# IPC-1782 Standard for Traceability Supporting Counterfeit Components

**Michael Ford**
**Mentor Graphics**

**Abstract**
Traceability has grown from being a specialized need for certain safety critical segments of the industry, to now being a recognized value-add tool for the industry as a whole. The perception of traceability data collection however persists as being a burden that may provide value only when the most rare and disastrous of events take place. Disparate standards have evolved in the industry, mainly dictated by large OEM companies in the market create confusion, as a multitude of requirements and definitions proliferate.

The intent of the IPC-1782 project is to bring the whole principle and perception of traceability up to date. Traceability, as defined in this standard will represent the most effective quality tool available, becoming an intrinsic part of best practice operations, with the encouragement of automated data collection from existing manufacturing systems, integrating quality, reliability, predictive (routine, preventative, and corrective) maintenance, throughput, manufacturing, engineering and supply-chain data, reducing cost of ownership as well as ensuring timeliness and accuracy all the way from a finished product back through to the initial materials and granular attributes about the processes along the way.

Having the proper level of traceability will also help ensure counterfeit components do not end up in a product. Through effective policing in the use of any and all components, any material found to be counterfeit will be immediately traceable to source, and hence responsibility is assigned. IPC 1782 will work hand in glove with the U.S. Department of Defence's current counterfeit component effort.

The goal of this project is to create a single flexible data structure that can be adopted for all levels of traceability that are required across the industry. The scope includes support for the most demanding instances for detail and integrity such as those required by critical safety systems, all the way through to situations where only basic traceability, such as for simple consumer products. A key driver for the adoption of the standard is the ability to find a relevant and achievable level of traceability that exactly meets the requirement following risk assessment of the business.

The wealth of data accessible from traceability for analysis can yield information that can raise expectations of very significant quality and performance improvements, as well as providing the necessary protection against the costs of issues in the market. Taking a graduated approach will enable this standard to succeed where other efforts have failed.

**Scope of standard**
This standard establishes the requirements across different scenarios for supply chain traceability based on perceived risk as defined by the Purchaser and Supplier (AABUS). The standard will apply to all critical products, processes, assemblies, parts, components and items as defined by the Purchaser and Supplier of equipment used in the manufacture of printed wiring assemblies, as well as mechanical assemblies.

Traceability is defined as an unbroken record of documentation of materials, parts, assemblies, processes, measurements and associated uncertainties.

Minimum requirements are based on four levels of traceability for materials and processes. These levels correlate to the IPC Product Classification System (Class 1, Class 2, Class 3) and/or another set of categories of compliance (e.g., IPC-2610 Grades A, B and C) based on the business model/economic needs of the end-use market for the final product (telecom, aerospace, automotive, medical device, and/or consumer electronics) or a subassembly within that product.

**Purpose of standard**

This traceability information is expected to improve operational efficiency and productivity, quality and reliability as well as enable activities such as predictive maintenance in the manufacturing environment. Current implementations of traceability have typically followed a hazy set of requirements often driven directly between customer and manufacturer for example in an EMS scenario. Requirements are based on quality expectations, limitation of responsibility, and management standards such as those defined by ISO.As such, the current definition of traceability differs from sector to sector, company to company, customer to customer and even from order to order.

When negotiating the levels of traceability that is required, the key concern is the cost and accuracy of the traceability data collection. When it comes to the need to use the traceability data, the concern is the completeness and accuracy of the data. On many occasions, the data that is needed is found to be omitted from the agreed specification on cost grounds. The feeling for traceability then is a double negative, in that there is cost and effort the collect the data which may end up being useless. The lack of a uniform component traceability standard has caused an unnecessary consumption of resources (e.g., time, people, money, etc.) to track down and remedy any quality, reliability, etc., issue and has made it difficult to uniformly create and appropriately enforce the necessary contracts.IPC-1782 identifies criteria for tracking component son or in a specific assembly and creates a means to specify different levels of traceability to accommodate different economic and business models/needs.

The purpose of the IPC-1782 standard then is two-fold. It sets out the definitive standard to control what data should be collected, and through the standardisation opens up the capability to introduce the automated collection of traceability data from processes that can support it. In so doing, it drives down the cost overhead. With this achievement in place, traceability can then be applied in a broader sense throughout the industry, for example, the application of traceability to counterfeit components in an organization’s supply chain.

This standard helps organizations more easily ensure end-users/consumers will receive products and services that meet or exceed their expectations and in the most timely and economically viable method.

**Application of standard**

This standard defines a template which can be used for, but not limited to:

- SMT components (including discrete components) and through-hole components
- PCBAs, PCBs, and Base Materials (laminate, glass, resin, etc.)
- Connectors and switches
- Cables
- Mechanical Assemblies and Covers
- Acoustic and RF Components (including Antennas, Power Amplifiers, etc.)
- Software

Levels are defined in the standard that describe up to 16 different levels that can be applied to different sectors in order that there is an appropriate balance between the detail of data collected and the cost / effort / values in doing so. The standard can therefore be applied in sectors as diverse as:

- Mil / Aero
- Consumer electronics
- Medical
- Automotive
- Industrial
- Telecom

**Getting Started**

The flow diagram in Figure 1 shows a simple process used by the user to determine the appropriate levels of traceability required, both in terms of materials and process traceability, based on risk assessment.

