NETWORK SYSTEMS SOLUTIONS INTEGRATION TO ELIMINATE MISSING OR INCOMPLETE SUPPLIER KEY DATA USED FOR COMPONENT TRACEABILITY

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ABSTRACT

In manufacturing industries, the material or product traceability is a vital component of the whole production operations and manufacturing system. The traceability aids on identification, location, and detection of the origin of the products or even the components used to produce output. Moreover, it is also beneficial to have comprehensive traceability as this provides complete historical information of the distributed product batches which eases investigations whenever there will be feedback or incidents. Having the product information from end-to-end process can bring in-depth analysis in the manufacturing history to identify the root-cause of encountered problem.

Traceability has become a fundamental feature for every company, ensuring a high standard of product quality and having a relevant sense of responsibility towards their customers. Furthermore, traceability is, currently, one of the most relevant demanded characteristics, increasing customer satisfaction and improving the operational processes (Shedletsky, 2019)

The test process step has the Vertical-cavity surface-emitting laser (VCSEL) Siren die identification file data as reference to identify the correctness of the traceability and inclusion of every module to the batch lot. There is an incident wherein multiple lots are failing in the test process step and the root-cause identified is missing and/or incomplete data uploaded in the ST server causing the traceability related failures on affected modules. The VCSEL Siren die file data is incomplete, thus the modules containing the component were affected. This incident has caused yield losses on the affected modules and lots since the unrecovered modules can no longer proceed to next process steps and considered rejects. Through the collaboration with the material supplier with the help of the Supplier Quality Engineering (SQE) and Digital Transformation and IT (DTIT), through the use of the 8D problem solving methodology, the root-cause for the incomplete data uploaded to the server was pinned down. Where the improvement actions were focused on. There is an overlapping time between the file uploading from output directory of supplier and the downloading of ST from the Secure File Transfer Protocol (sFTP) server causing the file harvest to be incomplete or missing.

With the root-cause identified, the specific countermeasures to address the absence or incompleteness of key data being used as reference in completing the test process step required for the module being manufactured has been conferred.

Validation has been performed on the effectivity of the proposed improvement through simulations. Since the activity is focused on the software update, trial runs have been performed to confirm the significant impact of the proposed improvements.

1. 0 INTRODUCTION

Digital traceability enables companies to meet their sustainability objectives and achieve a broader set of business goals, including efficiency, resilience and responsiveness. It allows companies to improve operational excellence and set aspirational new goals. In the future, our expectation is that companies with traceable value chains will outperform those without them. (Betti, F., 2021)

As part of the complete traceability of the material or component, the material supplier provides ST the complete map or ID of the VCSEL Siren dice being used to assemble the module. This map is the reference of ST during test process step for the complete traceability record of the die component and module, and to countercheck that all the modules being tested are modules included on that batch lot.

On a usual test process step, the production encountered multiple lots failing due to the error string related to the lot traceability, this is the trigger of the operations to validate the VCSEL data file as this indicates the symptoms of incomplete data file uploaded in the server.

And on the other hand, in the case that the file is missing, an error message displays on the user-interface of the tester. Where this would cause delays on the processing and impacted the operation's cycle time.

Both issues are affecting the operations as this could cause stoppage of test and machine idle status since testing could not proceed.

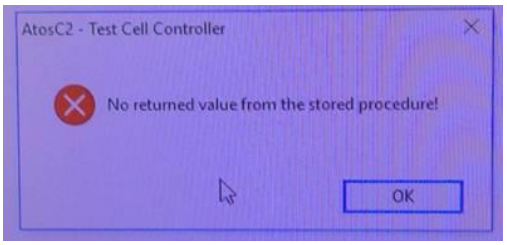

Figure 1. User-interface error message

Table 1. Summary of Lot Affected

Lot ID	Lot Qty @ Spea	Assy QTY	REMARKS
78234C720R	13011	13099	w/ 110u SB910
78235CPL04	14290	14362	w/ 70u SB910
78235CPL0B	14308	13997	w/ 311 -variance on TQT qty

As impact of the missing/incomplete traceability data, there have been lots with over rejection. With this, the lot information has been checked for the validation of the rejects and its description.

