



White Paper

# **STMICROELECTRONICS FOUNDRIES INTEGRATION**

## **RosettaNet PIPs 7B1 – 3B2 implementation**

# 1 Table of Contents

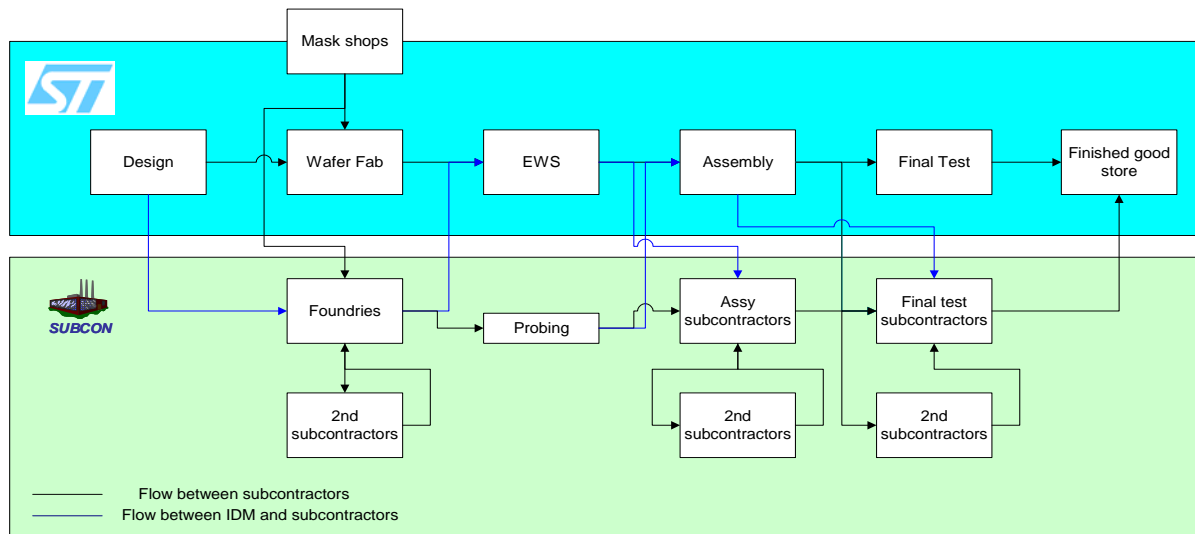
<b>1</b>	<b>Table of Contents</b> .....	<b>2</b>
<b>2</b>	<b>Introduction</b> .....	<b>3</b>
2.1	Business challenges at STMicroelectronics .....	3
2.2	Business challenges in the Semiconductor Industry .....	4
<b>3</b>	<b>RosettaNet Standards implemented</b> .....	<b>7</b>
3.1	WIP integration .....	7
3.2	ASN integration .....	7
3.3	Web-based WIP monitoring .....	8
<b>4</b>	<b>Business benefits</b> .....	<b>9</b>
4.1	STMicroelectronics business benefits .....	9
4.2	Foundries' business benefits .....	10
<b>5</b>	<b>STMicroelectronics process background</b> .....	<b>11</b>
5.1	The process before the implementation .....	11
5.1.1	<i>Process description</i> .....	11
5.2	The process after the implementation .....	12
5.2.1	<i>Process description</i> .....	13
<b>6</b>	<b>Key success factors</b> .....	<b>14</b>
6.1	Business process vision .....	14
6.2	The key project steps .....	14
6.3	Lessons learned .....	15
<b>7</b>	<b>Conclusion</b> .....	<b>17</b>



## 2 Introduction

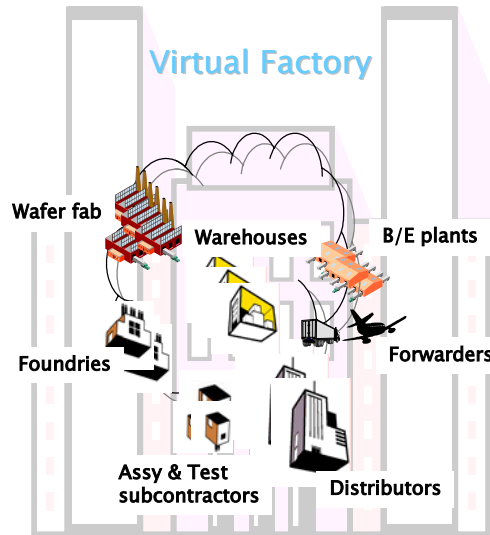
### 2.1 Business challenges at STMicroelectronics

