Autonomic Approach to Planning and Scheduling in Networked Small Factories

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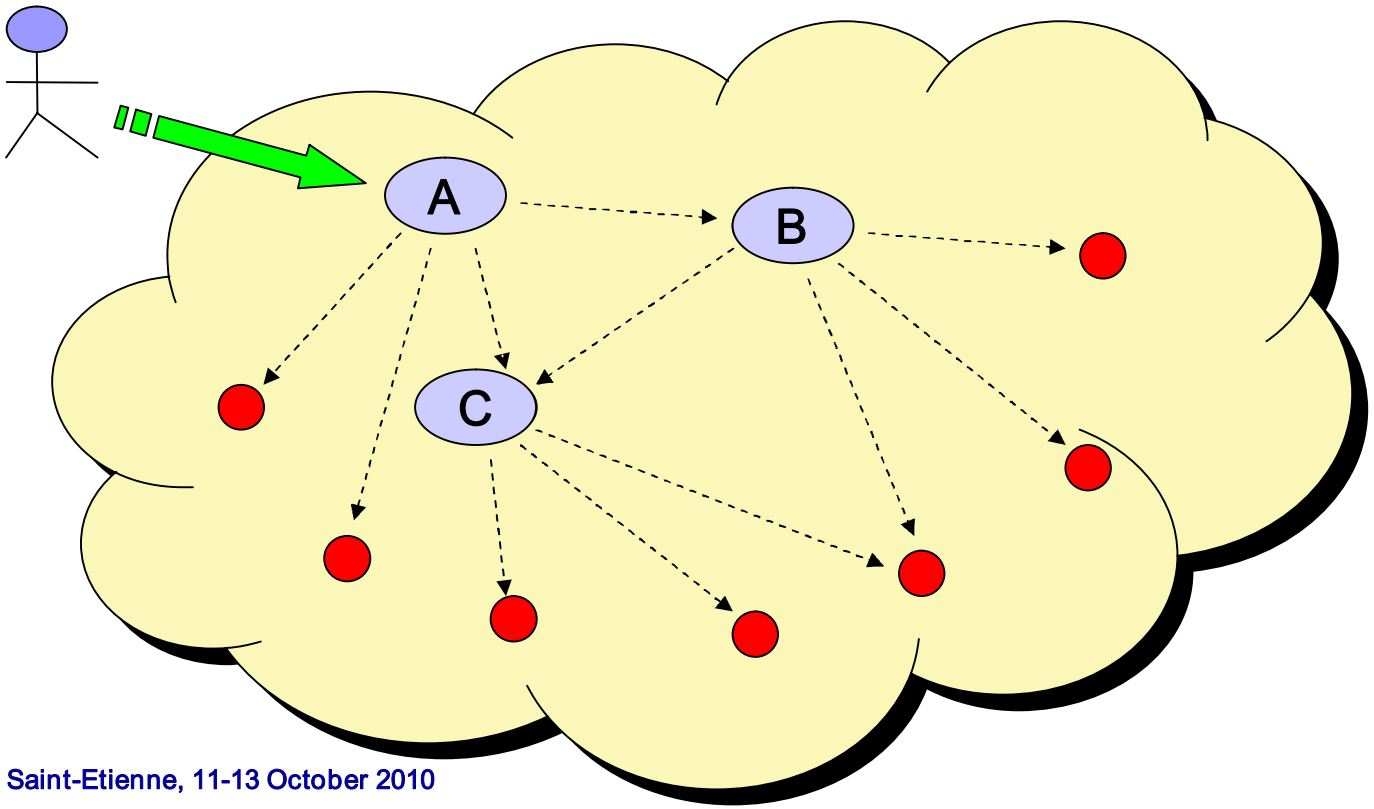
Outline

- Business ecosystem
- Company behaviour
  - As leader
  - As supplier
- Autonomic computing
  - Why autonomic computing
- The showcase

Business ecosystem

- Legend
  - Order from outside to one company in the business ecosystem
  - Supply chain lead in the business ecosystem
  - Supplier of products / services in the business ecosystem
- A company can act as a leader or supplier