78235CPL04

FMT - Get Bin Count By Lot

#	LotId	SBin	SBinCount	SBinName	HBin	HBinCount	HBName
1	78235CPL04	1	14204	Pass	1	14204	Pass
2	78235CPL04	504	1	Continuity_Open	5	4	Continuity
3	78235CPL04	604	3	Continuity_Short	5	4	Continuity
4	78235CPL04	760	2	BC_0_Dark	7	4	Anything related to Ranging, at 0, 50, 100, 300mm
5	78235CPL04	765	1	100_Delta_n_Ratio	7	4	Anything related to Ranging, at 0, 50, 100, 300mm
6	78235CPL04	783	1	Ranging_Grey_300_DARK	7	4	Anything related to Ranging, at 0, 50, 100, 300mm
7	78235CPL04	910	70	2D_READER_fail_Unknown	9	70	Anything related to traceability
8	78235CPL04	521	7	VcselTrim	14	7	IDD

Figure 2. The defect description related to the issue

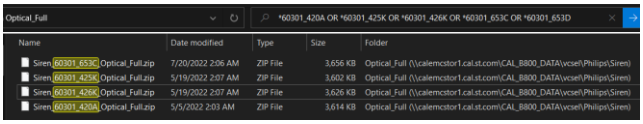

Figure 3. Data availability checking on ST Folder

1.1 Identification of Affected VCSEL ID

Since the VCSEL dice have its distinct traceability ID compiled through a data file, a proper mapping or plot can be generated as part of the initial investigation. Figure 4 shows the distribution of the dice on each affected lot per VCSEL ID. Apparently, there is a specific ID that all the affected modules have its dice came from. From there, further investigations on the VCSEL ID that determined to have commonality, it is then known as the scope of the encountered problem.

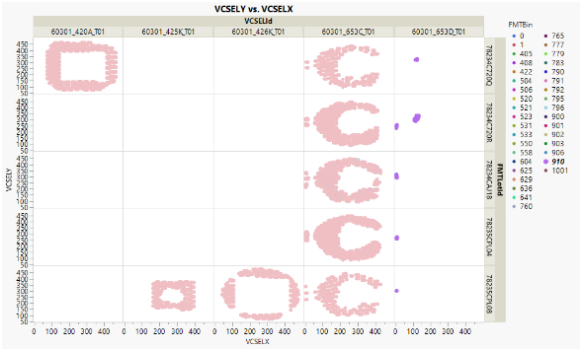

Figure 4. Map of VCSEL ID per lot

From the identified affected VCSEL ID, the further investigation took place. As validated through the data folder where the files are being stored, the identified VCSEL ID has missing record or with incomplete data content. Refer to the Figure 3 for the usual file data validation as part of initial investigation.

1.2 Affected VCSEL ID Binning

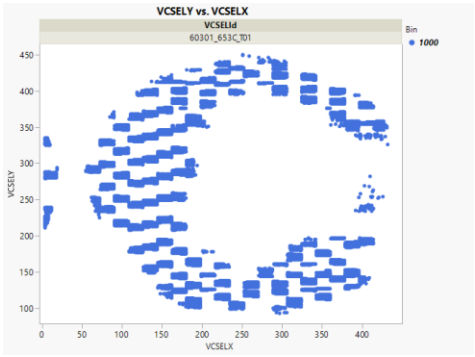

Figure 5. Bin 1 Map of Affected VCSEL ID

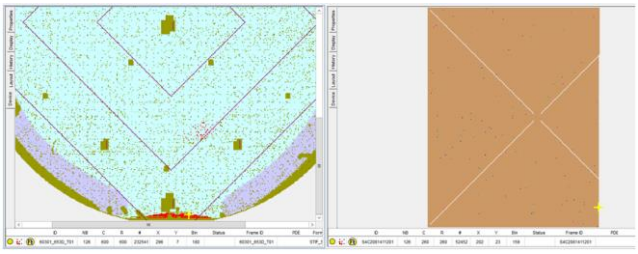

Figure 6. Reconstructed Wafer Binning checking

The material supplier could possibly re-upload the data file in the server so ST could try to evaluate the affected modules again through retest. From there, if the data is complete, the initially affected or failing modules can be recovered.

