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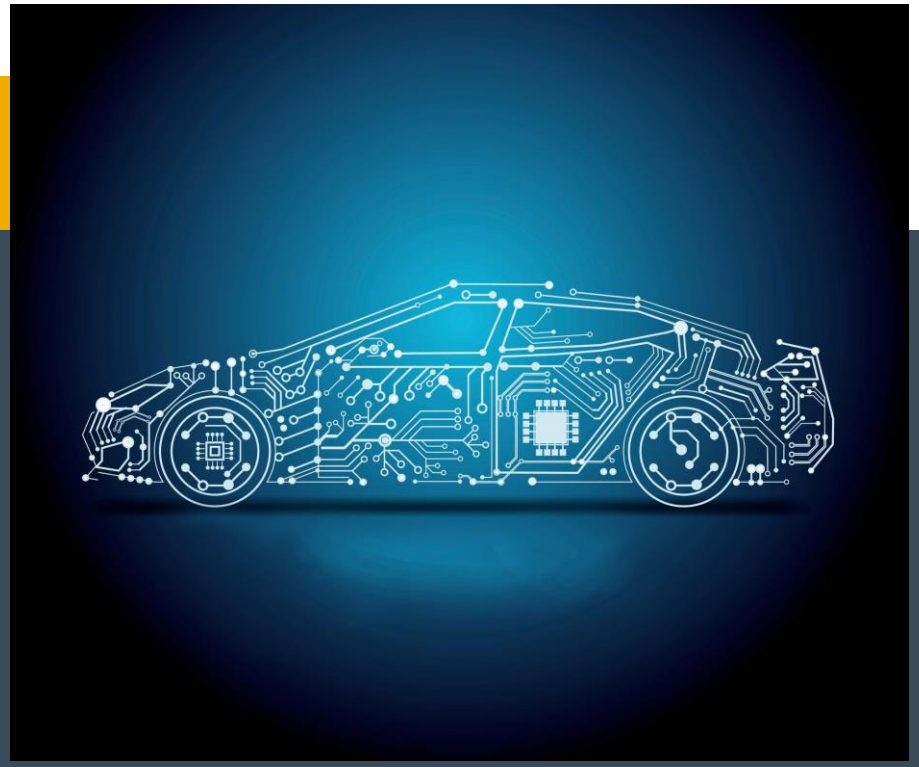
Meet the challenges of automotive electronics ,

Driving to success with IPC standards



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Mar. 26, 2024

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Content

IPC简介

- **成立于1957年**，IPC是全球电子制造业最有影响力的行业组织之一，最初由北美6家PCB制造商发起成立，全称为 Institute of Printed Circuits 印制电路协会。如今，IPC旨在帮助OEM原始设备制造商、EMS电子制造商、PCB印刷电路板制造商、线束线束制造商以及电子行业供应商更好地制造电子产品。
- **IPC 使命:** Furthering the competitive excellence and financial success of members. **提升会员竞争优势，使其获得财务成功。**
- **IPC 愿景:** Helping the World Build Electronics Better. **帮助世界更好地制造电子产品。**

1957-1966

IPC正式成立

出版《IPC-A-600印制电路板的可接受性》

1967-1976

IPC活跃于IEC

出版第一份《印制电路板市场调研报告》

1977-1986

接受ANSI认证

出版《IPC-A-610 电子组件的可接受性标准》

1987-1996

定义EMS行业

(电子制造服务业)
发起IPC印刷电路博览会(IPC Expo)

1997-NOW

中国办事处成立

出版《IPC-A-620标准》
成立设备制造商、焊料、无铅化等理事会、委员会

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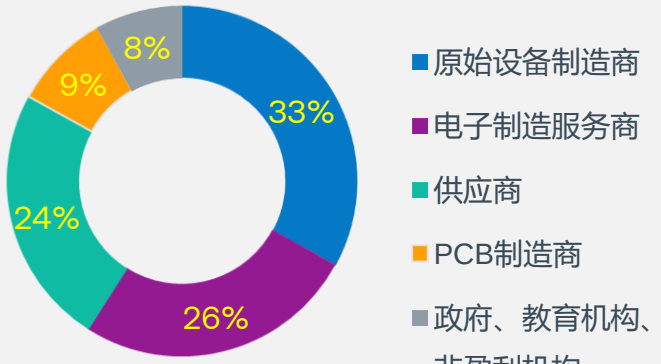
IPC全球分布及亚洲布局

