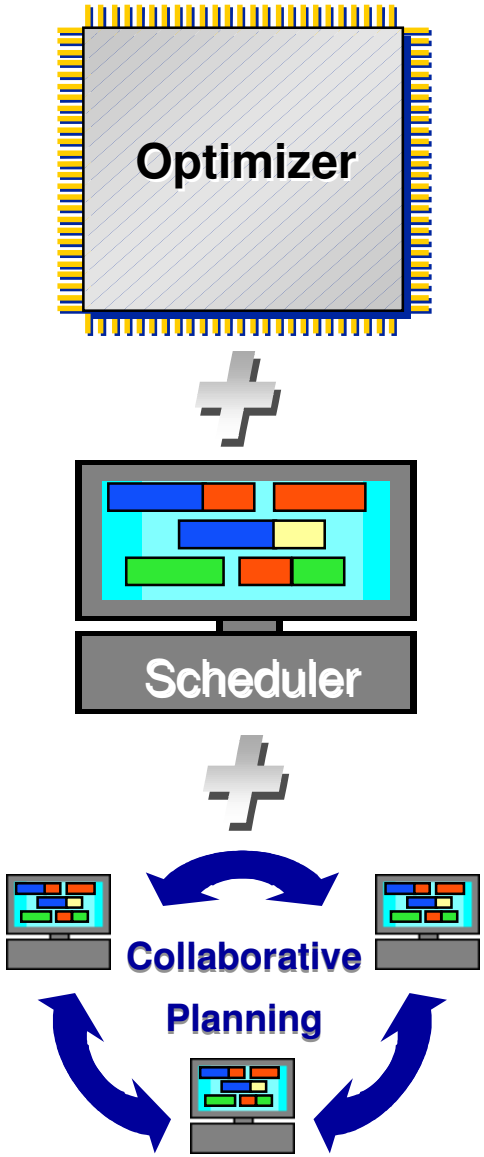


Planning Tool



„3-in-1“ Integrated Solution Approach



Genetic algorithm based optimizer

In-house development: EvoPlan

User-friendly tool for manual updates

Toolbox: Aspen MIMI™

Mechanism for collaborative planning

Environment: Windows NT® / 2000®

Toolbox: Aspen MIMI™

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Positive Observations

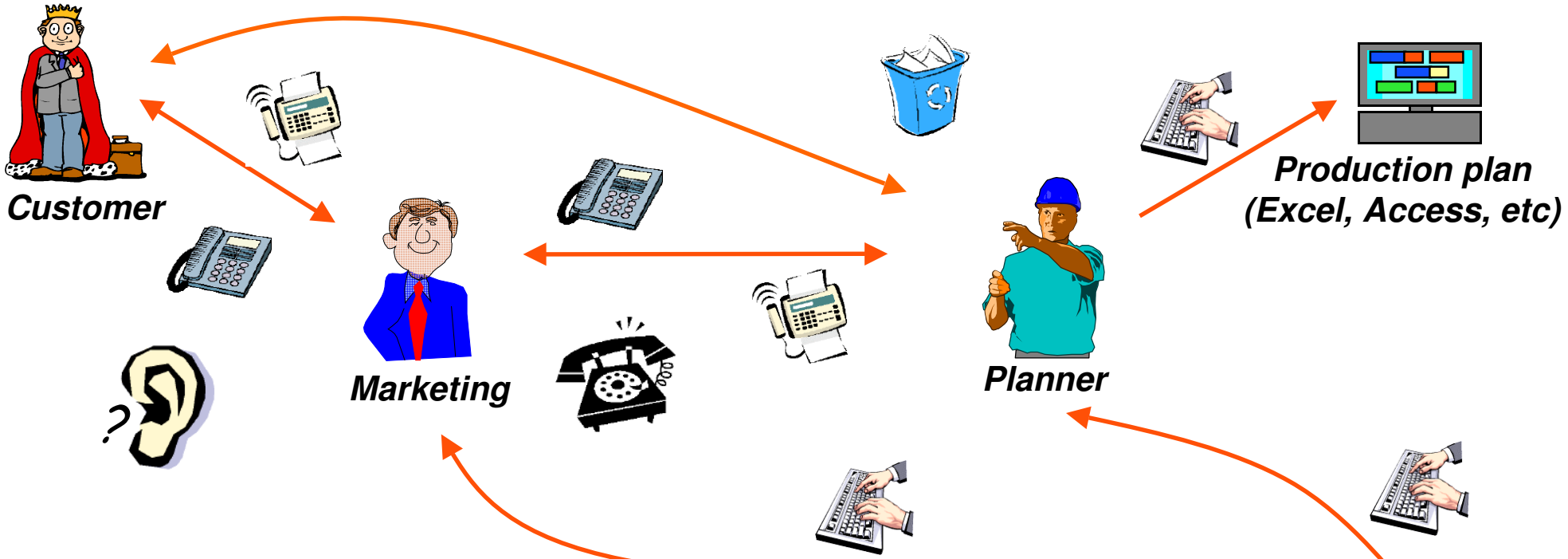
„However beautiful the strategy, you should occasionally look at the results.“

