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# Realizing Large Virtual Web-Based Collaborative E-Commerce with B2X Middleware

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**Abstract:** E-commerce enterprises are facing the challenges from globalization. However, it costs much time and budget in building and maintaining web-based collaborative e-commerce platforms. It's also difficult to integrate several collaborative platforms into a larger platform, so as to make better collaboration. Manual collaboration between different platforms results in non-timely information exchange in large scale e-commerce and un-efficient end-to-end business collaboration. Yet a new cost efficient middleware, B2X (business to any), is proposed to integrate different e-commerce platforms and related protocols are defined. The architecture and related protocol of B2X are presented. A prototype of B2X has been built and a continuous integration model for large virtual web-based B2B (Business to Business) collaboration with B2X is presented to enhance the collaboration between the e-commerce enterprises.

**Key words:** Order decomposition, information exchange, electronic collaboration, virtual alliance, manufacturing enterprise, incremental integration model

## INTRODUCTION

Business to business (B2B) e-commerce includes wide range of inter-company transactions, such as wholesale trade, some inter-company financial transactions, as well as company purchases of services, resources, technology, manufactured parts and components and capital equipment (Sculley and Woods, 1999). Productivity gains from B2B e-commerce come from four areas: possible efficiencies from automation of transactions, potential economic advantages of new market intermediaries, consolidation of demand and supply through organized exchanges and changes in the extent of vertical integration of companies (Alaniz and Robarts, 1999; Lucking-Reiley, 2000; Moore and Trenker, 2000; Philipsand and Meaka, 2000; Lucking-Reiley and Spulber, 2001).

E-commerce benefits the organizations with global extension (Motiwalla *et al*., 2005; Sung, 2006; Apigian *et al*., 2005), lower communication costs (Jih *et al*., 2005; Apigian *et al*., 2005) and better customer relationship (Bremser and Chung, 2005; Jih *et al*., 2005).

Since, the international e-commerce environment is gradually consummated, the global orientation of e-commerce enterprises is inevitable for expanding foreign trade and economic cooperation, adapting to economic globalization and improving the competitive of the enterprises. Enterprises must foster new value chains and combine the relative parties into a strategic alliance for common benefits.

The e-commerce websites should be improved to match such demand. For instance, product search function is essential in e-commerce website, however, not all these websites have excellent search capabilities (Signals, 2003). Lin and Chan (2008) investigated the search and purchase functions in one e-commerce web site from the beliefs and intentions perspective and found that there is interaction between search and purchase functions and it's better to provide different interface features to support users' purchase. Many e-commerce websites are repeatedly constructed and featured by similar orientation and business. Since, customers' demands are various, strategic alliance and collaboration should be formed by complementary merger.

The order decomposition is an important in B2B and B2C e-commerce and should be taken good care of Chen (2001) and Wunsch and Bratukhin (2007). In order to alleviate the integration difficulties of legacy systems and e-commerce software (Strebinger and Treiblmaier, 2006; Lee and Kim, 2006; Shan and Hua, 2006). This study presents, a method to decompose order in a collaborative model on the basis of previous research (Hu and Xu, 2007; Yu and Xu, 2008). A web-based collaborative e-commerce middleware and large scale virtual collaboration integration model are introduced. The main attributions of this paper are providing a new alternative collaboration technique for large scale virtual e-commerce and proposal for incrementally establishment model for such large scale virtual e-commence collaboration.