Historically, ST has always subcontracted on the average 10% to 15% of its assembly and final test activity to subcontractors. One worldwide subcontracting back-end organizations was created in Singapore to handle this activity. This ST organization had developed the required systems and processes to collect subcontractor data, to load them in the ST corporate systems and to manage the subcontracting activity. However, these local developments were not designed to support the enhanced requirements of speed and agility for the future communication with subcontractors. In fact, we expect that the ST subcontracting activity, as presented in the figure below, will significantly grow in the coming years.



Whilst several foundries emerged in the past decade, a strong ramp-up of the foundry activity was realized in year 2000 during capacity shortage, when ST also understood that the existing corporate systems to manage this activity were poorly integrated with those of the foundries. For ST, the ratio of the subcontracting activity should be stable in coming years (15–20% of the overall dollar production activity), but current business projections for the next few years' production let us conclude that the subcontracting activity will grow significantly in volume.

Based on the need for more speed and agility to exchange business data with subcontractors, Virtual Factory programs of RosettaNet and NEMI have defined new standards for information exchanges between IDM (Integrated Device Manufacturer) and subcontractors. These standards represent a suitable solution to support ST vision to integrate manufacturing subcontractors as if they were ST Virtual Factories, as shown in the figure below. Once ST will have implemented this vision, there will be a similar level of visibility for ST employees on subcontractor activities versus internal manufacturing activities.



Indeed, the chain of business actors responding to a customer demand nearly always involves not only the IDM of the product itself, but also the entire chain of suppliers, subcontractors and their service providers (e.g. forwarders). To synchronize the activities of this complex supply chain, the use of Internet technologies for communication is widely adopted today, along with sophisticated Supply Chain Management and Collaborative Planning applications. As companies implement these tools, they soon discover that there are gaps forming an invisible barrier that limits their ability to act in concert and achieve their responsiveness goals. The critical barrier is about ensuring the availability of accurate and timely data from manufacturing operations. This limiting factor for speed and agility is especially acute when dealing with multiple factories, physically separated and/or controlled by multiple enterprises.

Current Virtual Factory concepts enable distributed facilities to perform in concert as if they were a single plant, made up of an infrastructure and a set of application layers, within a connected supply chain that allows production schedules, product data (configuration, process definitions), plant data and status information to be synchronized and made available throughout the supply chain of the collaborating partners. In this context, the WIP should be considered as a global WIP for the corporation, i.e. from wafer start until finished good store. Therefore, logistics steps such as shipment and storage become logical steps belonging to the overall route of the lot.

Finally, another important business need that ST had to consider during the planning of this project was the increasing number of very small assembly and test subcontractors, located in Asia-Pacific, that have a poor infrastructure in place for B2B transactions. It became rapidly of prime importance to provide to these small companies an extranet Portal application to manage the business they were or will be doing with ST. For this part of the project ST followed the Human-to-System approach based on ST's extranet portal to provide a collaborative environment for information sharing and supply chain information visibility.

## 2.2 Business challenges in the Semiconductor Industry

A typical semiconductor chip travels between 5,000 and 25,000 miles from its inception to the electronic assembly location. During this journey, it changes location typically three to eight times. The total manufacturing cycle ranges from thirty to seventy-five days. Constant



## White Paper – ST Foundries integration

communication takes place between various business entities as the product moves through the supply chain, such as IDM factories and warehouses, foundries, assembly and test subcontractors as well as forwarders.