W. Churchill

- ✓ Early diagnosis leads to best treatment: **Due date violations avoided**
- ✓ Correct information is power: Global use **reduces inventory** levels
- ✓ Better overview of customer orders and purchase orders **reduces idle time**
- ✓ Better and quicker manual planning **reduces planning effort** in plant
- ✓ Quick response through ATP/CTP **increases customer satisfaction**

*High level of **Transparency** makes life of a planner much easier*

Information Flow before Project

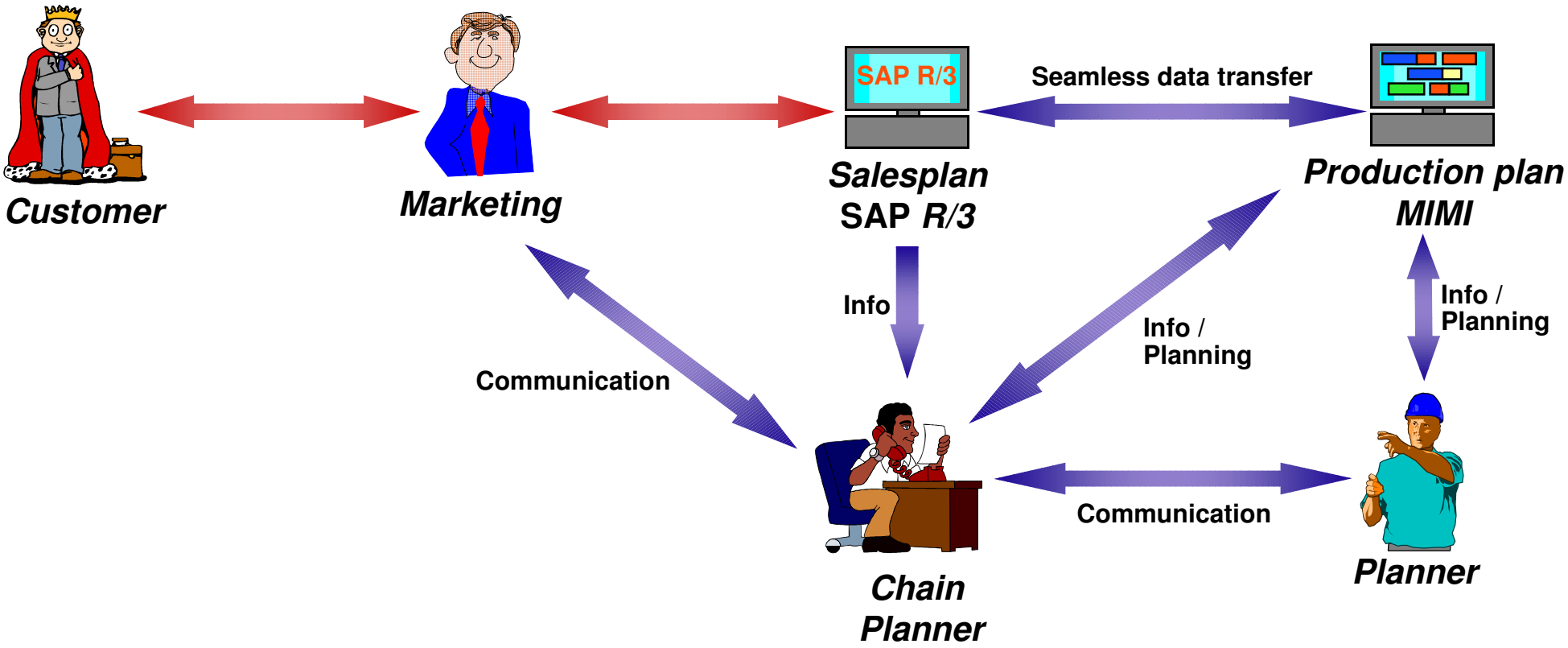


Communication time consuming

Crucial information lost at each step

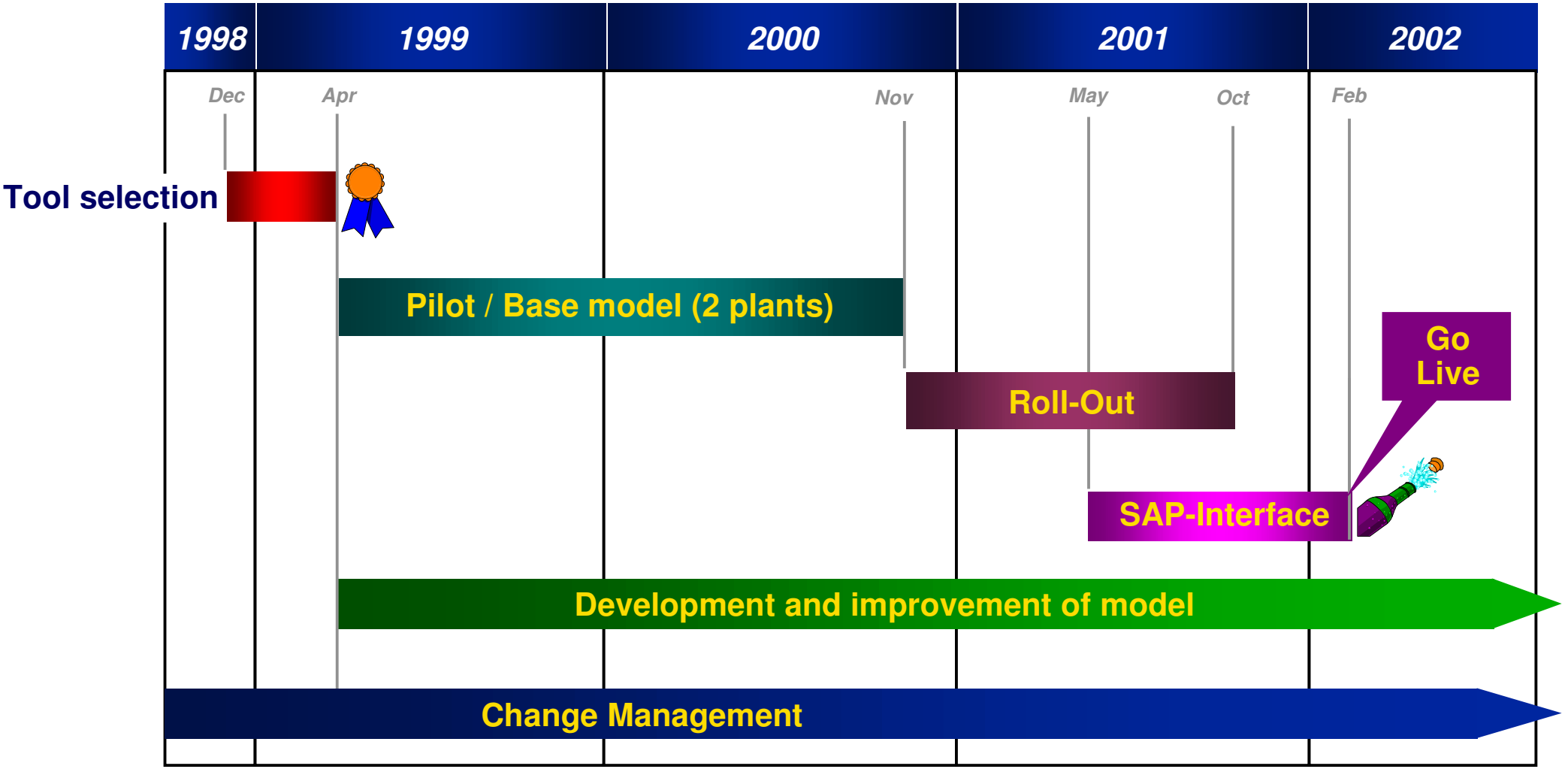
Information flow too confusing

Information Flow after Project



Seamless data transfer + Clearly defined flow of information + Transparent planning

Milestones



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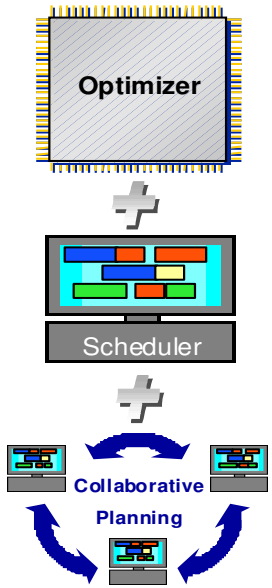

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