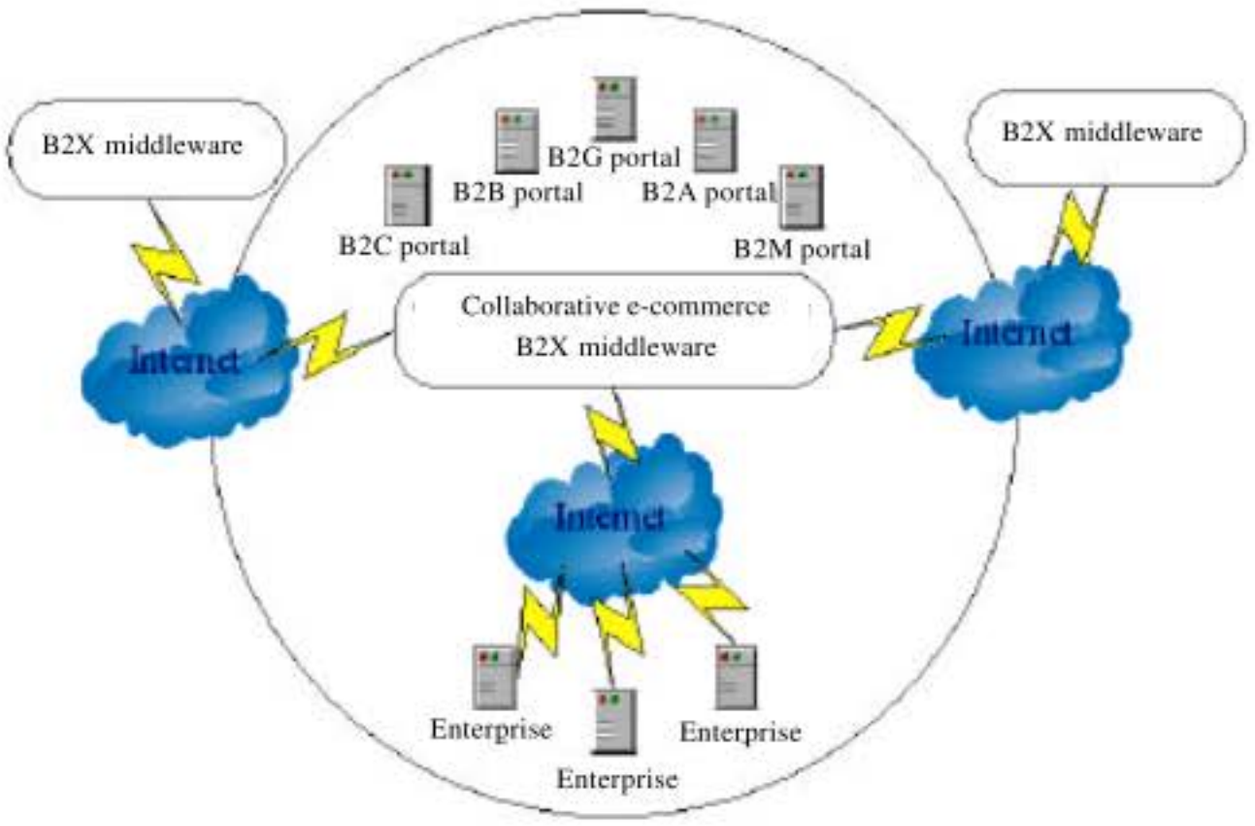


Fig. 1: Collaborative e-commerce platform

## COLLABORATIVE E-COMMERCE MIDDLEWARE B2X

Figure 1 demonstrates the connections to a collaborative e-commerce middleware, namely B2X (Business to any). The portal of the alliance and the enterprises, the middleware and the applications of enterprises can be connected together to generated more powerful collaboration in the trading. This model could be adopted in manufacturing enterprise so as to enhance the collaboration in design, manufacture and trading.

There can be several portals connect with B2X, namely B2B portal, B2C portal, B2G portal, B2A portal and B2M portal. Such portals enable different clients to put their orders to the virtual e-commerce platform in different manners. For example, the manager may use B2M portal. The middleware can be connected or shared by several enterprises and other platforms built with B2X. These enterprises will generate an alliance as a larger e-commerce platform via B2X. The connections between different platforms via B2X will then generate an even large virtual alliance.

## INTERFACE OF B2X

There are three kinds of connections toB2X, including the connections with:

- Portal
- Other e-commerce platforms
- Enterprise interface

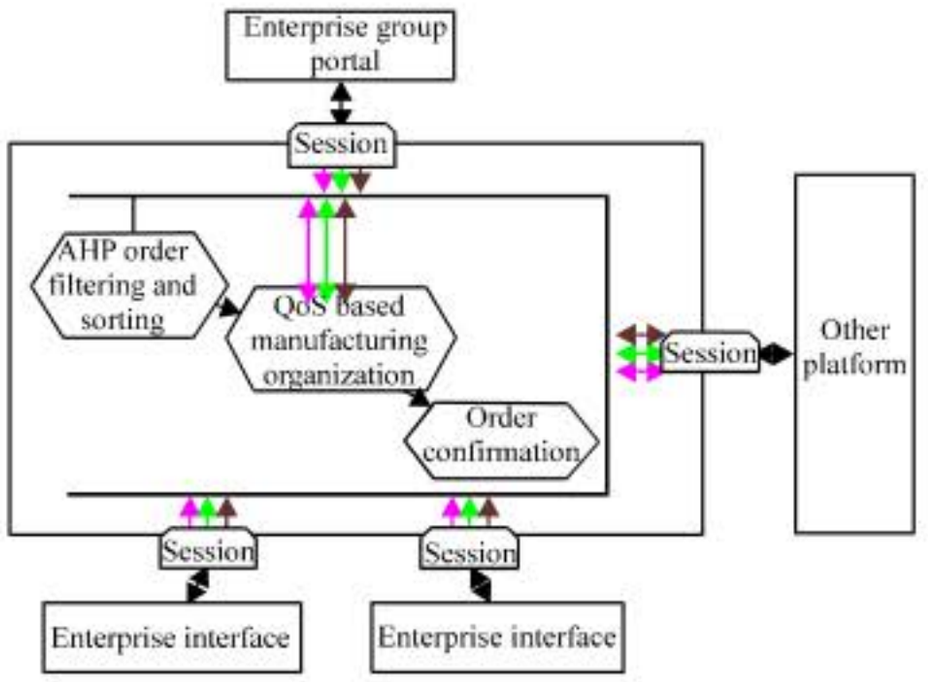


Fig. 2: Interface of an individual collaborative platform with B2X

As shown in Fig. 2, the connection with portals is used to transfer the trading requests from clients, managers, agents and some other enterprises.

As demonstrated in Fig. 1, the portal connection can be used in the environment of B2C, B2B, B2G, B2A and B2M. That is to say, any one of them can be connected to the collaborative e-commerce platform using the existing portal interface.

Trading requests will be sent out to other collaborative e-commerce platform when one collaborative e-commerce platform couldn't match the trading requests from the clients, managers, agents and enterprises. In such case, the connection interface with other platform is used to transfer the trading requests or manufacturing contracts between platforms.

For example, when an order is too large to be fulfilled by only one alliance or when there is some goods cannot be produced by only one alliance, B2X will analyze the gap and send out a related order to other platforms requesting the rest goods.

The interface between B2X and enterprise application is used to transfer the trading requests or manufacturing contracts from the enterprises to B2X and vice versa.

## COLLABORATION PHASES IN B2X

There are three components contained in B2X, named order filtering and sorting, manufacturing organization and order confirmation. Three phases represented by these components should be performed to fulfill the trading requests and manufacturing contracts.

Not all the orders are creditable, some discreditable order should be figured out with the measurement and evaluation. At the first phase, the trading requests and manufacturing contracts will be valued according to AHP method so as to filter some low value trading requests and manufacturing contracts. All these trading requests and manufacturing contracts will be sorted according to the AHP value. In such way, the most important orders will be matched at first. The historic data and the profile of the customers will be analyzed according to AHP method to generate the AHP value. The scale of the customer, the success proportion of the trading and the total volume of the trading will be used as criteria to value the customer (Table 1).