“作为会员驱动型的组织，**IPC成立至今已有3200+集团会员分布在全球64个国家**。结合中国“十四五”规划和2035年远景目标，IPC聚焦产业标准、高技能人才教育、科技创新解决方案等项目，集聚全球产业链资源，提高中国电子制造业的竞争优势，促进中国电子制造业的**高质量发展。**”

会员全球行业分布



- IPC于2002年在上海开设了其在亚洲的第一个办事处。目前在**上海、深圳、台北**设有办事处，在**日本、韩国、泰国、越南**设有常驻团队。

- **IPC 亚太区委员会**
  - ATG: Asia Task Groups
  - ASSC: Asia Standards Steering Committee
  - AESC: Asia Education Steering Committee
  - AGRAC: Asia Government Relations Advisory Committee
  - CAEC: China Automotive Electronics Committee
  - CIMSC: China Intelligent Manufacturing Steering Committee
  - KAC: Korea Advisory Committee

- **IPC 亚太区标准技术组：16个**

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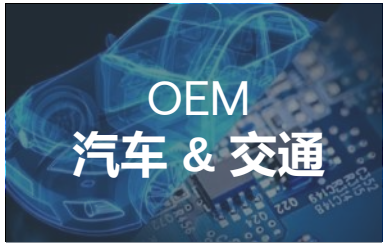

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鵬鼎控股 AVARY HOLDING · COMPEQ · 住友电工 Connect with Innovation · KINWONG 景旺电子 · SCC 深南电路 · 生益电子 · 生益科技 · TTM Technologies

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IPC 亚太区开展的服务

标准

IPC拥有超过300多个活跃的多语言行业标准，超过70个国家和地区的企业采用了IPC标准。

认证培训

以IPC标准为基础，为业界提供课堂培训和认证项目。每年约有12万人次获得IPC认证。

工厂审核与认证

通过认证证明企业符合现有行业要求的IPC标准并承诺保持高质量。让企业成为行业首选的可资信供应商。

职业教育

IPC对行业职业人员提供职业技能教育、实习生项目以及院校合作等，从而促进行业人才的发展。

会员服务及活动

IPC开展一系列会员专属活动。包括CEMAC中国电子制造年会、IPC WorksAsia、技能大赛等。

解决方案

IPC与电子制造行业合作，了解行业面临的挑战，并与我们的成员合作开发解决方案。

IPC CEMAC 2023

IPC WorksASIA

IPC Masters Competition China 电子装联大师赛

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IPC标准

IPC标准在全球范围内被业界广泛采纳，现有的超过**300份**IPC标准和指南覆盖电子制造的各个环节，帮助制造商提升产品质量、可靠性、一致性；使产品生产过程更规范，废品率更低，从而降低成本；改善制造、质量等部门之间，设计、工艺、操作及检验等人员之间乃至行业上下游之间更好的沟通。

1. 全球**70+**个国家的**5000+**专家志愿者参与制定（中国活跃的专家志愿者超过**500**名）。
2. 为整个供应链提供普遍接受的标准和语言；最受欢迎的IPC-A-610和IPC-J-STD-001标准已被翻译成近**20**种语言在近**70**个国家应用。
3. 涵盖电子产品设计、材料、PCB制造、组装、测试、验收等各环节。
4. 提高产品设计可制造性，质量可靠性。
5. 提高生产效率，控制成本，减少返工和浪费。