After performing the file re-uploading and retest process step, it was confirmed that the affected modules were recovered. For ST to avoid this scenario to reoccur, the root-cause for the incomplete or missing data should be addressed and an improvement action should be implemented.

Through interactions of the SQE, DTIT, Supplier, and the Process Engineering, an 8D was requested to complete the investigation and pinned down the root-cause for the proper identification and implementation of effective solution or improvement.

2.0 REVIEW OF RELATED WORK

According Schuitemaker R. on a written paper, a framework is an essential part of any traceability system design as it enables a company to tailor a system to their specific products and requirements.

In addition, the traceability process can be carried out actively or passively. Passive traceability refers to implementing a traceability system that enables the forward and backward approach. Therefore, in case of failure, it is possible to detect the trigger that caused it. Active traceability includes passive
traceability, however, performing active traceability implies using the obtained information to apply constant improvement to the manufacturing processes, controlling and optimizing them (Jansen-Vullers et al., 2003)

In Figure 7, and in Figure 8, there is a simpler representation of the concepts of backward and forward traceability, occasionally known as upstream and downstream strategies. The images show the entire course that the product goes through and how the query is processed to extract the necessary information.

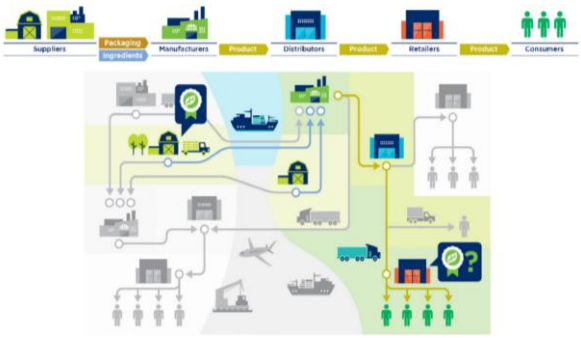

Figure 7. Upstream query process (GS1, 2017)

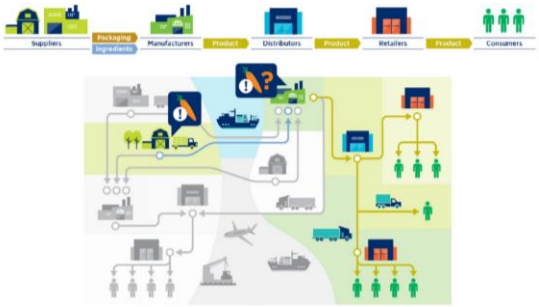

Figure 8. Downstream query process (GS1, 2017)

The International Organization for Standardization defines traceability as the "ability to trace the history, application or location of an object", being the object a product or a service (International Organization for Standardization, 2015)

3.0 METHODOLOGY

For this paper, further investigation started on the mapping of the system work flow. This step provided the overview on when the problem could possibly take place that caused the unwanted problem of missing or incomplete file data downloaded in the Secure File Transfer Protocol (sFTP) Server.

The process mapping has been narrowed down to the steps where the transfer of data take place. From there, the focus of the investigation was easier and faster. This helped to immediately pin down the contributor of the issue and the brainstorming of the possible solutions have been generated.

With the communication and discussion among stakeholders and the supplier, the issue has been identified and the possible solutions have been determined.