Table 1: Example of customer evaluation via AHP

| Customer | Scale | Success proportion (%) | Total volume | AHP value |
|---|---|---|---|---|
| A | 2000 | 80 | 60 | 87 |
| B | 3000 | 90 | 200 | 102 |

Having finished order filter and sorting, the phase of manufacturing organization will be started. The phase of manufacturing organization can be separated into two conjoint parts. The enterprises in current platform will be contacted at first and the other platforms will be accessed when current platform is not able to satisfy the trading requests. Therefore, the manufacturing contracts will be sent to the directly connected enterprise application interfaces at first and the application interfaces response with the expected amount of goods they may produce in time. B2X will value the feedback from the application interfaces and sum all the expected amount of manufacturing contracts. The gap will be calculated and send out to the other platforms. When another platform, assume $P_B$, receives the manufacturing contracts from this platform, assume $P_A$, the contracts will be regarded as trading requests by $P_B$. Similar procedure will be performed by $P_B$ to fulfill the requests. When $P_B$ finishes the manufacturing contracts, it responses $P_A$ with the volume of goods it could produce.

The phase of order confirmation begins when B2X captures all the feedback from the connected enterprise application interfaces and the connected platforms or when the time is expired for the trading requests to be confirmed. B2X should response the client, manager, agent or enterprise with the final volume it may produce and wait for the confirmation. As soon as B2X gets the confirmation, order confirmation messages will be sent to the related enterprise applications and other collaborative e-commerce platforms. The manufacturing will then be planed accordingly.

## DEFINITION OF THE MESSAGES IN B2X

The portal connect to B2X will be accessed by some individual clients or other business units. The enterprise application is the interface for the manufacturing alliance organized by B2X. There can be some other collaborative platforms which can integrated together to generate a large virtual alliance.

**Definition 1: goods list:** A goods list contains the goods in the order. It is defined as gl::=<l, g, v, d>.

Where:
l : The line number in the list
g : The ID of the goods
v : The volume expected
d : The deadline for the goods to be ready

**Definition 2: order:** An order is a manufacturing contract or trading request. It is defined as ord::=<oid, s, t, gl, ext>.

Where:
oid : The identification of the order
s : The source of the order
t : Refers to expected vendor of the order;
gl : Refers to the good list;
ext : The expired time for the order.

Since, manufacturing contracts is similar as trading request, both of them can be modeled as order in B2X. Therefore, the messages contained in Table 2 can be cataloged as 4 different types of messages related to order, including order drawing, order feedback and order confirmation or cancellation.

**Definition 3: order draw message:** Order draw message is used by clients to draw an order via a collaborative platform, which can be defined as om ::= <mid, cid, pid, oid, line, g, v, ex-time, d-date>.

Table 2: Messages to collaborative e-commerce Middleware B2X

| Connection | Output messages to connections | Input messages from connection |
|---|---|---|
| Portal | 1. Feedback to the trading request | 1. Trading requests<br>2. Request confirmation or request cancellation |
| Enterprise application | 1. Feedback to the trading request or manufacturing contract<br>2. Manufacturing contract | 1. Trading request<br>2. Manufacturing contract<br>3. Request confirmation or request cancellation<br>4. Feedback to the manufacturing contract |
| Other platform | 1. Feedback to the trading request or manufacturing contract<br>2. Manufacturing contract | 1. Trading request<br>2. Manufacturing contract<br>3. Request confirmation or request cancellation<br>4. Feedback to the manufacturing contract |

Where:
mid : The identification for the order message
cid : The ID of the client
pid : The ID of platform
oid : The ID of the order
line : The line number of the order
g : The ID of the goods
v : The volume expected
ex-time : The expired time for the order
d-date : The deadline for the goods to be ready

**Definition 4: order feedback message** Order feedback message is used by the enterprises or platforms to provide feedbacks to the clients' order, which is defined as ofm ::= <mid, epid, pid, oid, line, g, v>.

Where:
mi : The identification of the message
pid : The ID of a platform
oid : The ID of an order
line : The line number of an order
epid : The ID of an enterprise or a platform
g : The ID of a goods
v : The volume expected

**Definition 5: order confirmation message:** Order confirmation message can be defined as ocom ::= <mid, cid, pid, oid, line>.

Where:
mid : The identification of the message
cid : The ID of the client
pid : The ID of a platform
oid : The ID of an order
line : The line number of an order

**Definition 6: order cancellation message:** When there is a cheaper material can be used in manufacturing or the client don't willing to purchase this goods, the client may cancel an order. Order cancellation message can be defined as ocam ::=<mid, cid, pid, oid, line, re>.

Where:
mid : The identification of the message
cid : The ID of the client
pid : The ID of a platform
oid : The ID of an order
line : The line number of an order
re : The cancellation reason for tracking

No cancellation can be made to a confirmed order. This is done by order status checking based on status transition diagram.

**Definition 7: order dispatch message:** Order dispatch message is used by platform to dispatch a manufacturing request to enterprises or other platforms, which can be defined as odm ::= <mid, pid, eid, oid, line, g, v, d-date>.

Where:
mid : The identification for the order dispatch message
pid : The ID of platform
eid : The ID of the enterprise
oid : The ID of the order
line : The line number of the order
g : The ID of the goods
v : The volume expected
d-date : The deadline for the goods to be ready

## STATUS TRANSITION DIAGRAM FOR ORDER STATUS CHANGE CONTROLLING IN B2X

Since, there are 4 different messages impacting the status of an order, related status check or status change controlling should be enabled for safe E-commence.

With the status transition diagram in Fig. 3, we may easy, to find that after an order is draw to a platform, the status will be active. An active order will remain active when receiving an order feedback message. An active order will become cancelled status when receiving an order cancellation message and became confirmed when

receiving an order confirmation message. An order with cancelled or confirmed status cannot be changed with any order message.