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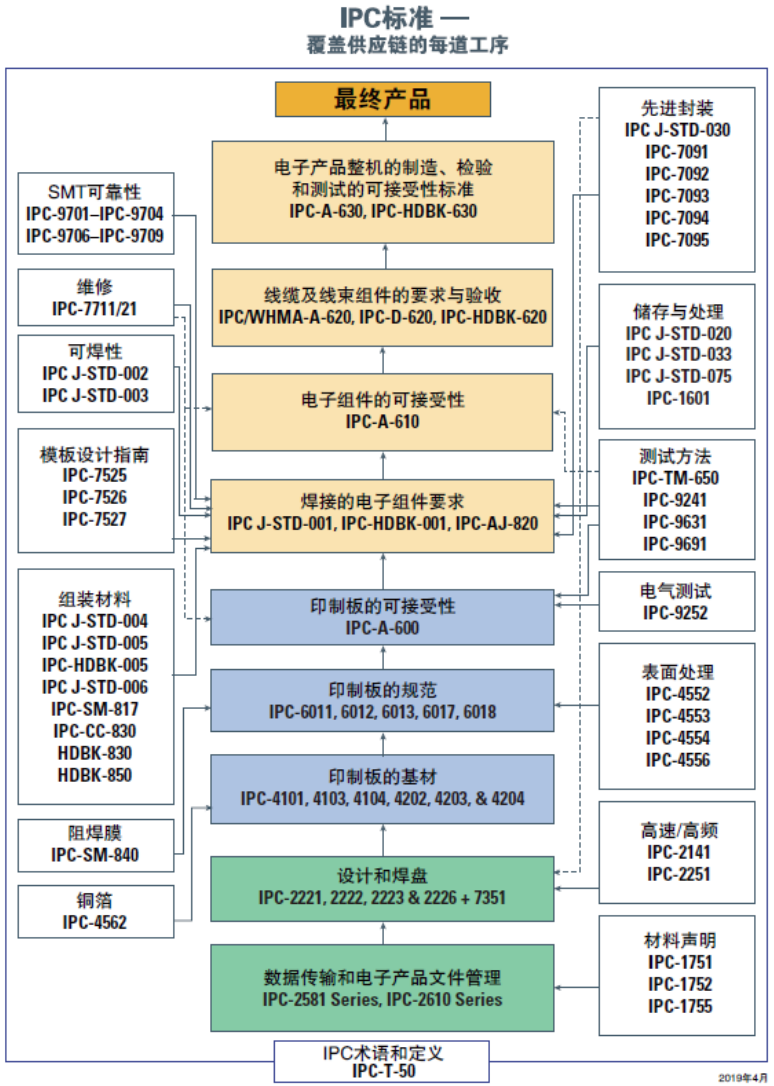
IPC标准树

六大认证标准

- IPC/WHMA-A-620
  线缆线束的要求和验收
- IPC-7711/7721
  电子组件的返工、维修和修改
- IPC-A-610
  电子组件的可接受性
- IPC-J-STD-001
  焊接的电气和电子组件要求
- IPC-A-600
  印制板的可接受性
- IPC- 6012
  刚性印制板的鉴定及性能规范



> IPC标准与印制板生产和组装过程中的每一个步骤都息息相关。从设计到采购到组装，再到最终验收，IPC都有对应的系列标准，他们可以促进会员 公司产品的所有电子组件都具备卓越的质量、可靠性和一致性。