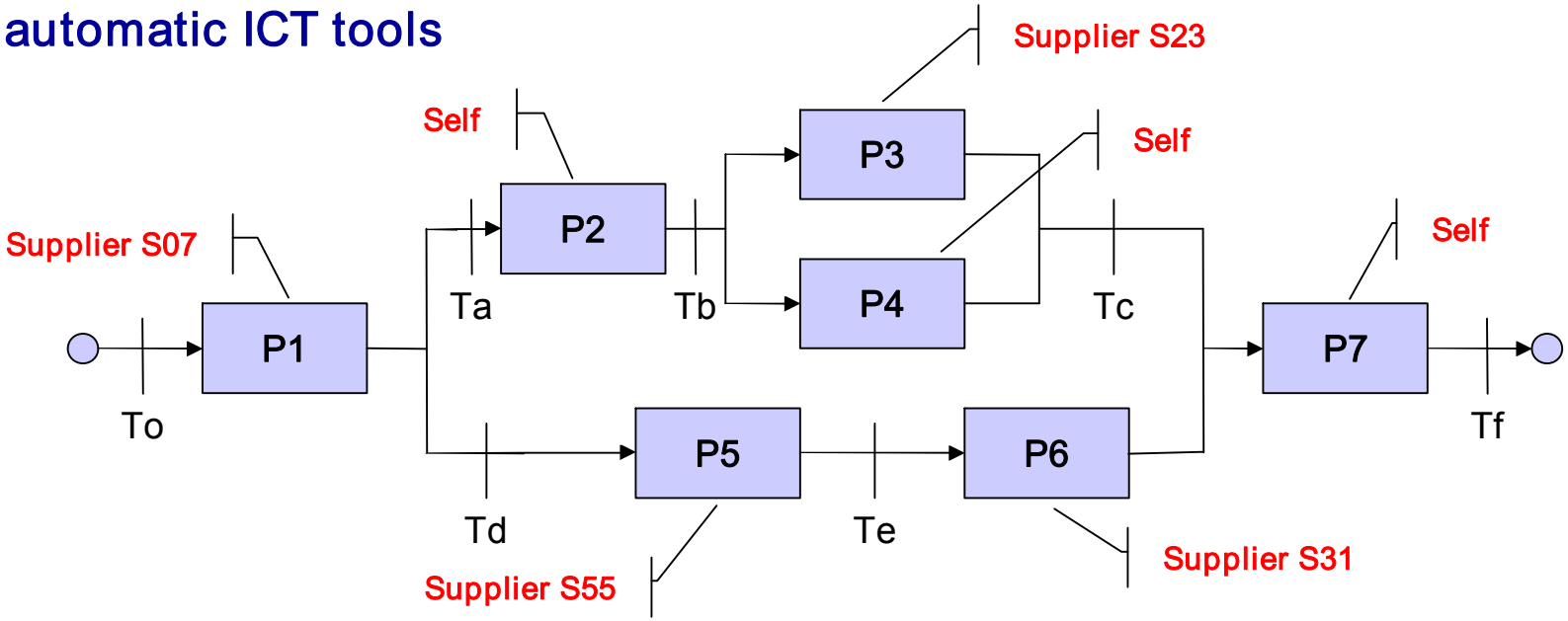


Company behaviour as leader

- Plan the best distributed process
  - Choose between make or buy alternatives for some activities
  - Select the most convenient suppliers for other activities
  - Ultimately, build up the preferred process configuration
- Confirm cost and delivery time
  - To the customer, if consistent with the planned process
  - Otherwise counterpropose affordable solutions
- Trigger and monitor the process
  - By sending operational orders to the selected suppliers
  - And performing internally the other activities
  - While checking the achievement of major milestones
- Handle possible exceptions
  - Coming from the customer
  - Coming from the supply chain
  - Coming from the internal shop floor

Distributed process planning

- For every combination of suppliers
  - Computation of total lead time and total cost
  - Plus computation of start and end time of each activity
- Selection of the most convenient configuration
  - By applying a proper policy (e.g. shortest lead time or lowest cost)
  - And then selecting the suppliers to whom assign tasks
- Reaching the optimal solutions is hard without using appropriate automatic ICT tools