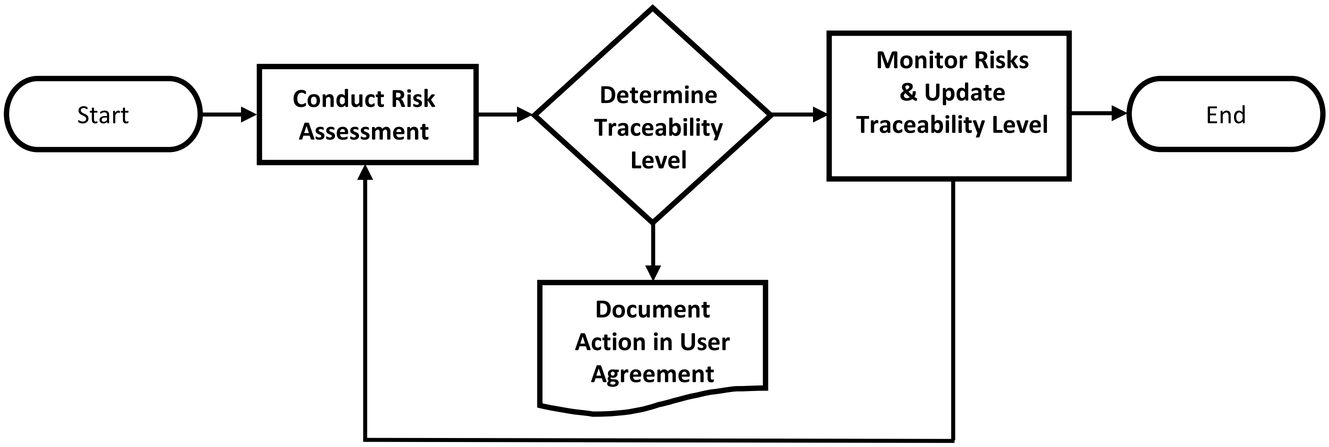



*Figure 1: Determination of Traceability Level*

Approaches to risk analysis can vary between industries and geographies. Traceability has grown from being a specialized need for safety-critical segments of industry to now being a recognized value-add tool for industry as a whole. What constitutes a risk can be quite different say between the failure of a satellite circuit in space, the failure of a missile to differentiate a target, or the protection of the brand associated with a consumer electronics product. Traceability, as defined in IPC-1782, represents the most effective quality tool available, which can become an intrinsic part of best-practice operations. This is accomplished with the encouragement of automated data collection from systems already integrating quality, manufacturing, engineering and supply-chain; reducing cost of ownership and ensuring timeliness and accuracy. This can greatly influence the cost versus risk assessment. The wealth of data accessible from traceability for analysis can yield information that can raise expectations of very significant quality and performance improvements, as well as providing the necessary protection against the costs of issues in the market.

**Levels of Traceability:**
IPC-1782 creates a flexible data architecture that can be adopted to represent all levels of traceability that are required across industry. This includes support for the most demanding instances for detail and integrity such as those required by critical-safety systems, all the way through to situations where only basic traceability may be needed, such as for simple consumer products. This standard presents a cellular-based structure so as to provide required flexibility and to create an efficient format in which unnecessary duplication of data is avoided. The format also allows data to be added after the completion of production, allowing further detail to be added as it becomes available.

Throughout the design of this standard, different key usage models of traceability were considered. It is written to explain how access to critical data, when needed to identify the exact scope of any market issues, can be ensured, while also being capable of providing “live” access to detailed product build records for advanced quality analysis. This standard also demonstrates the benefits of best-practice data collection through automated means. This is reflected in the definitions of the different levels of traceability.

To suit the many different sets of requirements for traceability across the various sectors of the electronics manufacturing industry, four levels each have been defined of material (M1 through M4) and process (P1 through P4) traceability (see Table 5-1). These levels may be combined in any way, such as to create requirements which can be agreed upon by user and supplier (i.e., the two parties agree to traceability of M3 with P1).

*Table 1: Overview and Summary of Traceability Levels*

| | **Level 1: "Basic"** | **Level 2: "Standard"** | **Level 3: "Advanced"** | **Level 4: "Comprehensive"** |
|---|---|---|---|---|
| **Material Traceability** | **M1:** Listed to work-order by part number and incoming order | **M2:** Listed to batch/work-order by unique material ID (where applicable) | **M3:** Listed as loaded, by PCB-A, by unique material ID (subject to the constraints of the processes) | **M4:** Exact materials used on each PCB-A |
| **Process Traceability** | **P1:** Significant process exceptions against batch record/traveller | **P2:** Capture common key process characteristics, exceptions and test and inspection records to serialized PCB-A | **P3:** Capture all key process characteristics, exceptions and test and inspection records to serialized PCB-A | **P4:** Capture all available metrics: complete test results and process data |
| **Data Integrity (in the range of)** | 3 Sigma | 4 Sigma | 6 Sigma | 9 Sigma |
| **Data Collection / Storage Automation** | 90% Manual | 70% Automation | >90% Automation | Fully Automated |
| **Reporting Lead Time** | 48 hours | 24 hours | 1 shift | Live Access |
| **Data Retention Time** | Life of product plus 1 year | Life of product plus 3 years | Life of product plus 5 years | Life of product plus 7 years |

Levels are roughly defined as follows:

- **Level 1 "Basic"**traceability can be considered an entry level of traceability. This is the minimum level expected for responsible manufacturing where any degree of traceability is required. It shows the materials used for a work-order of products. Requirements at this level are set such that adoption should not be significantly challenging for a properly managed operation, thereby representing a low operational cost and a low cost of any change being required. Individual PCBs and materials are not serialized. Assemblies are grouped and identified under production lot/date code/work order/batch code, while materials are identified using their part number and incoming order information. As data collection is predominantly manual, it is expected that rare omissions of data will occur.