3.1 System Work Flow

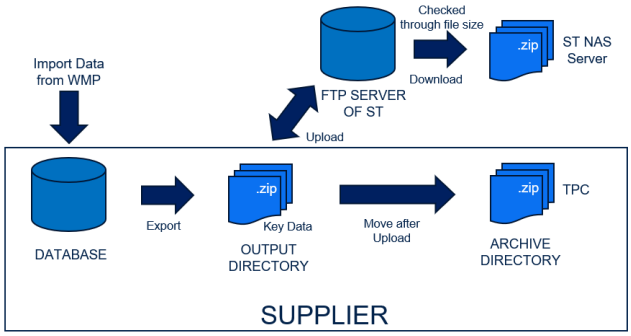

Figure 9. Framework of Flow Diagram of the Data Transfer

Table 2. IS vs. IS NOT

CHECK ITEMS	IS	IS NOT
What is the Problem?	Incomplete Content of Optical full files	Optical full files transferred, not missing, not empty
Where is the problem discovered?	On customer's side	Not on supplier side. Files are successfully uploaded and saved in report folder. Files in the report folder are complete and have no error
Extent (How many/How Much/How Often?)	41614_075C 60301_678J 60301_694K 60301_667G 60301_674I 60301_657K 60301_699A	
When dit it happen	Nov 5th	
Has the problem been seen before?	First occurrence	Did not happen before

From the work flow diagram illustrated shown in Figure 9, it has been identified that the issue could possibly took place on the portion where the files are being transferred since form the source it is validated that data file is complete and accessible.

3.1.1 Force Field Analysis

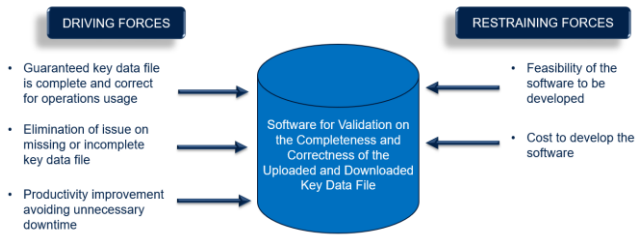

Figure 10. Time delay on FTP downloading

From the identified process step of the source of the error causing the problem, it is then proposed to have a software development that would automatically detect the correctness and the completeness of the key data file being uploaded from the supplier database until the downloaded file saved in the ST Network Attach Storage (NAS).

3.1.2 Delay time on FTP

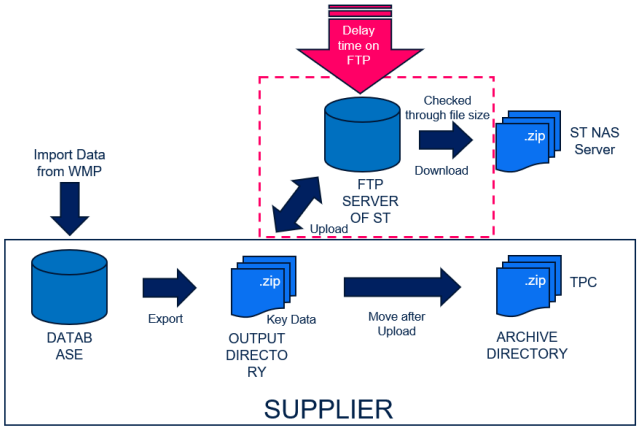

Figure 11. Time delay on FTP downloading

From this solution, the objective is to address the overlapping timing of file uploading from the supplier database and downloading to the ST Server.

Upon validation, this can't be effective enough since the solution is still dependent on the timing from which the possibility of having the file be downloaded to ST NAS while the uploading is on-going could still possibly to occur. This will still result to incomplete key data file.