## COLLABORATIVE WORKFLOW FOR VIRTUAL E-COMMERCE VIA B2X

The collaborative workflow for order decomposition in virtual e-commerce contains four stages, including Order Input stage, Task Arrangement stage, Order Feedback stage and Order Confirmation stage:

Coflow ::= <Order input stage>
< Task arrangement stage>
<Order feedback stage> <Order confirmation stage>

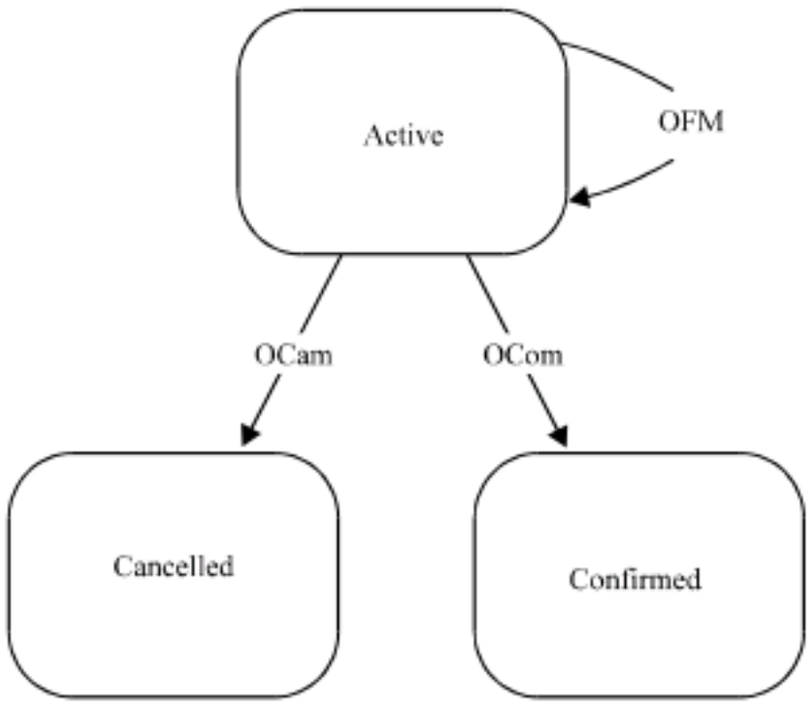


Fig. 3: Status transition diagram for order status change controlling

There are several tasks in task arrangement stage and task arrangement stage can be defined as:

<Task arrangement stage> ::= <Order evaluation> <Order dispatch> <Order reply> <Production evaluation>

Order confirmation stage can be defined as:

<Order Confirmation stage> ::=
<Order confirmation by client> <Order reply evaluation and sorting> <Order reply choosing>
<Order confirmation by platform>

Order confirmation can be dispatched to other platform and that platform will forward the message to the right place accordingly.

Figure 4 demonstrates the detail work flow for the collaborative e-commerce. At first, orders will be input by the clients from the alliance portal. Orders will be filtered and those order cannot be fulfilled will be forward directly to the other platforms such that those platforms will response the orders as soon as possible.

The order can be done internally will be broadcasted within the alliance. All the enterprises with the required service will receive such orders. When all the enterprises reply the orders, the evaluation and summary will be made so as to pre-arrange the production.

However, an order will be forward out to other platforms if the volume of order cannot be satisfied. Finally, the feedback will be sent to the client via portal when all feedback has been collected or the time is expired.

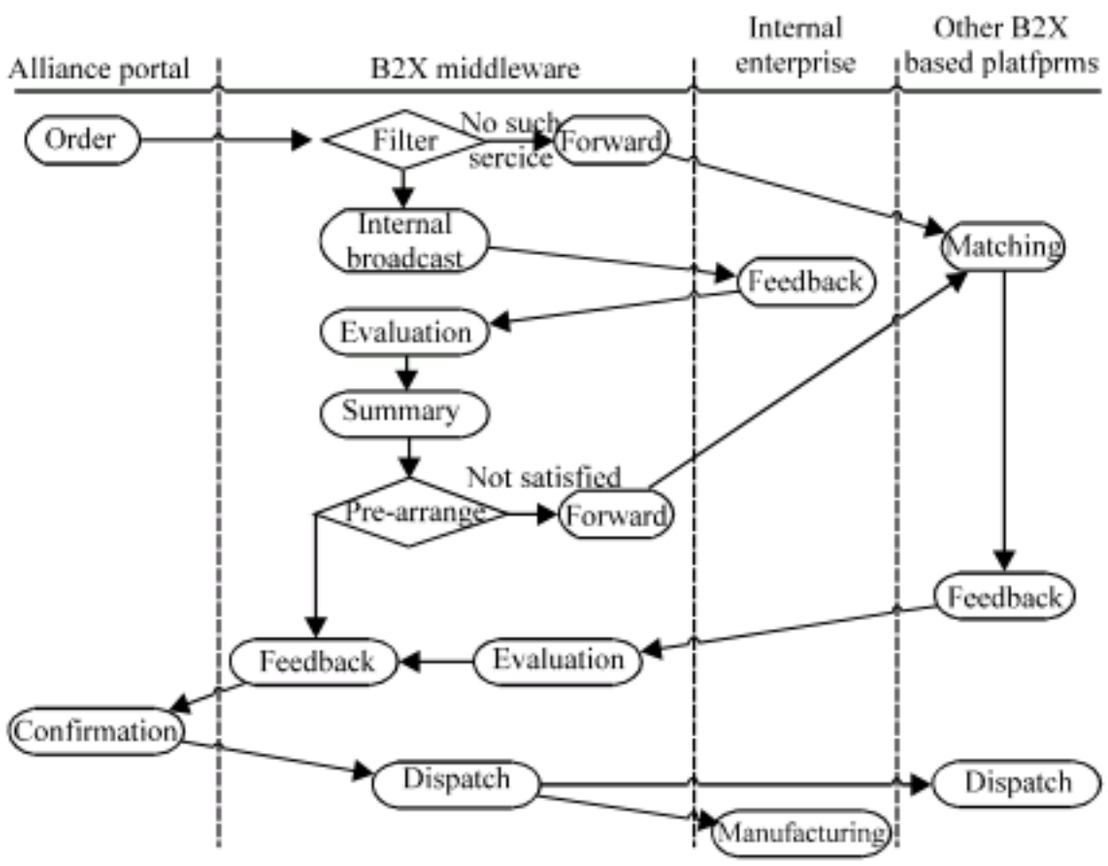


Fig. 4: Activities in collaborative e-commerce platform with B2X

When the client confirms the order, platform will send out the entire confirmation message to its enterprises and other connected platforms. Those platforms will then send out the confirmation message to their enterprises according to the detail confirmation list.