The consolidation of OEM companies and the growth and global integration requirements have created large IDM companies that face the challenge of coordinating all the actors of a complex supply chain. In parallel, the pressure for semiconductor companies to reduce costs, to improve efficiency, and to enhance customer satisfaction are becoming more and more challenging requirements. Shareholders expect companies to grow and be profitable. Product life cycles continue to get shorter, which drives the need for quicker time-to-market, while the number of products is increasing due to the diversity of customers demand. In addition, customer expectations get higher requiring rapid response from their partners. Customer satisfaction implies more and more the capability to react fast to problems, to quickly analyse manufacturing problems, and to have and provide visibility on planning processes.

As a consequence, the supplier must work harder and smarter than ever to achieve the goals. This requires improved speed and agility to communicate and exchange in real time business information between all the actors of the supply chain. Indeed, the efforts toward competitive advantage in the subcontracting business models also imply a high capability to reconfigure each company's supply chain to integrate more subcontracting foundries. This can be facilitated by the adoption of industry standard processes.

Industry's best practices to face these challenges have therefore evolved using the principles of the Virtual Factory, initiating several programs of global process standardization, with the goal of resolving a number of critical challenges:

- As the industry moves to a model with production being outsourced at an increasing rate, rapid product introduction and cost efficiencies promised by the outsourcing model depends on quickly linking the OEM's and foundries information systems with those of their trading partners.
- This challenge is amplified for the foundry/EMS providers, which must be able to accept designs produced by a variety of systems and return both product and formatted information back to their OEM customers.
- The inefficiencies (costs and product delays) in outsourcing models will ultimately be passed on to the customer until they can be resolved through an effective e-Manufacturing environment, of which the requirements are graphically presented below.
- Other challenges encountered are about providing labels to subcontractors, communicating prices to subcontractors who may also be competitors, and having supply chain visibility at lot level.





### 3 RosettaNet Standards implemented

This ST project aimed at integrating WIP management (WIP aggregation, visibility, tracking, stats reports, etc.) and Logistics data within ST central systems for system-to-system exchanges using the RosettaNet standards PIP7B1 (Distribute Work in Process) and PIP3B2 (Advanced Shipment Notification ASN). These standards must be seen as the technology enablers that allowed ST to reengineer the internal processes toward end-to-end exchange automation with ST foundries. In particular, ST used the RosettaNet format and specifications to reengineer and define ST internal standard data format for the WIP and the ASN integration. Part of the reengineering effort included the integration with ST ERP's implementing a new Enterprise Application Integration platform (webMethod), and the development of a new web-based solution for WIP monitoring.

Today, this ST process implementation has been deployed with all RosettaNet-compliant tier-1 foundries.

#### 3.1 WIP integration

The **WIP integration** based on PIP7B1 represented ST's first implementation of a RosettaNet manufacturing process. After having contributed to the development and a 6-month long validation process of this RosettaNet PIP, ST decided on its adoption to overcome some fundamental problems that needed process improvement:

- Improve data reliability and integrity by linking data extraction from ST product information referential and by making accurate the WIP projection in the planning system.
- Improve supply chain data visibility to allow real time WIP tracking and production monitoring.
- Improve the accuracy and availability of semi-finished goods information from the foundries to support the synchronization of the logistics processes with the WIP integration.
- Improve the incomplete process of uploading once a day the WIP status in access database before to send it to the planning system.

When we look at industry implementations of the WIP PIP7B1, we realize that in most cases foundries use it to distribute the WIP status and not the WIP events. In ST implementation, however, the information exchanged with the WIP is of both types: ST receives **WIP snap shots** of the foundries production 3 times a day and **WIP events** such as start, scrap, etc. once per hour. The transaction frequency is on the average more than 1500 inbound PIPs/month corresponding to a volume of data of 200 Mbyte and to a business volume of several hundreds of millions US\$.

#### 3.2 ASN integration

The PIP3B2 for the **Logistics integration** in the project had been previously implemented at ST for RosettaNet exchanges with several customers at logical level only. ST then participated with one of its partners to the development and validation process for the new release of this PIP including the requirements at the physical level (containers, etc.) to be used with foundries. In parallel to



## White Paper – ST Foundries integration

this implementation, ST did a reengineering of its internal ASN integration process with the goal of removing the manual workload through process automation and also of reducing the transit time from the foundries to the next ST manufacturing facility through direct shipment. ST therefore gained on speed and efficiency in the control over the full process. Now, when a foundry sends a shipment notice to ST, this is sent automatically with ASN PIP3B2, which creates the “in transit” information, and then generates automatically the closing of the WIP and creates a good receiving note in the financial systems.