  Together with the lack of use of unique IDs for materials or PCBs means the value from this Level 1 Traceability is limited in terms of the ability to identify the scope of an issue or to ensure conformance to operational standards. The storage of traceability data at Level 1 Traceability may comprise a mix of computerized records and manual record keeping, across different locations/sites. As such, the time required for the use of traceability data for analysis of any issue is high.

- **Level 2 "Standard"**traceability builds on level 1 traceability by adding the unique identification of both materials and assemblies. This allows the ability to show the materials that were available for use during the period each sub-assembly was/is being processed. Materials should gain a unique material ID as early as possible upon entry to the manufacturing site.

  Typically, each individual carrier of materials obtains a unique ID, such that each individual carrier of materials can then be tracked. For process traceability, the PCB should also receive a unique ID as early in the production process as possible. Starting with each final product, all key sub-assemblies, such as PCBs, all the way back through to initial assemblies consisting of all raw materials, should have a unique ID assigned, such that a hierarchy of traceability identified by the final serial number of the shipped product can relate to each of the sub-assemblies within the product. In order to manage the flow of serialized assemblies, a work-order structure should be adopted to define the processes through which sub-assemblies will pass. A selection of key process data is then captured for each product at each process.

It is expected that there is an increase in the level of automation of data capture with level 2 traceability, as computerized systems will typically be required to provide the serialization process, manage the database of individual material and product elements and provide the work-order management required. This reduces additional effort of manual data management as well as increases the accuracy and timeliness of data capture. In situations in which data capture is built into the operating procedure, increased assurance of compliance with procedures can also be achieved, thereby making cost of ownership of level 2 traceability to be balanced with operational benefits. The ability of level 2 traceability to limit the scope of product recall and rework is significantly superior to level 1 traceability.

- **Level 3 "Advanced"** traceability is a tightened specification of level 2 traceability, in which more detailed information about processes and materials are defined and retrained. Level 3 traceability also promotes a higher degree of data gathering automation, with an associated decrease in degree of errors and an increase in the speed of use. As such, this level 3 traceability brings significant additional value from the quality and assurance perspective to the operation.

- **Level 4 "Comprehensive"** traceability is the highest level of traceability, representing an achievable goal that demonstrates maximum value of traceability in terms of the precise definition of the complete production build record of any product and assembly. In level 4 traceability, data for both materials and traceability are collected in precise detail. Material data are precise, with no doubts of where materials are exchanged or replenished during the execution of placement, for example. In level 4 traceability, process data collects results in a comprehensive set of data. In all cases, the intent is that data are captured automatically by way of integration or interfacing with operational and supporting systems, ensuring no data are lost or delayed. The use of level 4 traceability data, therefore, is compatible with updates and maintenance of live dashboards showing various key performance indicators (KPIs).

Table 2 provides recommendations for mapping IPC-1782 levels of traceability to the IPC Product Classification System. The classification and the final choice of traceability levels shall be AABUS.

| **Process / Material Level** | **M1** | **M2** | **M3** | **M4** |
|---|---|---|---|---|
| **P1** | Class 1 | Class 1 & Class 2 | | |
| **P2** | Class 1 & Class 2 | Class 2 | Class 2 | |
| **P3** | | Class 2 | Class 2 & Class 3 | Class 2 & Class 3 |
| **P4** | | | Class 2 & Class 3 | Class 3 |

*Table 2: Traceability Level to Product Classification System Matrix*

**Hierarchy of Traceability Data:**

The adoption of a hierarchy allows a complete tree of traceability data to be constructed, linking together different "cells" of data that describe different elements of the traceability data. The uppermost head of the traceability data is likely to the completed shipped product. This product will contain sub-assemblies and component materials, each of which may have their own tree of traceability data cells linked. In this way, critical components can be traced all the way back to the fundamental manufacturing processes where the need exists. Figure 2 provides a visual representation for the cell structures belonging to a defined assembly, showing how sub-assemblies are related, each of which is the head of another traceability cell structure.