## MESSAGE CHAINS AND PROTOCOLS DEFINITIONS IN B2X

As shown in Fig. 6, there are several message chains in B2X. B2X may communicate with portal, enterprises and other collaborative platform with these chains. The communication between B2Xs is run in P2P model, so that B2X don't need to aware where the B2X is allocated. For each order draw from the portal, there is a primary B2X, which directly attached with the portal. The other B2Xs which assist the primary B2X to finish the order are called secondly B2Xs.

The protocols can then be designed as Fig. 5. Assume the client id for Good Luck of Asia company is c6, the id of client Sale Agent SA is c8, the platform id for platform I-J is p5, the order id is 89210, the id of goods cloth XX is 2098, the id of enterprise enterprise E is e7, the platform id for platform K-M is p8.

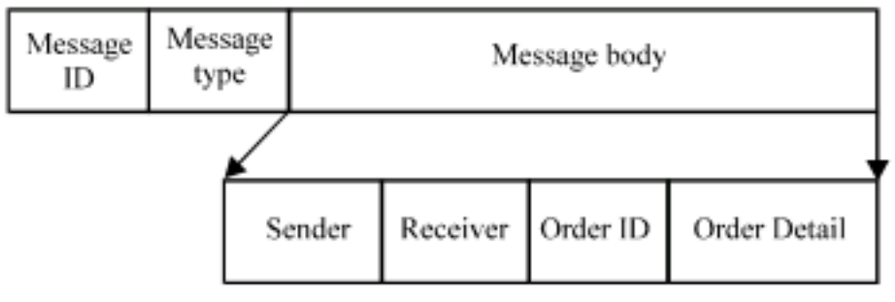


Fig. 5: Protocol in B2X order draw

**Portal -> B2X, order draw:** Assume the message id for order is 11, then {11, #MANUFACTURINGREQUEST, c6, p5, 89210, 2098, 3000, 2009-03-22 17:00:00, 2008-05-31 17:00:00} refers to an order draw by Good Luck of Asia company via the portal to the platform platform I-J for 3000 m cloth XX, the order should be responded before 2009-03-22 17:00:00 and the volume should be delivered before 2008-05-31 17:00:00.

**B2X -> Enterprise, manufacturing request:** Assume the message id for the manufacturing request is 12, then {12, #MANUFACTURINGREQUEST, p5, e7, 89210, 2098, 3000, 2009-03-22 17:00:00, 2008-05-31 17:00:00} refers to a manufacturing request sent by the platform platform I-J to enterprise E for 3000 m cloth XX, the order should be responded before 2009-03-22 17:00:00 and the volume should be delivered before 2008-05-31 17:00:00.

**Enterprise->B2X, feedback:** Assume the message id for feedback is 101, then {101, #ORDERFEEDBACK, e7, p5, 89210, 2098, 600} indicates that enterprise E can produce 600 m cloth XX for the order sent by Good Luck of Asia company via the platform platform I-J.

**Primary B2X->Secondly B2X, manufacturing request:** Assume the message id for manufacturing request is 201, then {201,#MANUFACTURINGREQUEST,p5,p8,89210, 2098, 2400} refers to a manufacturing request sent by the platform platform I-J to the platform platform K-M for 2400 m cloth XX, the order should be responded before 2009-03-22 17:00:00 and the volume should be delivered before 2008-05-31 17:00:00.