380
全球共计380个标准技术组

70
来自70多个国家地区的各行业内顶级企业共同参与

5,000
全球活跃的志愿者人数超5,000人

由企业担任IPC标准的主席单位

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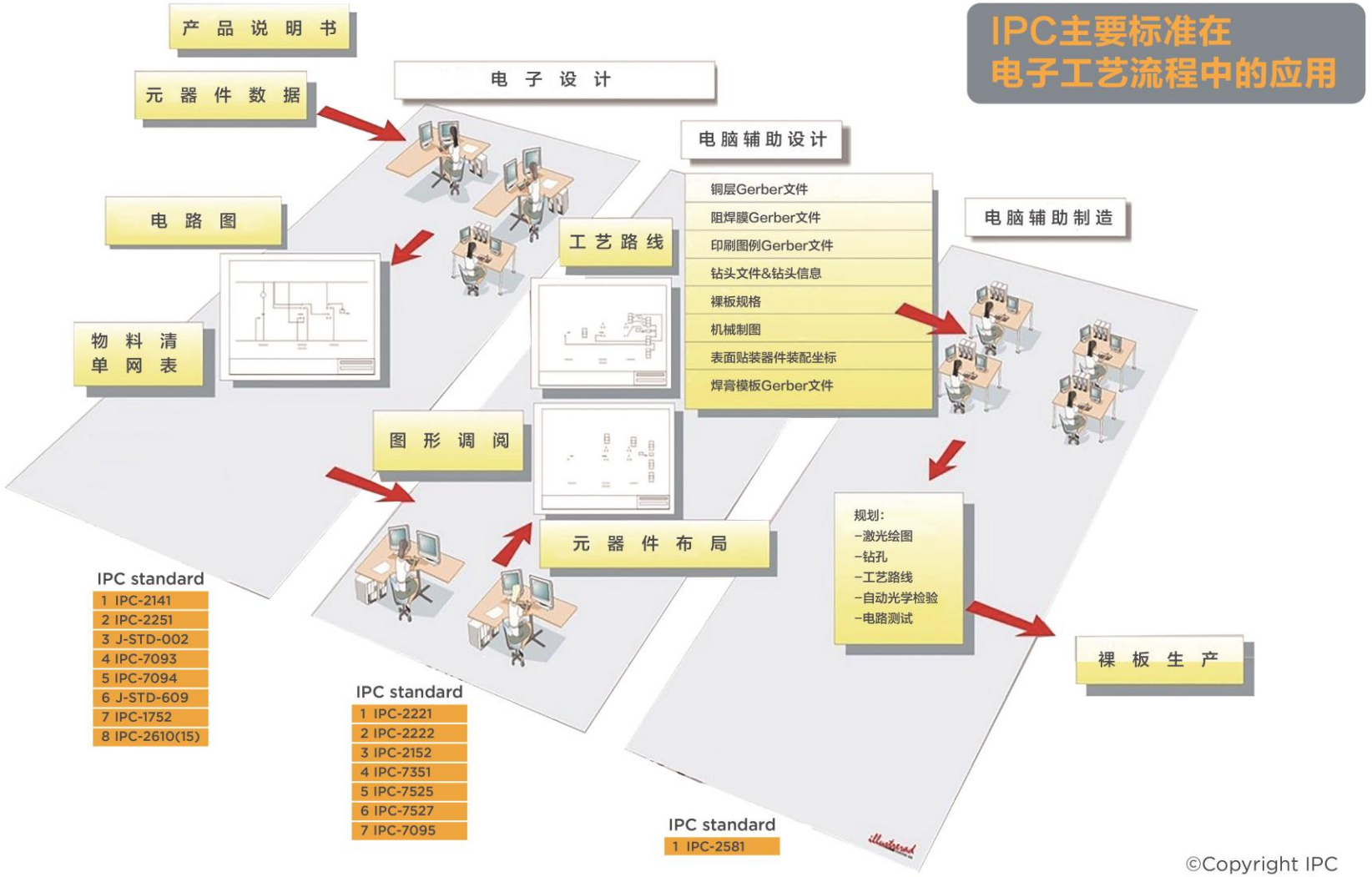
IPC印制板及电子产品设计标准



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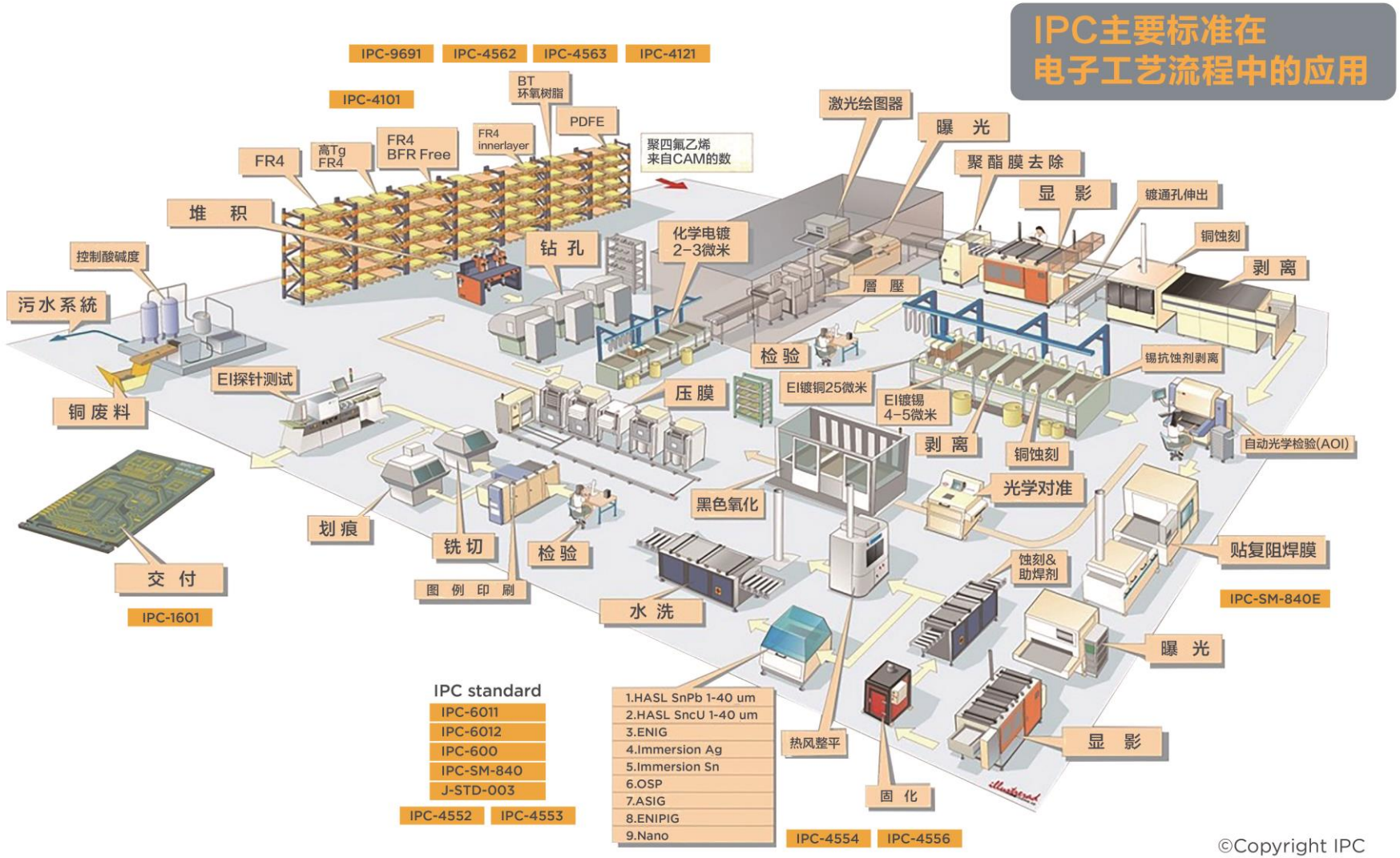
IPC印制板制造标准