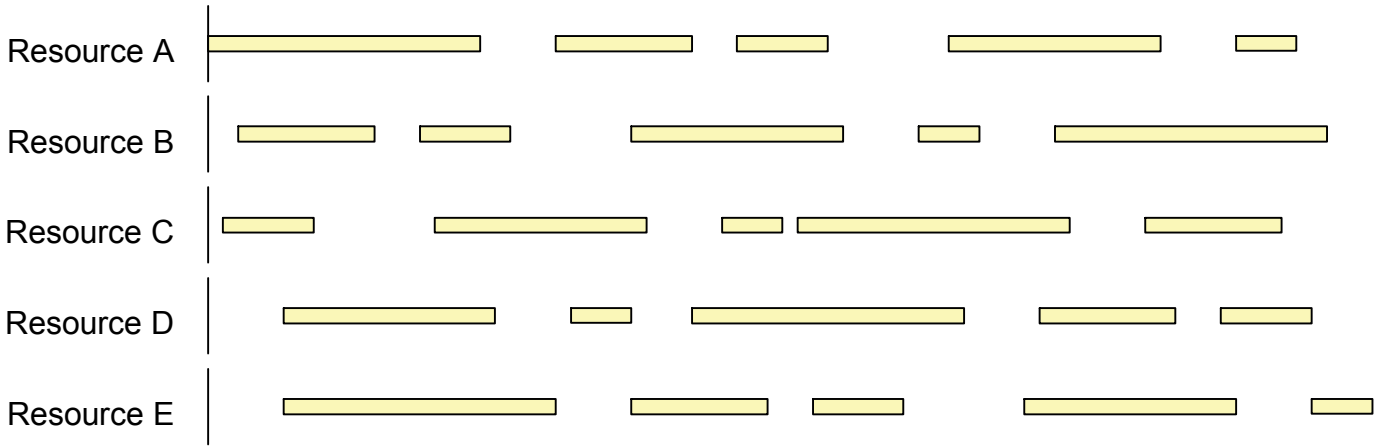


Company behaviour as supplier

- **Schedule internal activities**
  - Choose among alternative routings (if any)
  - Select the most convenient resource types among those available
  - Apply a finite capacity algorithm to allocate single resource instances
- **Confirm cost and delivery time**
  - To the customer, if consistent with the planned process
  - Otherwise counterpropose affordable solutions
- **Execute and monitor the shop floor work**
  - By assigning tasks to internal resources
  - While checking the achievement of major internal milestones
- **Handle possible exceptions**
  - Coming from the customer
  - Coming from the internal shop floor

Internal process scheduling

- Adopt the most convenient schedule
  - By applying the preferred policy
  - And consequently book the involver resource instances
  - On their respective work calendars
- Optimise resource allocation
  - To reduce or remove resource idle times
  - Or to overcome changes in resource availability



Autonomic computing & system

- Autonomic Computing Initiative
  - Launched by IBM in 2001
  - Automating low level tasks
  - Adjective taken from autonomic nervous system
  - Dynamic adaptation and reorganization to the new needs of the users
- Autonomic System
  - Self-Configuration
  - Self-Optimization
  - Self-Healing
  - Self-Protection

Why autonomic computing /1

- Current situation in planning (self-configuration)
  - Manual (intuitive) procedures taking some days
  - Many phone calls and negotiations, waiting for supplier answers
  - Impossible to evaluate all alternatives
- Current situation in scheduling (self-optimization)
  - Manual (intuitive) procedures taking some hours
  - Approximate estimation of time
  - Approximate estimation of cost
- Current situation in exception handling (self-healing)
  - Late detection and always manual management
  - Often propagation of perturbations up to the final customer
- Analysis of past performance (self-protection)

Why autonomic computing /2

- Relieve companies from hard tasks
  - They don't like to divert resources from core business
  - They wish to assure fast response to customers
  - They wish to accurately estimate time and cost
  - They wish to choose the most convenient configuration
  - And recover fast delays and problems on resources
- The smaller they are the more they need
  - Although they don't know it … yet

The textile cluster case

- Ten companies in the Carpi district
  - Providing textile services
  - E.g. prototyping, knitting, …, finishing, ironing, packaging
  - Covering most of the productive cycle phases
  - Looking for new customers and markets
- For further information
  - luca.martinelli@unimore.it
  - www.softlab.unimore.it >> our University laboratory
  - www.ebest.eu >> the European project developing this technology

Exception handling

- From the upper level
  - Customer asks for earlier delivery time
  - Customer proposes a later delivery time
  - Customer changes the order quantity (or cancels the order)
  - The company tries to damp down alone the perturbation otherwise propagates below
- From the lower level
  - Supplier declares a delay on an assigned task
  - Supplier declares a loss of materials
  - The company tries to damp down alone the perturbation otherwise propagates above
- Internal in the company
  - Problems occur in the shop floor
  - Typically changing the availability of resources
  - The company tries to damp down alone the perturbation otherwise propagates above