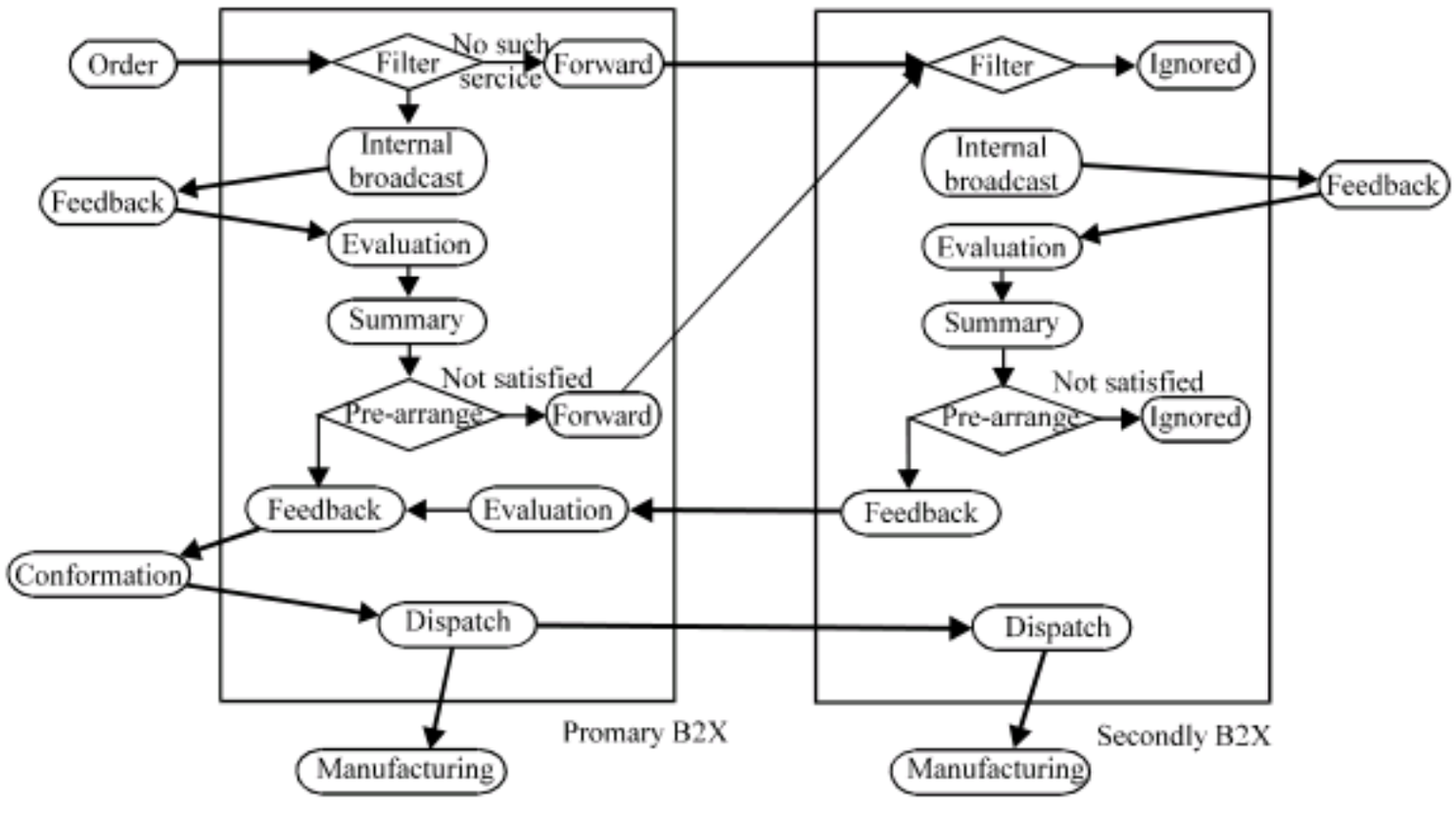


Fig. 6: Message chains in B2X

**Secondly B2X->primary B2X, feedback:** Assume the message id for this feedback is 501, the platform id for secondly B2X is p8, the platform id for primary B2X is p5, then {501, #ORDERFEEDBACK, p8, p5, 89210, 2098, 2000} indicates that platform K-M can produce 2000 m cloth XX for the order sent by the platform platform I-J.

**Primary B2X->portal, feedback:** Assume the message id for feedback is 601, then {601, #ORDERFEEDBACK, p5, c6, 89210, 2098, 2600} indicates that platform I-J can produce 2600 m cloth XX for the order sent by Good Luck of Asia company.

**Portal->B2X, confirmation:** Assume the message id for order confirmation is 701, then {701, #ORDERCONFIRMATION, c8, p5, 89210, 1} indicates that Sale Agent SA declares that feedback from platform platform I-J for the goods contains in first line of order 89210 has been approved for manufacturing.

**Portal->B2X, cancellation:** Assume the message id for order cancellation is 801 and the id of the order to be cancelled is 109209, then {801, #ORDERCANCELLATION, c8, p5, 109209, 1, the goods is no longer needed as a cheaper ones can be replaced} indicates that Sale Agent SA cancels the purchase of first line of order 109209 originally sent to platform platform I-J.

**B2X->enterprise, dispatch:** Assume the message id for the order dispatch message is 901, then {12, #ORDERDISPATCH, p5, e7, 89210, 2098, 600, 2008-05-31 17:00:00} refers to a manufacturing request sent by the platform platform I-J to enterprise E for 600 m cloth XX, the volume should be delivered before 2008-05-31 17:00:00.

**Primary B2X->Secondly B2X, dispatch:** Assume the message id for the order dispatch message is 1001, then {1001, #ORDERDISPATCH, p5, p8, 89210, 2098, 2000, 2008-05-31 17:00:00} refers to a order dispatch message sent by the platform platform I-J to platform K-M for 2000 m cloth XX and the volume should be delivered before 2008-05-31 17:00:00.

## INCREMENTAL INTEGRATION THE VIRTUAL E-COMMERCE WITH B2X

Large virtual collaborative e-commerce can be established incrementally with B2X middleware. The integration can be made in three stages according to different condition. When an enterprise has a famous portal but without a collaboration support platform, only manual collaboration can be performed with other enterprises as demonstrated in Fig. 7. If an order is too large for an enterprise to produce in time, the client or the enterprise will have to choose some other enterprises to finish the rest volume. This manual collaboration is not timely and most of the time, the management of collaboration is problematic.

B2X enables an enterprise share its famous portal with other highly related enterprises. An alliance will be generated with the collaboration among these enterprises. While, an order can be produced by the collaboration between the enterprises in one alliance, the enterprises can improve their resource utility efficiency through gaining more production chance. However, an alliance may produce some similar products and cannot satisfy the clients which requires different kinds of products. The clients should try to find different alliances to finish different products as in Fig. 8.