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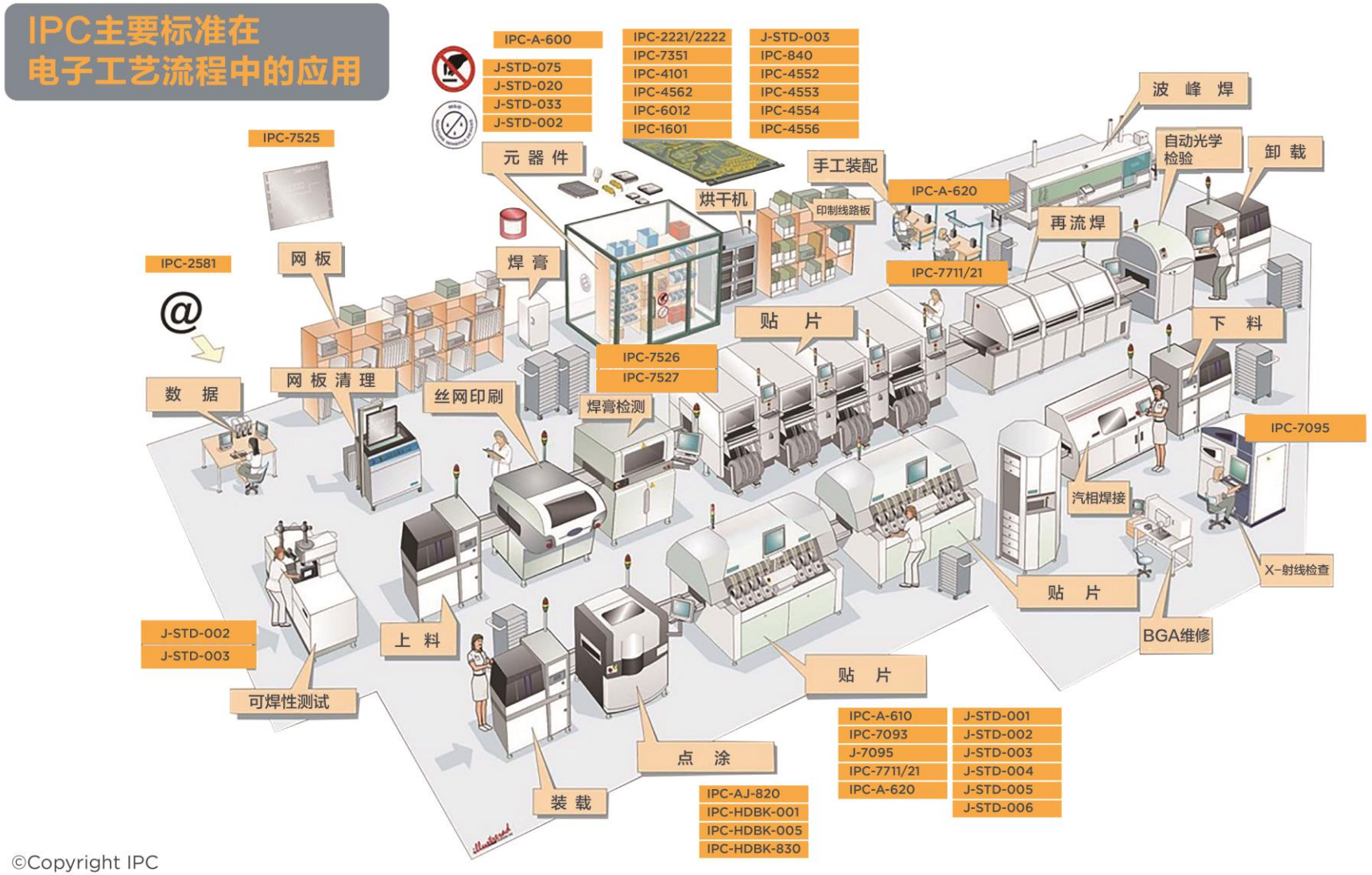
IPC电子产品焊接和组装标准



