

Part II

OVERVIEW OF INDUSTRIAL MPC TECHNIQUES

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Chapter 1

INTRODUCTION TO MODEL PREDICTIVE CONTROL

1.1 BACKGROUND FOR MPC DEVELOPMENT

Two main driving forces for a new process control paradigm in the late 70's
~ early 80's:

- Energy crisis + global competition + environmental reg.



- process integration
- reduced design / safety margin
- real-time optimization
- tighter quality control



higher demand on process control.

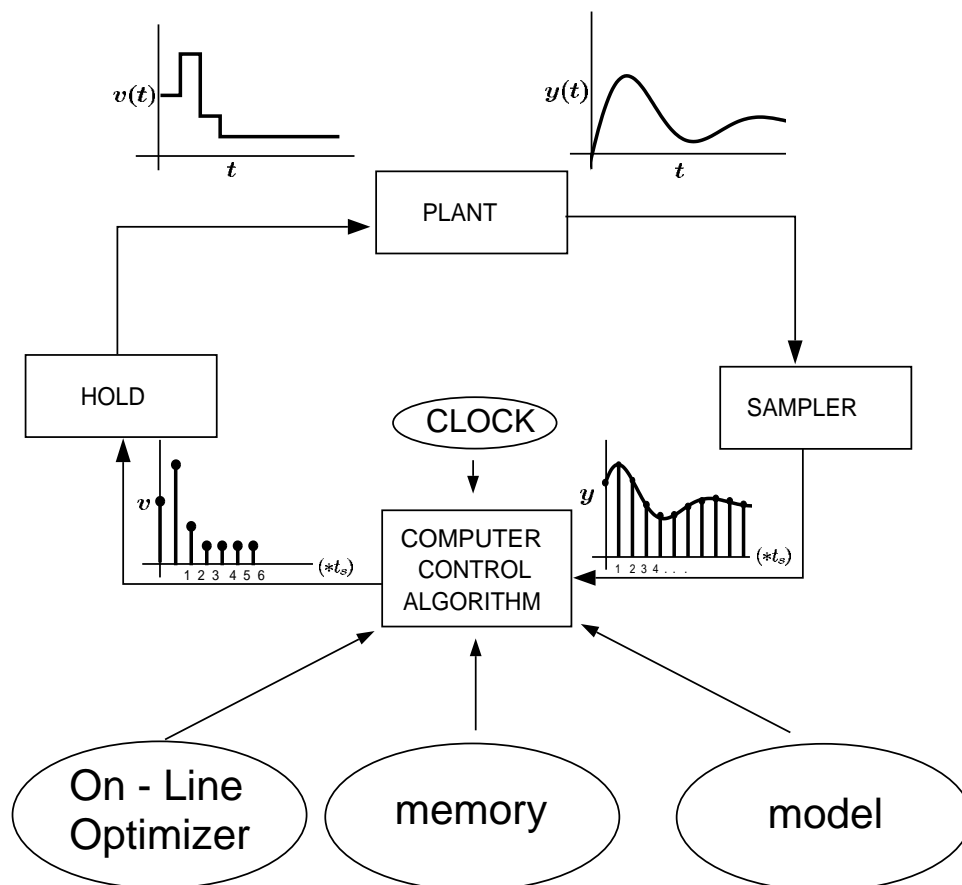
- (Remarkable) advances in microprocessor technology.

- cheap, fast and reliable medium for implementation.
- network environment(e.g., DCS) conducive to hierarchical approach.

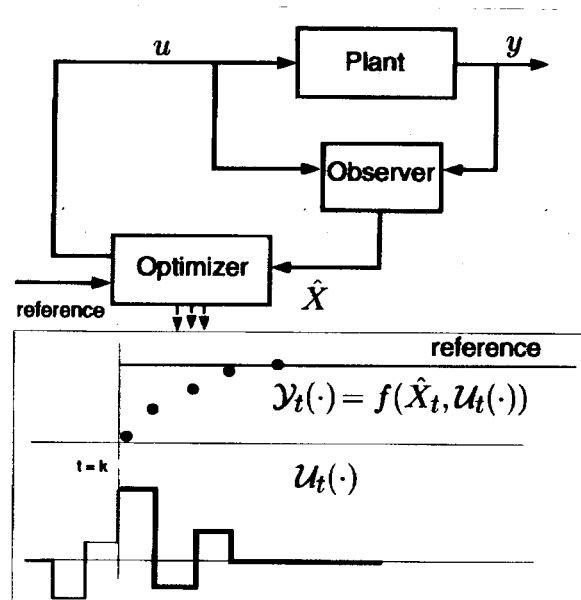
Industry's response \Rightarrow MPC

1.2 WHAT'S MPC

It's a computer control system.



It's a computer control system consisting of an observer & an optimizer.



$$\min_{u_t(\cdot)} \int_t^{t+p} l_1[\text{Error}(\tau)] + l_2[\text{Input}(\tau)] d\tau$$

$$u(\cdot) \in U, \mathcal{Y}_t(\cdot) \in Y$$

The optimization is based on prediction of future behavior of y.

MPC (software packages) is sold under different names:

- DMC (Dynamic Matrix Control, now AspenTech)
- IDCOM (Setpoint, now AspenTech)
- SMCA (Setpoint, now AspenTech)
- RMPCT (Honeywell)
- PCT (Profimatics)

- HEICON (Adersa)
- OPC (Treiber)
- MAC
- IMC
- GPC
- GMC
- UPC
- \vdots

It's major features are

- model based
- *explicit* prediction of future system behavior
- *explicit* consideration of constraints
- use of on-line mathematical programming
- receding horizon control : repeated computation of open-loop optimal trajectory with feedback update \Rightarrow implicit *feedback* control.

1.3 WHY MPC?

Difficult elements for process control:

- delay, inverse response
- interaction