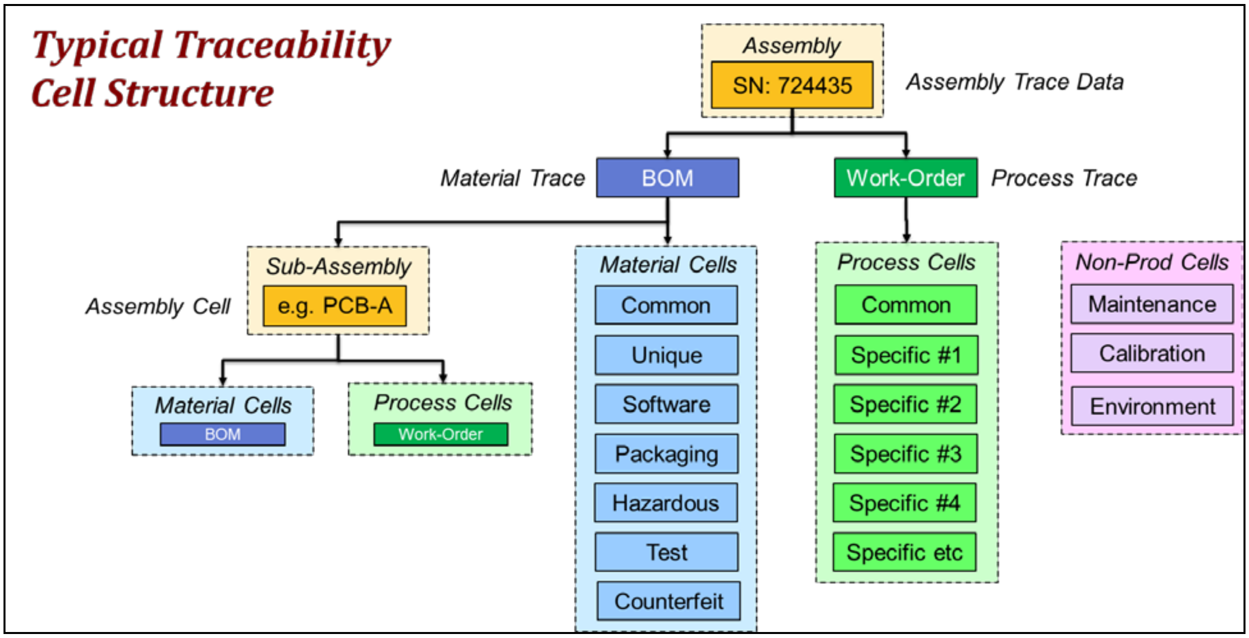



*Figure 2: Traceability Cell Structure*

**Traceability Data Cells**

The tree is made up of different cells of data, each type of which are populated according to the designated level of traceability, either material or process. Cells link together so as avoid unnecessary duplication of data. For example, a reel of materials may be used on an SMT placement machine where many PCBs are populated. The traceability record for each PCB will contain the ID of the material used, which refers to another cell that holds the actual traceability data of the reel. All PCBs made using that reel can therefore link to the same instance of traceability data, rather than containing duplicate copies. This very much ensures that the traceability data is consistent and concise. While this paper seeks to summarize the defined content, the full detail can be found in the draft working document of the IPC-1782 standard. The cells currently defined are as follows:

- **Assembly Cell:**
  - The Assembly Cell is the head of the traceability structure. For a complete product, the Assembly Cell refers to the final product, by serial number if it exists.
  - The Assembly cell also represents sub-assemblies which themselves have a tree of traceability cells linked to them.
  - The associated data within the Assembly Cell is as follows:
    - Production Bill of Materials (BOM): Components and sub-assemblies
      - Where possible, components should be referenced using an individual unique reference designator.
      - Components without a unique specific reference designators should be called with a standard descriptive name (such as screws, M3, 5mm)
      - The higher the level of material traceability adopted, the more precise the detail should be, in terms of events such as material replacement, slicing accuracy on SMT machines and in terms of certainty of exactly which material was used for each reference designator
      - Each material entry in the Assembly cell links to an associated *Material Cell*
      - Materials with unique ID – (e.g., serialized battery)may have additional unique process information, and are described by an associated *Unique Material Cell*
      - Sub-assembly traceability information is defined in the associated *Assembly Cell*

            - Software traceability is defined in the associated *Software Material Cell*
        - Hazardous/Prohibited Substance Content Summary is also summarized in an associated *Hazardous/Prohibited Substance Cell*
        - Information about the processes that the assembly has been through is contained in an associated *Process Data Cell*. The items and detail of data recorded about the processes is again dependent on the level of traceability selected.

- **Material Cells:**
    - Materials may be identified by a unique ID (e.g., battery, screen/display, hard disk drive (HDD), central processing unit (CPU), have a unique ID on their material carrier (i.e., those on an SMT reel, tray or stick or any materials in a bag, pallet, box etc.) or for generic materials, be identified by part number and local. Key fields within the cell are used to define the scope of the cell as to how the materials are identified.
    - Depending on the level of material traceability adopted, the cell may include such items including internal part number, receiving order name, purchase order, date of receipt, material carrier unique ID, quantity, manufacturer name and part number, batch code, place of manufacture, MSD classification, shape code, supply format, use-by date, counterfeit determination, ESD Classification, incoming inspection test record, as well as additional data in more detail identified in linked cells such as a *Test Cell, Hazardous Substance Cell, Counterfeit Component Cell*
    - Unique materials or sub-assemblies are identified individually by unique ID (e.g., battery, screen/display, HDD, random-access memory (RAM) module, CPU, etc.).Additional requirements are needed for these materials, such as manufacturer unique ID. Information is defined in the associated *Assembly Cell* if it is a sub-assembly and *Test Cell* for example.
    - A software component of a product is treated in the same way as a regular material, that is, as part of the BOM, with related traceability, for example software revision checksum (CHKSUM), documentation of software processes etc.
    - Other cells exist for packing and shipping materials, and labels