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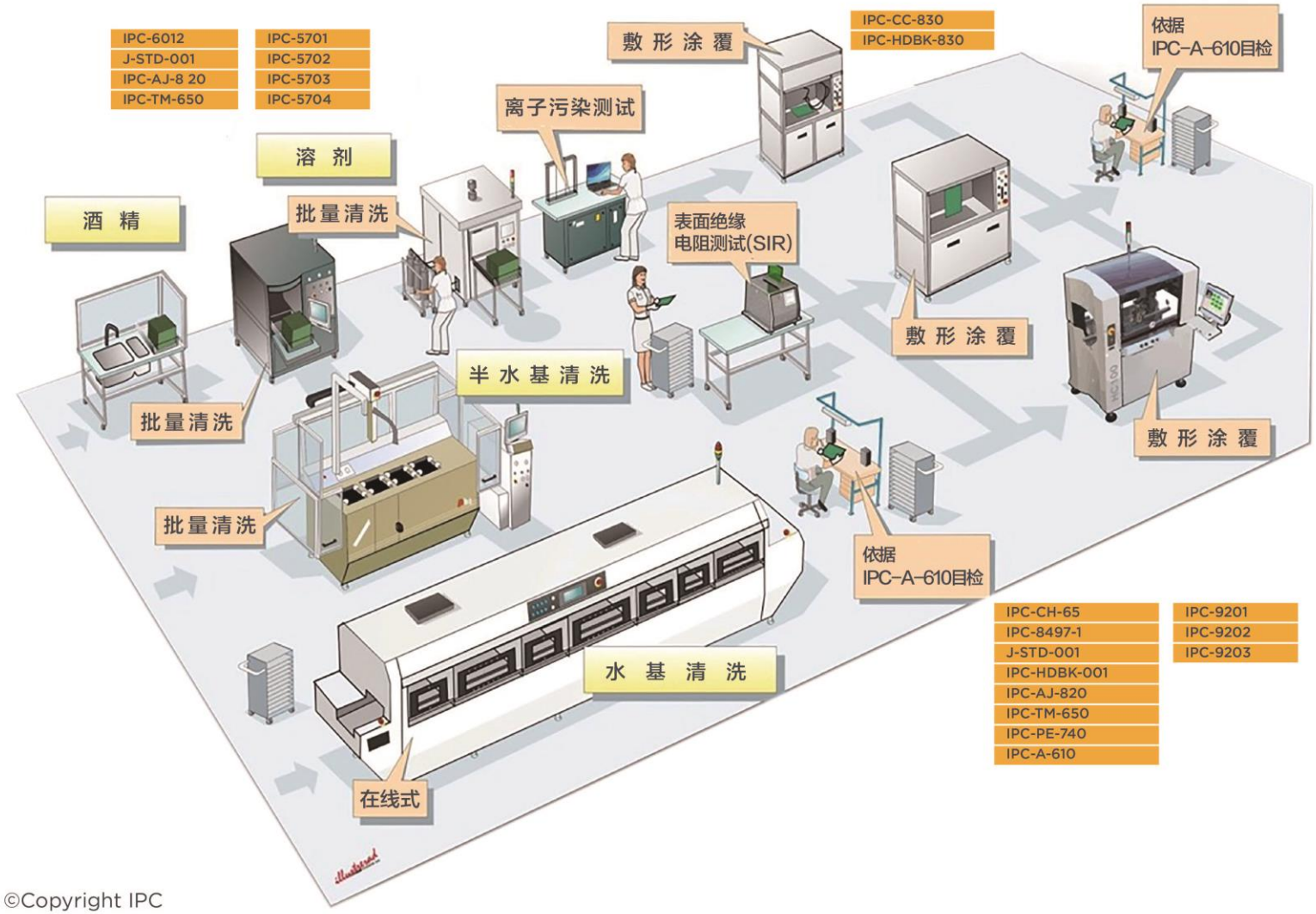
IPC清洗和敷形涂覆标准