More and more collaborative e-commerce platforms join together and generate a large virtual alliance. Large

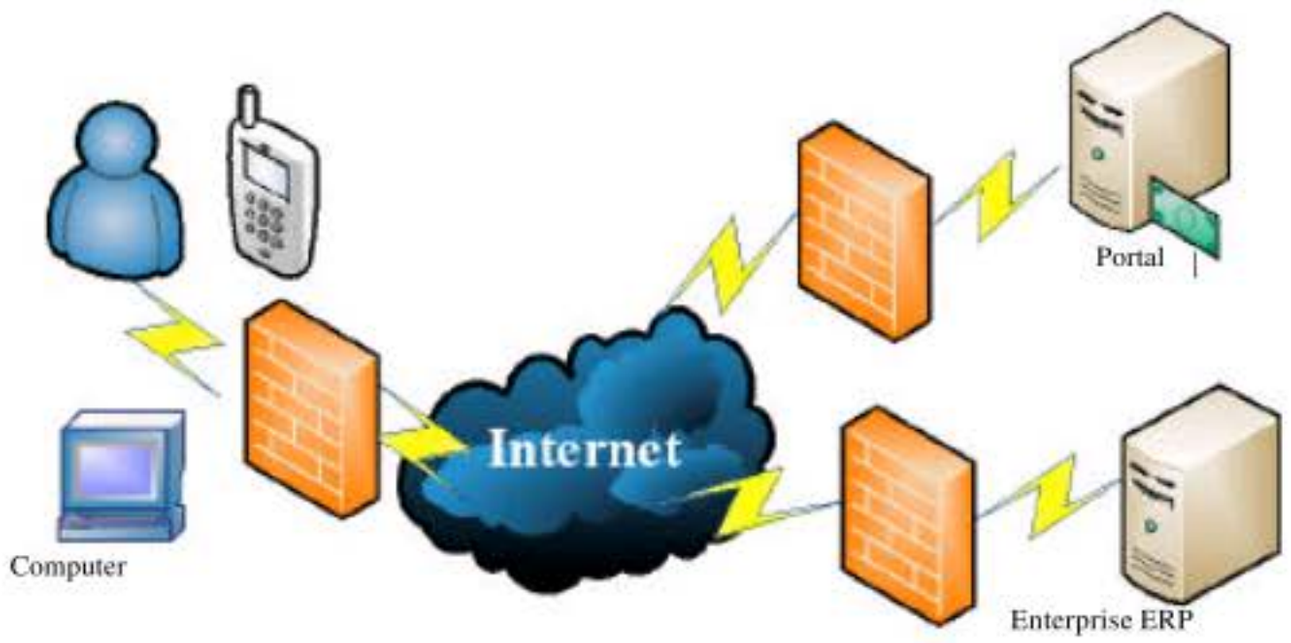


Fig. 7: Manual stage of collaborative e-commerce

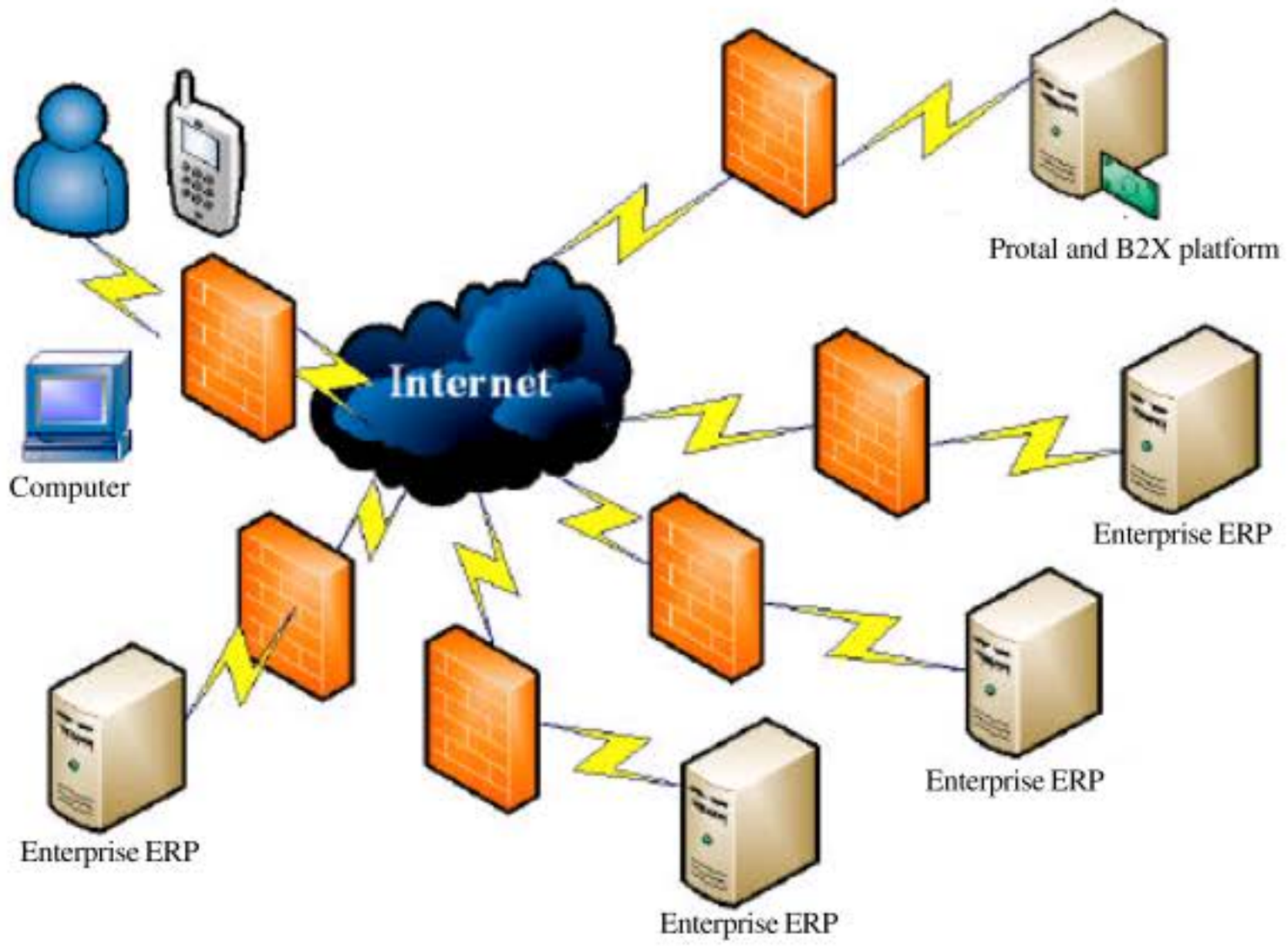


Fig. 8: Alliance Stage of collaborative e-commerce via B2X

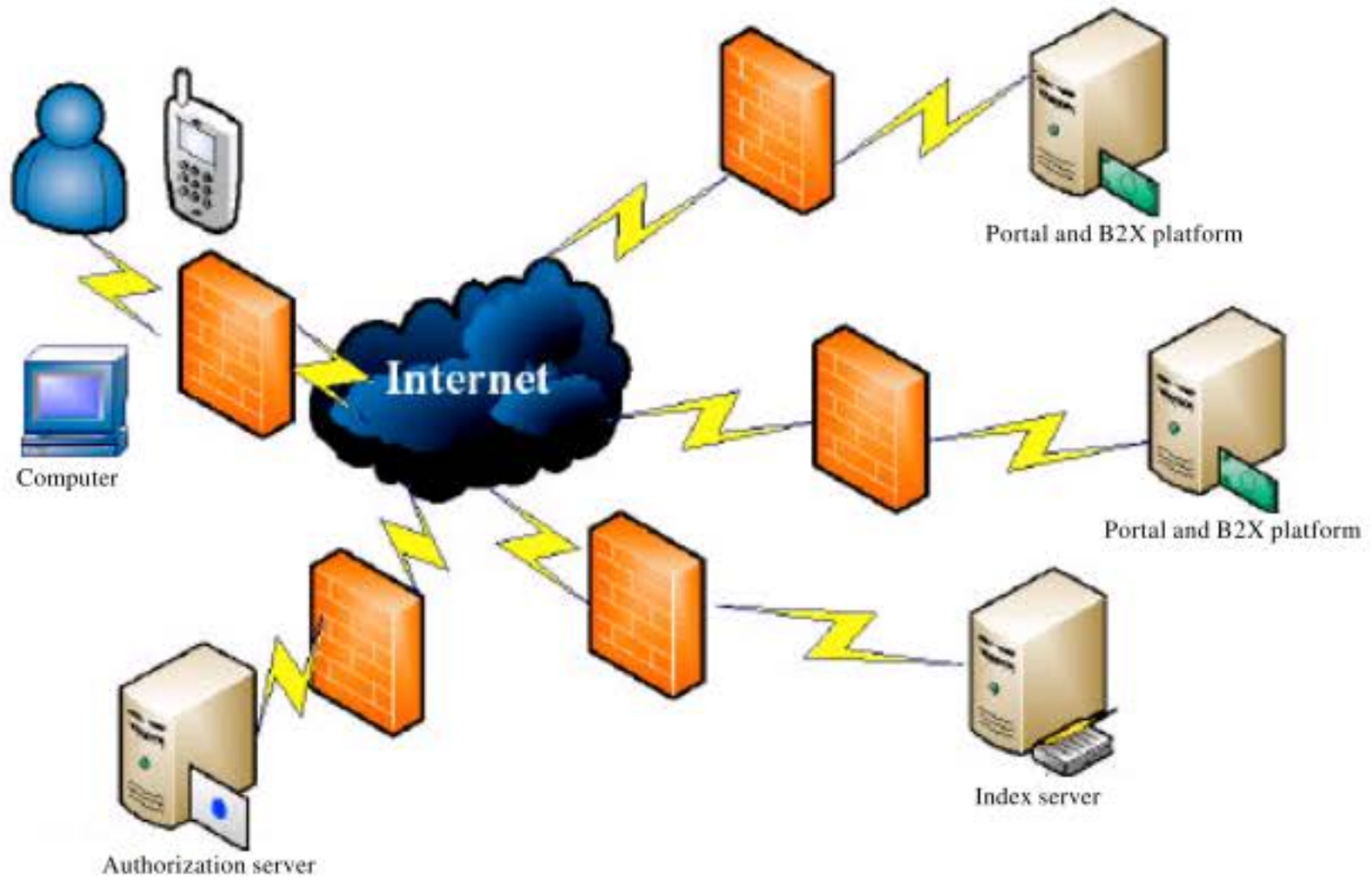


Fig. 9: Deployment of collaborative e-commerce platform

and efficient collaboration will happen among all the enterprises in different alliances linked by the different the collaborative e-commerce platforms. In such way, the collaboration can be improved incrementally such as Fig. 9.

## CONCLUSION

A middleware B2X is introduced for integration of collaborative e-commerce and the involved communication protocols and the collaborative workflows

are designed. The incremental integration of large virtual e-commerce is suggested and the deployment models are introduced.

This collaborative e-commerce middleware can be used to facilitate the electronic collaboration between different enterprise and alliances through virtual order decomposition. A prototype has been produced and role based collaboration mechanism has been used in the implementation to clarify the relationship between portal, enterprise interface and platforms (Zhu *et al*., 2008a, b). The author is leading the effort to adopt the electronic collaboration model in manufacturing enterprises to reduce the communication delay and related cost.

Typically, collaboration is made within center controlled manufacturing in e-commence. This study presents yet a new method to generate large scale collaboration. Such method enables the e-commence collaboration to be established incrementally with individual distributed platforms based on B2X.

The cluster of B2X integrated platforms will generate a P2P collaborative E-commerce environment, traditional reputation management will be enhanced (Zhong *et al*., 2006).

Currently, the suggested middleware has been implemented in prototype but no large scale experiment has been performed so as to make sure the performance is sufficient for daily e-commerce operation. The performance issue and possible solution will be studied in furture research. Besides, security is essential for the collaboration and will also be studied in future work.

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