3.1.3 Renaming .temp to .zip

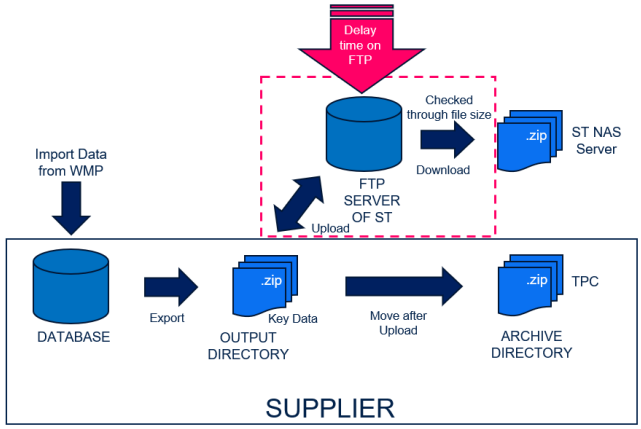

Figure 12. File renaming from .temp to .zip

The file while being uploaded will have .temp as its extension, so regardless of the file uploading timing it will not be downloaded immediately. After the completion of file uploading, it will then be renamed with .zip extension. Then for the next cycle of file harvesting, the file is complete. From there, the upload and download timing of file will not overlap.

This solution provides potential to address the issue encountered that causes missing or incomplete optical file data.

3.1.4 Implement checksum comparison

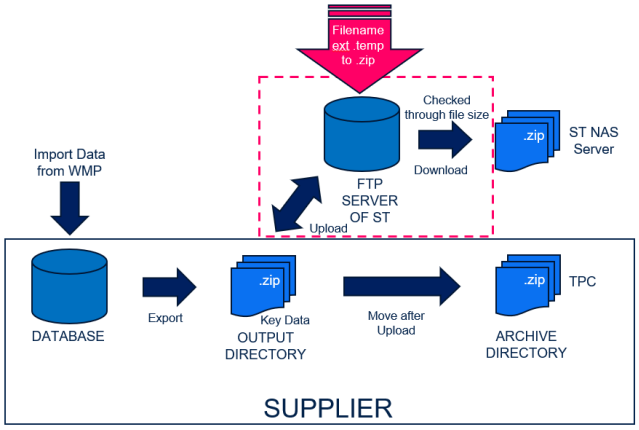

Figure 13. Checksum comparison

On the implementation of the checksum checker software, the supplier implemented a checksum inspection wherein there will be comparison of the checksum from the file uploaded with the downloaded file. If the checksum is similar then it guarantees that file is complete and there is no missing content. From there it is then concluded that implemented action is effective

4.0 RESULTS AND DISCUSSION

With the encountered issue on the test process step. Here below are the summary of lots affected and the impact with the set statistical bin limit for the control. Lots share the same failure which is related to the traceability.

Table 3. Summary of Lot Affected

Lot ID	SB910 Failures	SBL %	SBL Check (0.2% Limit)
78234C720Q	18	0.12%	Passed
78234C720R	111	0.84%	Failed
78234CAJ1A	59	0.55%	Failed
78234CAJ1B	100	0.97%	Failed
78235CPL04	70	0.49%	Failed
78235CPL08	17	0.12%	Passed

These are some of the lots captured during the investigation. It shows the actual affected quantity and the impact on the yield of the lot.

It is the result of the distribution of VCSEL ID batch on different transport lot being assembled during the Assembly process steps.

Table 4. Summary of the VCSEL ID Affected

VCSEL ID	Uploading Date	Uploading Time	Remarks
41614_075C	7-Sep-22	2:13 AM	Incomplete file size in trace database
60301_694K	7-Sep-22	3:02 AM	Incomplete file size in trace database
60301_678J	7-Sep-22	2:50 AM	SFTP trace data importing issue

This table is the list of the affected VCSEL ID identified during the mapping and data tracing. This can be recovered through file data reuploading from the side of the supplier and be downloaded again in ST. Once verified the availability of the data file, retest can proceed for the recovery of initially failing modules.

Table 5. Summary of Validation

Proposed Solution	Result	Remarks
1. Delay time in FTP Server Data Downloading	Delaying on the data downloading to ST FTP Server will still encounter overlapping of file uploading to downloading depending on the	The action will not be effective to address the problem encountered
2. Renaming of file while uploading with .temp extension with .zip once completed	ST FTP Server will only scan the folder with files having .zip extension and proceed the downloading activities. Thus, files with different extension will not be part of the data	File extension renaming can resolve the problem since this could avoid the downloading of data file while the uploading is still on-going.
3. Implementation of checksum comparison between file from supplier database to ST FTP Server	The checksum guarantees that the uploaded file is complete and OK2Download	This helps to countercheck that the uploaded data file is complete. Beneficial to consider that the data file is OK2Download

There were three (3) items that have been identified to be the possible solution to avoid the reoccurrence of the encountered file data issues.