IPC主要标准在电子工艺流程中的应用

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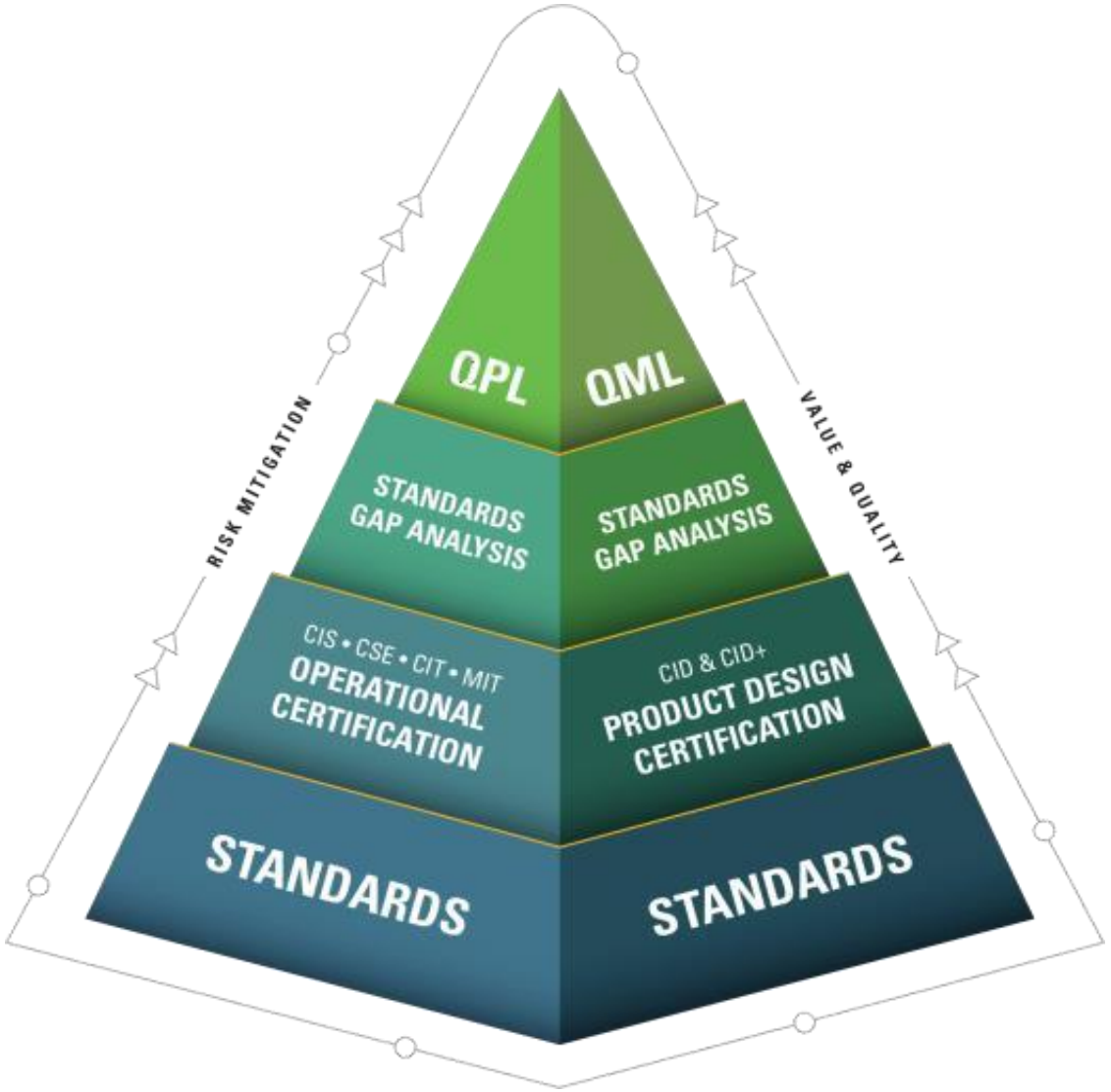
标准实施体系