- **Process Data Cells:**
    - This cell describes the process history to create the assembly
    - Information about the work order is defined in the associated *Work-Order Information Cell*
    - A list of actual processes, in sequence. The actual number of process sequences may exceed the number specified in the work-order (i.e., due to repair loops). Process data are required for each listed process, according to the chosen level of traceability.
    - Due to the varied nature of the many possible production process, and the wide range of associated data, the process data is split into two sections. The first contains the common process traceability data, applicable to all processes equally, and the other is the process dependent section containing the unique process traceability data elements
    - Common Process Traceability data includes logical process name as described in the work-order, serious process exception, such as breakdown event, unique process ID, date and time in / out of the process, operational documentation, program / setup data (name / revision / date), process operator, date of last PM / calibration, completion certification and environment data.
    - Unique Process Traceability Data is defined for each type of process, including:
        - *Unique PCB Marking:* the marking of the PCB and or individual boards with a unique ID that can be scanned to identify the specific board.
        - *Product Routing Station:* including PCB flip / turn, storage / stock / waiting area etc.
        - Screen Printer: including stencil ID (unique ID or part number), duration that the paste had been opened, number of cycles performed by the stencil since maintenance, age of squeegee/syringe, total cycle count etc.
        - *Automated Paste Inspection:* including pass/fail result, inspection/ test record detail or even retained images

  - *Glue Dispenser:* including stencil and squeegee ID if applicable, number of cycles since last maintenance, programmed speed/pressure, Duration since glue removed from cold storage etc.
  - *SMT Placement:* including material exchange events, verification events, pass / fail of visual inspection, manually recovered pick-up error cycles, automated material exchange event, automated splicing detection, fiducial read-error event, panel location error, MSD-remaining exposure time for each MSD component, automatically recovered pick-up error cycles, instances of safety stop and other machine stops or exceptions, actual nozzle used per each reference designator etc.
  - *Pin Through-Hole Insertion:* Including material verification, manual material exchange event, splice (joining the tape), manually recovered pickup error cycles, material exchange event fiducial read error, panel location error, instances of safety stop and other machine stops or exceptions.
  - *Manual PCB Assembly:* Including manual material verification and exchange events, key tools, including gloves, guides etc.
  - *Reflow:* Including profile ID or name actual parameters (e.g., temperature, speed, etc.) recorded, indication of how the profile was developed, cooling profile beyond machine down to ambient condition
  - *Wave Solder/Selective Solder:* including profile, fixture ID, actual temperature/speed readings, chemical composition of solder pot etc.
  - *Manual Visual Inspection:* including actions taken, pass/fail, specific defects, acceptance criteria, magnification used etc.
  - *Automated Optical Inspection (AOI) and X-Ray Inspection:* including pass/ fail, specific defects, full test result capture, false reject rate, acceptance criteria, retained images etc.
  - *In-Circuit Test:* including fixture ID and revision, pass/ fail, full parametric test result capture, fixture cycle count
  - *Press Fit Operations:* including manual material exchange event, tooling ID, profile name, actual insertion force or pressure, speed
  - *Touch-Up:* including all rework and touch-up recorded, tooling ID, tip size/shape, iron temperature, mass reflows cycles
  - Encapsulation: including speed, cure time and temperature, vibration settings
  - *System Assembly (Final Assembly):* including tooling ID, torque measurement, last calibration/verification
  - *Mechanical Assembly Operations (Includes Robots):* including manual material exchange event, tooling and fixture IDs, torques driver ID, critical parameters for hold times, pressures, cure times, etc., for adhesives, conformal coatings, under-fill, heat sink pressure pads, etc.
  - *Software / Firmware Programming:* including pass/ fail, checksum recorded
  - *Quality Assurance Check/Test/Inspection:* including pass/ fail, defects recorded
  - *Repair/Rework Station:* including tooling IDs, settings and recipes, tooling details and configurations, repair method – preparation (for example cleaning), testing during/after repair
  - *Functional Test:* including definition of test, pass/ fail, details of test parameters, results capture
  - *Burn-In / Extended Test:* including pass/ fail, static/ dynamic, temperature / time profile, parametric test results
  - *Shipping/End User/Post Manufacturing Environment Test:* including drop-test, shipping profile test, humidity & temperature & pressure, pass/ fail, test profile, parametric test results
  - *Packing and Shipping:* including quantity, weight, carrier, serial numbers, shipping destination, specific material configuration, shock monitor ID & setting (limit values)

- Process Deviations: Theseare deviations for a range of products which have been planned in advance, deviation number (incident number), customer approval
- Labelling: Unique label information, image of applied key label(s)

    - Exceptions: These are unplanned deviations (i.e., smoke, dust, high-temperature conditions or any other environment issues) which have affected one or more products which caused mitigating action to be taken. Details can include exceptions encountered, such as wiped PCB due to misprint, hand placed part normally machine placed, work-order processed with known shortage, process step performed out of sequence
    - Non-conforming items: Identify and document the nonconformance condition of affected items. Records include the inspection results, evidence of performance of required test or inspection, extent of nonconformance, disposition of nonconforming items, and responsibility for corrective action. The items shall be positively identified to permit recall in the event of nonconformity to specified requirements.

