CombineNet

Tomasz P. Michalak

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Introduction - Sourcing

- **Sourcing** - a process by which companies buy goods and services needed for their operations;
- It entails complex interactions of preferences, constraints and prices;
- The "buyer’s problem" — how to choose best suppliers and allocate business among them;

What are the challenges?
- How both sides can express their needs and valuations?
- Does it provide valid solutions?
- Is it quick?
- Is it structured, repeatable, impersonalised?
- Is it transparent?
Introduction - Sourcing Methods

Traditional method — in person negotiations — what is the advantage?
- Very expressive method :) — human languages are, in general, very expressive;
- It provides a valid solution as all constrains of a seller and a buyer can be internalised in the final outcome.

Disadvantages:
- It is, in general, extremely slow;
- It is usually unstructured;
- Not repeatable;
- Based on human-to-human relation, i.e. personal relations — renders competition;
- In general, leads to suboptimal outcomes.
In mid 90s, due to technology improvements suppliers started to submit offers in electronic way;

Buyer can then decide who should be allocated the business using a protocol;

Advantages of this method:
- speed;
- structure;
- transparency;
- increased competition (it is easier to enter);
- simultaneous negotiations;

The most popular — reverse auctions

- a buyer combines items in lots;
- auction is descending and the winner is the seller with the best price;
- the best is not necessarily the lowest;
- it may take some extra attributes — like reliability, reputation, etc.
Bundling items — not economically efficient

- Bundling items is not economically efficient;
- The buyer bundles (according to his best interests) and it does not have to correspond to economically efficient solutions of sellers;
- Many smaller suppliers are out of the process as they cannot supply all item in the bundle;
- Reverse auctions do not support side constraints (those outside the bundle);
- Reverse auctions cannot express their production efficiencies (if buyer bundled a few bundles);

**In short**: Reverse auctions simplify the problem and do not consider complexity as an opportunity!
In 1997 it dawn on me that it is possible to achieve the advantages of both manual negotiations and electronic auctions while avoiding the disadvantages. The idea is to allow demand and supply to be expressed in a drastically more detail (as in manual negotiations) while conducting the event in the structured electronic marketplace where there the supply and demand are algorithmically matched (as in the reverse auctions).

The official name of this new paradigm is Expressive Commerce™;
Being more expressive and having a possibility to better match supply and demand is a **Pareto**-improvement;

However, it is an **extremely complex combinatorial problem**;

Combinet developed the world’s fastest algorithm to solve it;

It is not one brilliant idea but rather a set of heavily-tested heuristics that was shown to work very efficiently.

**CombineNet:**

- **Advanced Sourcing Application Platform (ASAP);**
- **ClearBox** — a core engine of the platform.
The technology development started in 1997

CombineNet was founded in 2000;

between December 2001 and December 2006 they hosted 447 highly combinatorial procurement events;

Total amount spent — $35 billion;

Individual events ranged from $2 millions to $1.6 billion;

More than 60 buyer companies were among Global 1000 companies;

12000 supplier companies;

many combinatorial auctions were the largest ever conducted in the history of human-kind to date :)
Expressive Commerce — Two sides

1. Expressive bidding $^{TM}$;
2. Expressive allocation evaluation $^{TM}$;
Expressive Bidding
Expressive Bidding — Forms

- Bidding on an arbitrary number of self-contained packages of items;
- Conditional discount offers;
- Rich forms of discount schedules;
- Broad variety of side constraints;
- Multi-attribute bidding;
- Expression of cost-drivers;

What is important — every supplier can choose a desired level of expressivity. Some suppliers will not be expressive at all.
Expressive Bidding — Example 1

Figure 2. A Simple Example of Bidding with Alternates, Cost Drivers, Attributes, and Constraints.
Expressive Bidding — Example 2

Figure 3. An Example of Bidding with Cost Structures and Attributes.
Expressive Bidding — Benefits

It leads to a *Pareto*-improvement in the allocation;

- Buyers and suppliers can express their preferences completely;
- Suppliers can diminish exposure risk;
- No-business risk — suppliers cannot win more than they can handle;
- Increased participation — less experienced suppliers participate in the bidding with experts;
- Items do not have to be pre-bundled — increased economic efficiency;
- It encourages creativity and innovation by both suppliers and buyers.
Expressive Bid Taking (Allocation Evaluation)
Expressive Bid Taking

- Buyers are supposed to express their preferences over allocations;
- They can do it in a very rich expressive way;
- It can include:
  - legal constraints ("I want minority suppliers to win at least 10%");
  - business rules ("I do not want more than 200 winners");
  - prior contractual obligations ("I want this firm to get at least $3 million contract");
  - strategic considerations ("I do not want more than 3 winners");
Real-Life Scenario

- **Buyers**: typically a company (which is an organization where each division has own objectives :)
  - Finance people — savings
  - Plant managers — small number of suppliers;
  - Marketing managers — reliability (on-time deliveries);
- Now, fast clearing becomes paramount — because companies can run the software multiple times and check what happens under various constraints.
Expressive Bid Taking - Interface Example

**Step 1. Select a rule and define the necessary parameters.**

- Require at least $1$ suppliers
- Allow a maximum of $1$ suppliers
- Require between $1$ and $1$ suppliers
- Award at least $1$ dollars to Archem
- Award at most $1$ dollars to Archem
- Favor Archem by $1$ percent
- Award as much business as possible to Archem
- Favor supplier by $1$ percent if their score is greater than $1$
- Exclude supplier with a score less than $1$
- Use payment terms of $10$ days. (Default is 60 days, applies everywhere)
- Use contract terms of $2$ years. (Default is 3 years, applies everywhere)

**Step 2. Apply this rule**

- For Everywhere:
  - All Items
  - All Bid Rounds
  - All Product Groups
  - All Products
  - All Sites
  - All Business Groups

- For to the following:
  - to Item(s):
  - to Bid Round:
  - to Product Groups:
  - to Products:
  - to Sites:
  - to Business Groups:

**Step 3. Review and Add the rule**
Clearing Algorithm

- Size of the auction and side constraints make allocating business among different suppliers and extremely challenging problem;

- In more scientific terms it is called Winner Determination Problem;

- Even in the simple combinatorial auctions (without any side constraints) the problem is NP-complete and inapproximable in the worst case in the polynomial time;

- Expressive commerce is a much richer problem — complexity carries over;

- Before, no technology was available to solve combinatorial problems of such a scale;

- Hohner et al. (2003): integer programming is effective for circa 500 items and 5000 bids;

- In 2001 CombineNet was given a trial trucking problem by P&G. Competition solved it in 30 minutes. They solved it in 9 seconds and since then improved by 2-3 orders of magnitude!
Speed of the algorithm

- Median run time is < 1 second!
- Average run time is 20 seconds;
- The average result is blown up by some instances taking days!
- But the algorithm is anytime.
Achievement and Summary
CombineNet — Achievements

Direct benefits:

- $4.4 billion savings to customers in lowered sourcing costs;
- This number is computed as a difference to what buyers used to pay one season earlier;
- This achievement is remarkable taking into account that prices of transportation went up 6-9% on average;
- Of course, there are also savings obtained by suppliers which are harder to measure;
- Overall Pareto-improvement was achieved; win-to-win situation;
- Many suppliers that boycotted reverse auctions came back to negotiation table;
- A very important saving - TIME - compressed from weeks/months to days.
CombineNet Today

- Employs 130 people;
- Half of them is engineering;
- A dozen of researchers;
- It has operations on four continents;
- Headquarters in Pittsburgh, Pennsylvania;
- Offices in Berlin and Hamburg, Brussels, Tokyo and Beijing.