In parallel, ST reengineering effort to implement this automated ASN offered the opportunity to standardize the use of bar code readers at the foundries' warehouses, and the deployment of ST labels nowadays avoids painful re-labelling procedures: the subcontractors' pieces are processed in the same way (with the same bar codes) as the ST pieces, generating an increased productivity.

### 3.3 Web-based WIP monitoring

With regard to the new **e-Solution for WIP monitoring** mentioned previously, it is the ST key solution to see foundries as ST Virtual Factories, and is so far dedicated to production monitoring. This tool is designed to process B2B exchanges in real time and provides a web-based user interface on ST's intranet portal. Silicon foundries provide ST WIP information up to once per hour. Thanks to advanced WIP monitoring capabilities and tight integration with ST planning systems, this e-Solution is fundamental to closely monitor foundries manufacturing activity as if they were ST Virtual Factories from ST's Product Groups and Customers view point. Six foundries within the RosettaNet membership, representing thirty fabs, are currently connected to this e-Solution.

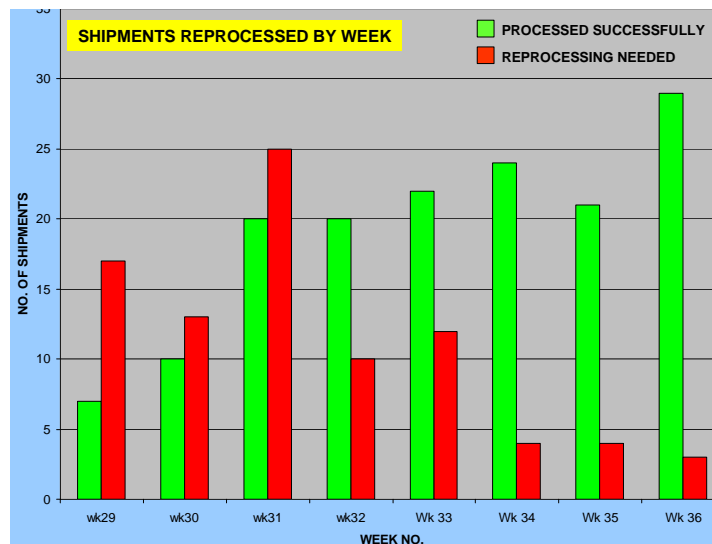


## 4 Business benefits

### 4.1 STMicroelectronics business benefits

The major business benefit that ST has obtained from this implementation is the ability to deploy a Standard "Public Process" with its foundry partners as well as the automation and integration with back-end systems (Logistics, SAP, I2) of WIP tracking and ASN information exchanged with its foundries. This automation success had a great impact on:

- **Productivity increase due to automation:** 20–30 minutes saved for each delivery for manual data entry and re-processing (see figures below), whereas, on average, 15 deliveries per day are handled for all ST foundries. Additional 20 minutes per shipment are saved at warehouses due to re-labelling removal.
- **Reduced latency:** Reduction of the time delay between information availability and input of the information (previously sent by e-mail) within an information system. The integration of ASN in real time in ST systems makes the shipments ready to be received.
- **Improvement of foundry data quality:** Automated checks have been implemented on WIP data received.
- **Improvement of the delivery process implemented:** the automation of PIP 3B2 allowed also a direct shipment from foundries to Back-end, whereas before ST had to centralize the shipping for additional control, packaging and re-labelling.
- **Improved monitoring of full execution process:** Automation toward real-time monitoring of production and logistics activities provides best measurable metrics and analytics reports on business processes.