- **Work-Order Information Cell:**
    - Information that describes the work-order used to produce the assembly, including unique work-order name, product reference, planned quantity, process list, theoretical processing times, scheduled start/end time, actual start/end time
- Hazardous Substance Cell:
    - A list of key elements that make up a material or assembly which can be used to represent the hazardous content of a material/assembly/finished product, reducing taxation and recycle costs.
    - List of substance codes and amounts (g, mg, pico grams etc.)
- Counterfeit Component Traceability Cell:
    - The result of visual inspection or automated determination of genuine components/assemblies. Includes the test or inspection statement, a flag to state whether the determination statement was derived manually or through an automated process and detailed result of visual inspection

- Material Test Cell:
    - A list of tests and results for the material or assembly including functional testing which can extend across a broad area of unique tests and associated result patterns. Information can include pass or fail, single, sample or bulk test, test equipment calibration statement, single, sample or bulk test, test name and measurement details upper and lower limits as well as measured value

- Process Maintenance Cell:
    - Process maintenance events and tasks can have significant effect on the quality of production. Planned maintenance events usually take place between work-orders, so they cannot be tied to a specific production work-order or product unit. Using the timing of these events relative to work-order execution, however, can aid root cause analysis. Unplanned maintenance is usually a breakdown of a process in terms of it not being able to work within defined parameters. These cases usually happen during production, resulting in a high risk of effect to the product unit being manufactured, as well as affecting a change between the conditions of the process before and after the maintenance event. Information includes process, date and time for the start and end, planned (scheduled) or unplanned (breakdown) flag, maintenance job code/description the responsible person, parts replaced, repaired or adjusted etc.

**Standard Going Forward**

The draft document created by the committee is currently going through reviews that include a widening circle of interested parties. It is encouraged for anyone with an interest in traceability to obtain a copy of the draft document, to read through it and feed comments back to the committee.

The committee looks forward to the time, currently estimated as the end of 2016, when the IPC-1782 can start to be used by different companies, creating the opportunity for enhanced quality, conformance and control of manufacturing, while at the same time acting to reduce the costs of traceability data collection, and bringing value to the manufacturing organisation itself.

# IPC-1782 Standard for Traceability

# Supporting Counterfeit Components

Michael Ford Mentor Graphics

# Counterfeit Is Not Funny…

- Safety concerns
- Brand image / company reputation
- Cost of market issues including recalls
- A barrier to technology adoption

# The Reality of Counterfeit Ingress

**Opportunity:**

- Many touch-points
- Raw materials
- Sub-assemblies
- Finished Products

**Cleverness:**

- Labels can be copied
- IDs are not hard to forge

Today, There Can Be No Guarantees

# Counterfeit: Risk versus Reward

**Today:**

- "Lost" in the crowd
- Buried in the detail
- Plausible deniability


**With Traceability:**

- Detection = prosecution
- Precise track-back of which, when, where, and who

With Real Traceability, Counterfeit Does Not Pay

# Traceability Today

**What is It?**

- Different in each case
- Negotiated
- Resented


**A Burden:**

- Additional cost
- Additional work
- Will it actually be effective?

Key for success: Can we turn the burden into a value?

# “A Single Traceability Standard For The Whole Industry”

IPC-1782

# IPC-1782 Concept & Background

## *Compelling Event*

- Due to a recent industry wide memory issue, a huge resource and cost was needed to find and remove impacted products
- IPC was approached and approved the development of a comprehensive tiered component traceability standard
- The working group is starting with SMT components to develop a template for other parts
- Draft completed in record time

# IPC-1782 Core Values

*Making Traceability Practical*

- Reasonable to implement with "off-the-shelf" technologies
- Economically viable / good return-on-investment
- Appropriate level of detail can be selected based on risk
- Importance of automated data capture
- Ultimate goal is to provide coherency
- Efficient approach of data storage

# IPC-1782 Concept & Background

*Removing The Burden*

## Insurance

- Scope of recall
- Show me the data
- Proof of Operation

## Assurance

- Conformance
- Do it “right the first time”
- Counterfeit track-back

## Quality

- Yield
- “One-off” analysis
- Lower returns
- Process defined maintenance

## Safety

- Pro-active management
- Appropriately focussed intelligent response

## Reliability

- More refined reliability models

IPC-1782 Traceability Values

# Historical Barriers & New Opportunities

## *Bringing Traceability Up To Date*

- Traceability has been applied uniformly independent of risk
- Automated data capture and "Big Data" tools are now more widely available
- IPC-1782 brings the whole principle of traceability coherently up to date
- Easy to articulate in a contract
- Traceability, as defined by IPC-1782 represents the most effective quality tool