On the validation of the time delay on data downloading from the FTP Server, it has been verified that the issue could still manifest as it is dependent as well with the timing of uploading and downloading. The activities could still overlap causing for ST to harvest the data file while it is being uploaded from the supplier's database resulting to incomplete or missing data file. With that result, it has been invalidated and the supplier did not implement the action.

While on the other hand, the supplier has thought of renaming the file being uploaded with extension of .temp so while the file is not yet completely transferred, ST FTP server would not download the file and only scan for the available files with .zip as extension.

In addition, for the supplier to ensure that the data file uploaded is complete and error-free, another item has been proposed to implement which is the addition of checksum checker. This is systems integration wherein there will be a checksum sent with the data file being uploaded to the FTP server of ST. Then after the completion of data transfer the system would run the checksum checking wherein it will compare the file in the supplier's database to the uploaded file in the ST FTP Server. Once the checksum is verified the same, it would indicate that the file has been uploaded successfully and completely. And in the case that there will be discrepancy, the file will be reuploaded to secure that the data file being sent is complete.

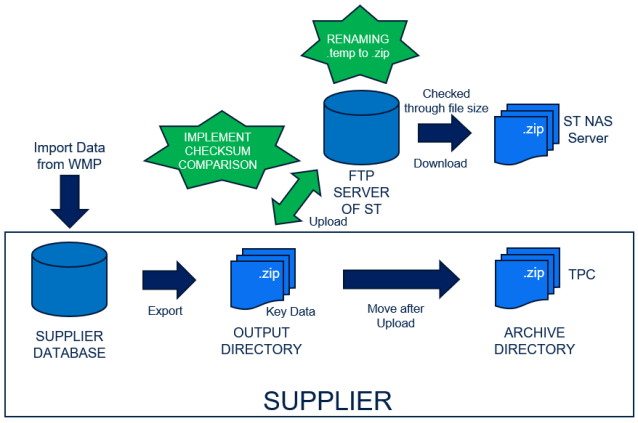

Figure 14. Implementation of Corrective Actions

As the corrective actions in place, the Figure 14 shows the new system framework wherein the integrated network system solution is in place and will prevent the issue to manifest again.

After the completion of the system integration since February 2023, there is no reported missing or incomplete VCSEL ID data file encountered in the test process step.

This confirms the effectivity of the implemented corrective action.

5.0 CONCLUSION

After the completion of the systems validation, it is identified that the issue encountered is due to the interaction in the system between the uploading of data file from supplier's database and downloading to ST FTP Server. The timing from which while the data file is being uploaded, the FTP server initiates at the same time the data harvesting to download the data file.

It is then proven effective that with the network system integration of file renaming from .temp while being uploaded to .zip if completely uploaded to avoid the unintentional downloading of incomplete data file.

The added checksum checking also strengthen the corrective actions making it robust since there is a second level checking of the completeness and integrity of the uploaded and downloaded data file.

With the corrective action in place, the test process step has avoided the unnecessary delay in lot processing caused by incomplete or missing file data.

6.0 RECOMMENDATIONS

The items identified to address the issue is mostly through the effort of the supplier with the help of the SQE and IT Team collaborated to think of a way on how to address the issue encountered. Actions performed is focused on software improvement and system integration wherein the bulk of work was completed by the supplier. Items identified are generated during the conference call with the supplier and served as the brainstorming venue. ST has completed as well a monitoring activity in order to add another level of counterchecking the completeness of file data received prior releasing to the server for traceability use in Assembly steps.

7.0 ACKNOWLEDGMENT

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