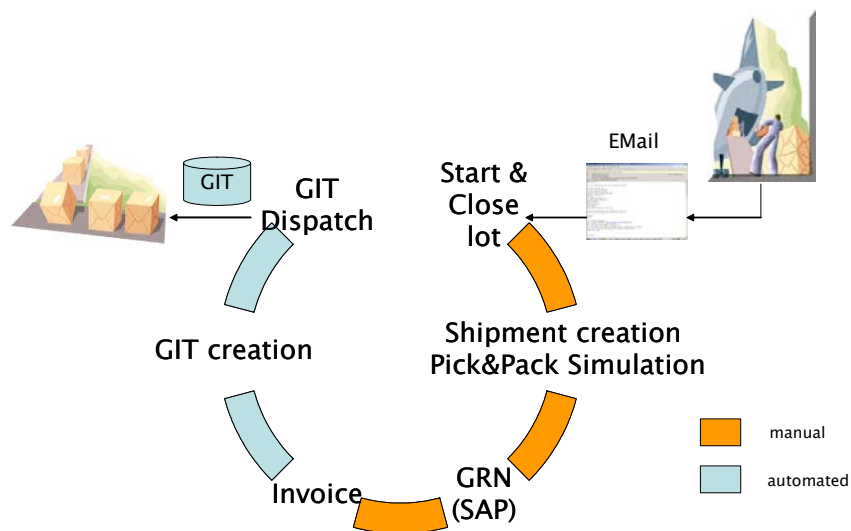
### 4.2 Foundries' business benefits

It must be mentioned that the benefit perceived by the foundries is as exciting as for ST. For them too, the fact that "Public Processes" are being used, allows them to maximize the ROI with their customers and partners choosing the same Standard approach. Indeed, the added value for them is even larger, because their development time for WIP and Logistics extracts is now shorter and they need fewer resources since they do no longer need to develop custom data extractions: with the PIP3B2 and PIP7B1, the data mapping based on the standard format is readily available and can be easily replicated. This implementation could also represent a fundamental step forward for a future integration of a self-billing process.

## 5 STMicroelectronics process background

### 5.1 The process before the implementation

Before this implementation project, the architecture existing at ST was based on reproducing subcontractors' Manufacturing Execution System (MES) transactions into an ST proprietary MES system. From this MES, various standard batches extracted the data needed to feed central systems and ST ERP's. This solution has proven its efficiency but also its limitations, mainly due to all typical disadvantages of a manual process.



#### 5.1.1 Process description

The process is initiated when the foundry sends a shipment alert by email. This shipment alert describes the characteristics of the shipment and its physical content (lot numbers, lot type, quantities, destination site, etc.). The different steps of the process are the following:

- Step 1: For each lot contained in a delivery, the operator simulates a lot start and a lot close in the SPN (Shipment) lot tracking system.
- Step 2: Once all lots are closed, the creation of bulks is simulated and the shipment is simulated in the logistics system.
- Step 3: The information is transferred to the accounting department to perform a Good Receipt Notification (GRN) in the purchasing system.
- Step 4: Manual reconciliation of invoices received from foundries with GRN.
- Step 5: The Good In Transit is automatically created in the logistics systems.



## White Paper – ST Foundries integration

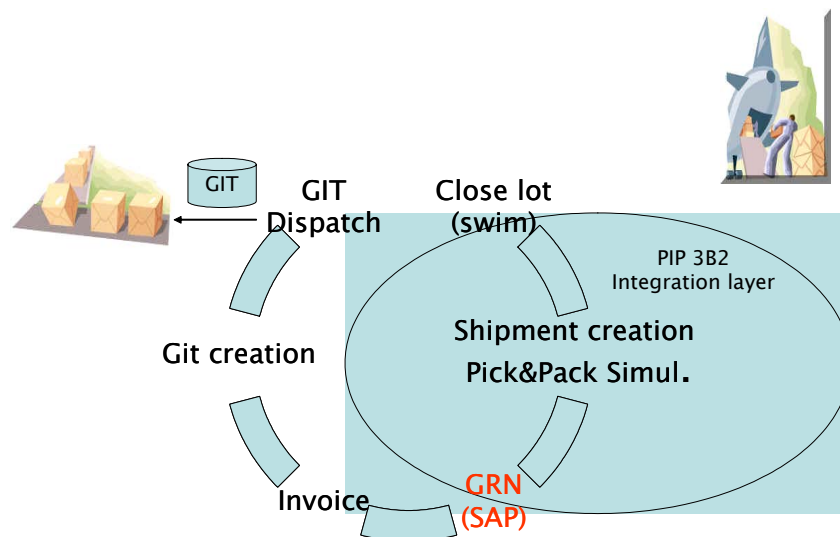
- Step 6: The Good In Transit is automatically dispatched to the receiving site so that the foundry shipment is received.