# Risk Analysis Determines Traceability Need

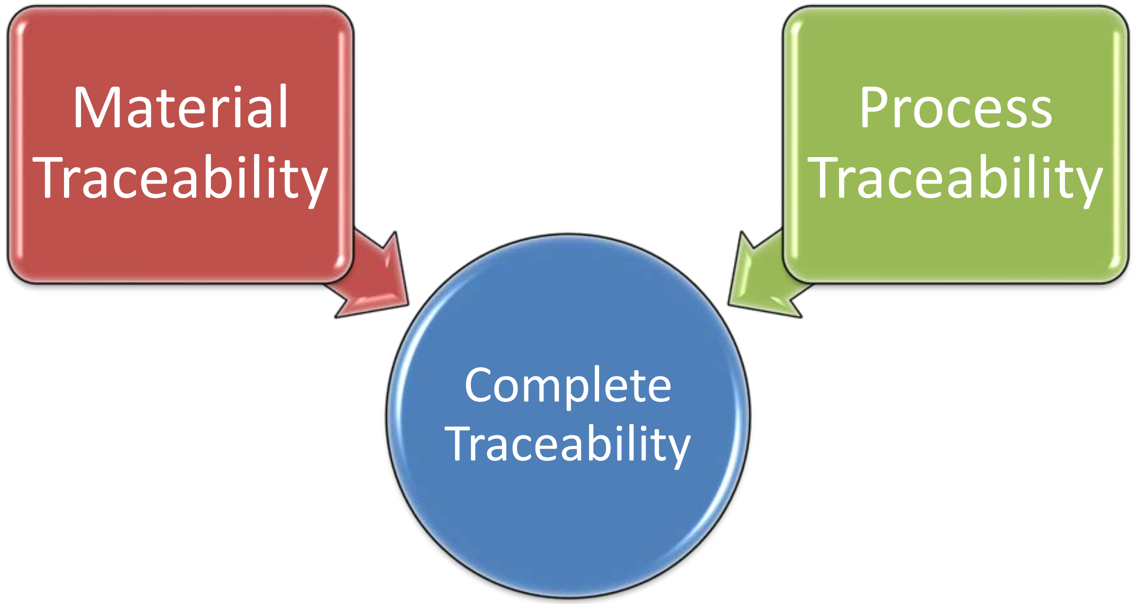
## *Risk Assessment Example*

### Risk Assessment Matrix from MIL-STD-882-E

| RISK ASSESSMENT MATRIX | | | | |
|---|---|---|---|---|
| SEVERITY / PROBABILITY | Catastrophic (1) | Critical (2) | Marginal (3) | Negligible (4) |
| Frequent (A) | High | High | Serious | Medium |
| Probable (B) | High | High | Serious | Medium |
| Occasional (C) | High | Serious | Medium | Low |
| Remote (D) | Serious | Medium | Medium | Low |
| Improbable (E) | Medium | Medium | Medium | Low |
| Eliminated (F) | Eliminated | | | |

# Content of Traceability

***Practical Adoption Of A Single Standard***




- The complete scope of traceability data collection includes many elements
- Details can be divided into Materials and Process
- Different levels of details of each are relevant in different situations
- The appropriate combination can be VOLUNTARILY agreed between parties

# Traceability Levels

## *Quick Reference Table*

| | Level 1 "Basic" | Level 2 "Standard" | Level 3 "Advanced" | Level 4 "Best" |
|---|---|---|---|---|
| Material Traceability | **M1:** Listed to work-order by part number and incoming order | **M2:** Listed to work-order by unique material ID | **M3:** Listed as loaded, by PCB, by unique material ID | **M4:** Exact materials used on each PCB |
| Process Traceability | **P1:** Significant process exceptions against batch record/traveler | **P2:** Capture common key process characteristics, exceptions and test and inspection records to serialized PCB | **P3:** Capture all key process characteristics, exceptions and test and inspection records to serialized PCB | **P4:** Capture all available metrics: complete test results and process data |
| Data Integrity (in the range of) | 3 Sigma | 4 Sigma | 6 Sigma | 9 Sigma |
| Data Collection / Storage Automation | 90% Manual | 70% Automation | >90% Automation | Fully Automated |
| Reporting Lead Time | 48 hours | 24 hours | 1 shift | Live Access |
| Data Retention Time | Life of Product plus 1 year | Life of Product plus 3 years | Life of Product plus 5 years | Life of Product plus 7 years |

# Importance Of Automated Data Capture

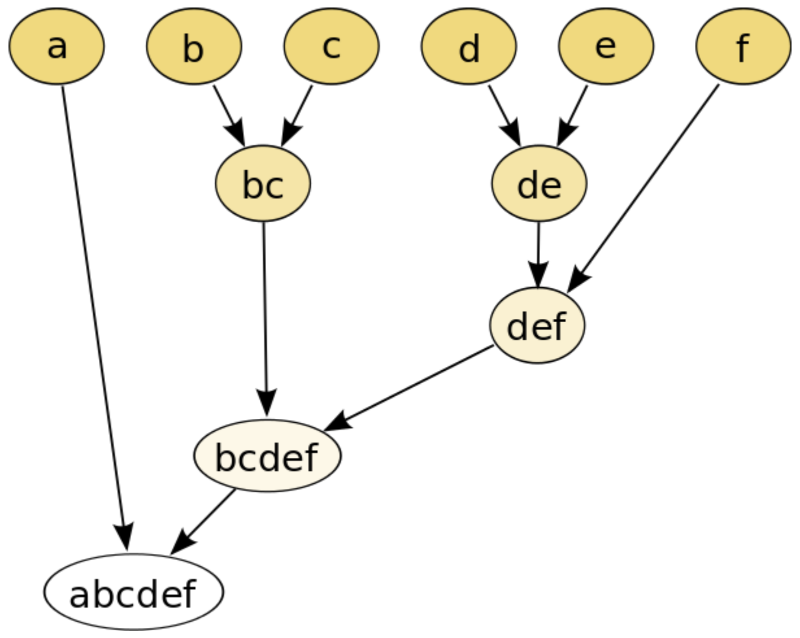
***Reliability, Timeliness, Accuracy***

- Costs of data collection and analysis are minimized
- High data accuracy
- Immediate access to critical information
- Higher levels of efficiency with data-driven decisions
- Root cause analysis can be reached with greater expedience

# Cellular Approach To Traceability Data

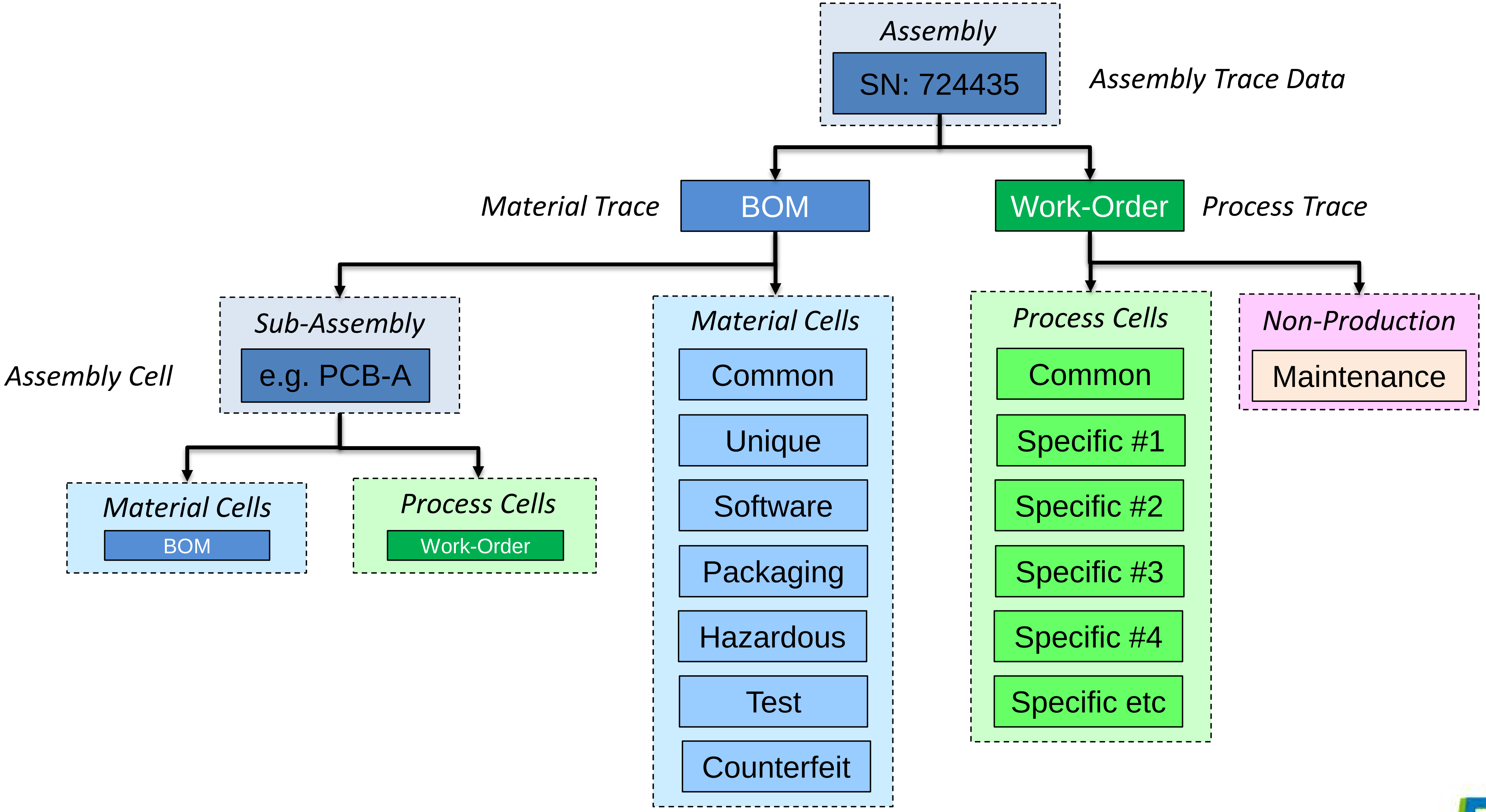
***Organization Of Traceability Data In An Efficient Way***

- The traceability data of one product can be very significant in itself
- Multiplying that be the number of the units made is incomprehensible
- A method was found to eliminate duplication, and inconsistency
- A single structure to represent all levels
- Make it possible to easily add information or links to other information



# Cellular Approach To Traceability Data

## *Organization Of Traceability Data In An Efficient Way*



## Thank you!

## We Look Forward To Your Questions And Comments