The main issues related to this process were the following:

- There was latency between the physical flow and the logical flow: the information system was not necessarily reflecting the reality.
- The process was human dependent: if the shipment alert was sent on Friday night, the information was not entered in ST system before the next Monday. As a result, the foundry shipment could no be received by ST before the Monday.
- Risk of data entry mistakes existed.
- There was no global visibility on foundry WIP during the foundry manufacturing process. The unique visibility was provided once the lots were shipped.
- Problems of data integrity when computing the foundry WIP availability for planning systems: in some cases, the projected availability of a lot was counted twice or could disappear.

### 5.2 The process after the implementation

After this implementation project, the architecture implemented at ST is based on capturing WIP snapshots and events in a web-based WIP monitoring solution, then automatically integrating the advanced shipment notification in ST logistics system. During the integration of this ASN, the WIP availability is closed in the WIP solution and the Good Receipt Notification (GRN) is automatically performed by the purchasing system. The WIP monitoring solution feeds a company operational data storage, which integrates the foundry WIP with ST manufacturing WIP and feeds central systems and ST ERP's. WIP and ASN integration processes are fully automated, which has proven its efficiency and provides a full visibility along the entire process.





### 5.2.1 Process description

The process is initiated when the foundry sends a lot start event through RosettaNet PIP 7B1. The different steps of the process are the following:

- Step 1: The Subcontractor's WIP Integration and Monitoring solution (SWIM) captures the WIP snapshot and the events from lot start until lot close.
- Step 2: Once the Advanced Shipment Notification is received through PIP 3B2, basic referential checks are done in the integration layer (e.g. definition of the product code) and the existence of the lots are checked in SWIM. Then the process closes the availability of the WIP in SWIM and creates automatically the delivery information in the central logistics system.
- Step 3: The process continues with the automatic posting of a GRN in SAP. An Enterprise Integration Platform orchestrates this process (step 3 still to be implemented).
- Step 4: Invoices will be received through EDI and will be automatically re-conciliated with GRN (step 4 still to be implemented).
- Step 5: The Good In Transit is automatically created in the logistics systems.
- Step 6: The Good In Transit is automatically dispatched to the receiving site so that the foundry shipment is received.



## 6 Key success factors

### 6.1 Business process vision

The first key success factor was to have from the beginning a clear vision about the business process improvement and automation needed including current Virtual Factory concepts. An adequate strategy and planning included the choice of RosettaNet e-Business process Standards and reflected the main business targets described in the following:

- Define a complete architecture to reach a global solution that integrates ST foundries, assembly and test subcontractors, taking into account their various levels of IT maturity and covering the main common processes of planning, scheduling, manufacturing and logistics.
- Have online visibility and monitoring on the supply chain elements of the foundries, at lot level, for both manufacturing and logistics information, in a way that the information reflects the physical process flow in real time. Indeed, the complete WIP is considered from the first operation in wafer factory (wafer start) until the finished good is stored, whereas logistics information (shipment receipt, shipment advise, out of stock, etc.) is communicated by event to avoid execution delays. The need is similar for manufacturing events such as lot start, lot close or exceptional events such as scrap.
- Integrate a Standard-based, end-to-end business process including the logistics data flow to remove the previous manual work for data entry in such a way that logical and physical data on critical events are synchronized.

The second key success factor was that the foundries ST wanted to address in this project had already reached a good level of RosettaNet standards adoption maturity for manufacturing processes. A specific analysis showed that the business importance for ST of selected foundries was matching their readiness to implement RosettaNet processes. Therefore ST decided that the technology enabler for the project would have been based on RosettaNet standards.

And finally, this project put evidence on the need of a new EAI platform. The end-to-end process integration was used as a pilot to successfully implement it.

### 6.2 The key project steps

As a summary, the key steps applied to this foundries' integration project are described in the following.

1. Definition of the processes to be implemented, discussion of the key concerns and of the driving principles for the project through a steering committee and workshops. Six projects were identified at the end of this project step. An external solution provider supported ST during this phase.
2. Analysis of subcontractors' Information Technology maturity and of their size and the business ST was doing with them.



## White Paper – ST Foundries integration

3. Then, each project was started with its own structure. A primary focus was given to the "subcontractor B2B project", as it was the key infrastructure for the project:
  - Defined the business process flow and the business transaction flow
  - Data gap analysis between RosettaNet transactions/data and ST requirements
  - Proof Of Concept (POC) with one foundry and one assembly subcontractor (about four months duration after kick-off).
  - **POC objectives:**
    - To define usage and mapping of PIP 7B1 to distribute WIP status
    - To define usage and mapping of PIP 7B1 to distribute lot start event
    - To define usage and mapping of PIP 7B1 to distribute lot close event
    - To define usage and mapping of PIP 7B1 to distribute lot scrap event
    - To then define volumetric figures for the subcontractor B2B project
    - To then give directions for an XML codification of the WIP in ST.
  - **POC deliverables:**
    - Data gap analysis matrix
    - List of needed enhancements for the PIP 7B1
    - ST PIP 7B1 Specifications for the Trading Partner Agreement
    - Recommendations for ST WIP codification.
  - B2B server training and set-up
  - Connectivity set-up and testing
  - Validation (period of maximum two months).
4. ST developed a WIP monitoring application, which was a solution that ST identified as missing in ST portfolio to cover the customers' needs. Today, the solution is implemented for ST foundries and is accessible through ST's intranet portal.
5. ST implemented a platform to ease the integration between applications and to automate business processes (e.g. automation of the Advanced Shipment Notification receipt from foundries).
6. Integration of the back-end systems of the subcontractors.

In terms of human resources, the support given was the equivalent of 4 persons full time during 2 years. In terms of technologies, the project was based on the RosettaNet XML standards and on EAI (Enterprise Application Integration), including 2 servers (1 platform for B2B server and 1 EAI server). The choice has been made to integrate, where possible, the existing software and to self-develop the non-existing software parts internally.

### 6.3 Lessons learned

This project has proven to represent a great opportunity to streamline and standardize business processes. The learning effect can be summarized as follows. This project has:

- Highlighted some logistics physical flows that were not in line with ST policies
- Highlighted some recurrent data quality problems
- Forced ST people to go from a workaround to a root cause solving



## White Paper – ST Foundries integration

- Highlighted the vital need for strong coordination across all IT teams involved in the solutions' design and validation
- Revalidated ST's e-Business B2B vision based on RosettaNet standards.

And finally, the implementation of this process scenario could only be successful thanks to the close cooperation between ST Business and ST IT experts. The need and importance of this internal cooperation has once more been highlighted, because the partnership between ST and its partners have been established at both Business Process and IT level.



## 7 Conclusion

The competitive advantage brought by the adopted solutions described in this paper comes from the very precise visibility of the manufacturing processes of ST foundries. Today, the improved processes give ST:

- A process and tools to challenge the subcontractors' performances
- Online monitoring of foundry activity (WIP, Shipments)
- Supply chain data visibility increase for all actors of the supply chain with maximum data quality
- A successful example showing that System-to-System integration enables ST to have all information systems integrated and aligned as soon as the subcontractor makes the manufacturing information available.

*“Taking into account the increase of manufacturing subcontractor activity, the mission of this project was to define a global solution integrating ST’s subcontractor activity. The outputs were a strong improvement of real-time visibility of the manufacturing process, the automation of shipments and the improvement of data quality and productivity. ST manufacturing foundries were integrated as ST “Virtual Factories” and a RosettaNet standard process has been adopted by almost all ST foundries” – STMicroelectronics’ IT Project Manager for Manufacturing processes.*