IPC Validation 认证服务

全球目前有90多家企业在IPC QPL/QML之列, 包括TTM、Lockheed Martin、Flex、SIEMENS、Haier等知名企业工厂。

IPC SGA标准差异分析

对制造过程作全面分析诊断，发现差距，定位纰漏，补齐短板。

标准的培训及认证

IPC全球每年认证的人数超120000人次。

IPC标准

IPC拥有超过300多个活跃的多语言行业标准，超过70个国家和地区的企业采用了IPC标准。

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IPC特定行业标准

汽车

> IPC-6012-Automotive：

《刚性印制板的鉴定及性能规范》汽车应用补充标准

> IPC-A-610-Automotive：

《电子组件的可接受性》汽车应用补充标准

> IPC-J-STD-001-Automotive：

《焊接的电气和电子组件要求》汽车应用补充标准

> IPC-9797：

《符合汽车应用要求及其他高可靠性应用要求的压接标准》

未来工厂

> IPC-2591：

《互联工厂数据交换》（CFX）

> IPC-HERMES-9852：

《表面贴装技术组装中机器对机器通信的全球标准》

电信

> IPC-6018-telecom：

《高频（微波）印制板的鉴定及性能规范》电信应用补充标准

> IPC-A-610-telecom：

《电子组件的可接受性》电信应用补充标准

轨道交通

> IPC/WHMA-A-620-Rail Transit：

《线缆及线束组件的要求与验收》轨道交通应用补充标准

> IPC-A-610-Rail Transit：

《电子组件的可接受性》轨道交通应用补充标准

医疗行业

> IPC-6012-Medical：

《刚性印制板的鉴定及性能规范》医疗应用补充标准

航空&航天

> IPC/WHMA-A-620-Space：

《线缆及线束组件的要求与验收》航天和军事应用电子部件补充标准

> IPC-J-STD-001-Space：

《焊接的电气和电子组件要求》航天和军事应用电子部件补充标准

> IPC-6018-Space：

《高频（微波）印制板的鉴定及性能规范》航天和军事航空电子应用补充标准

> IPC-6012-Space:

《刚性印制板的鉴定与性能规范》航天和军事航空应用补充标准

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IPC

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Automotive Addendums
汽车应用补充标准

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Why Addendums?

- **Addendums:**
  - Provide modified and additional requirements over those published in the base documents to ensure the performance of the product that must survive the identified environment.
  - Written for a specific revision.
  - Are released after the base documents to ensure information meets industry needs.
  - Not stand-alone documents.

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Automotive-Focused Documents

Board Fabrication	IPC-6012 Automotive Applications Addendum to IPC-6012E Qualification and Performance Specification for Rigid Printed Boards 刚性印制板的鉴定及性能规范汽车应用补充标准
Assembly	**J-STD-001 and IPC-A-610 Automotive Addendum** to IPC J-STD-001H Requirements for Soldered Electrical and Electronic Assemblies and IPC-A-610H Acceptability of Electronic Assemblies （电气与电子组件的焊接要求）与IPC-A-610H（电子组件的可接受性）的汽车补充标准 **IPC-9797**, Press-Fit Standard for Automotive Requirements and Other High-Reliability Applications 汽车应用及其他高可靠性应用要求的压接标准 **IPC-HDBK-9798**, Handbook for Press-fit Standard for Automotive Requirements and other High-Reliability Applications 汽车应用及其他高可靠性应用要求的压接标准使用手册
Planned	HV Cable Addendum to IPC/WHMA-A-620 Requirements and Acceptance for Cable and Wire Harness Assemblies 线缆及线束组件的要求与验收 高压电缆

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BUILD ELECTRONICS BETTER

J-STD-001HA/IPC-A-610HA

（电气与电子组件的焊接要求）与IPC-A-610H（电子组件的可接受性）的汽车补充标准

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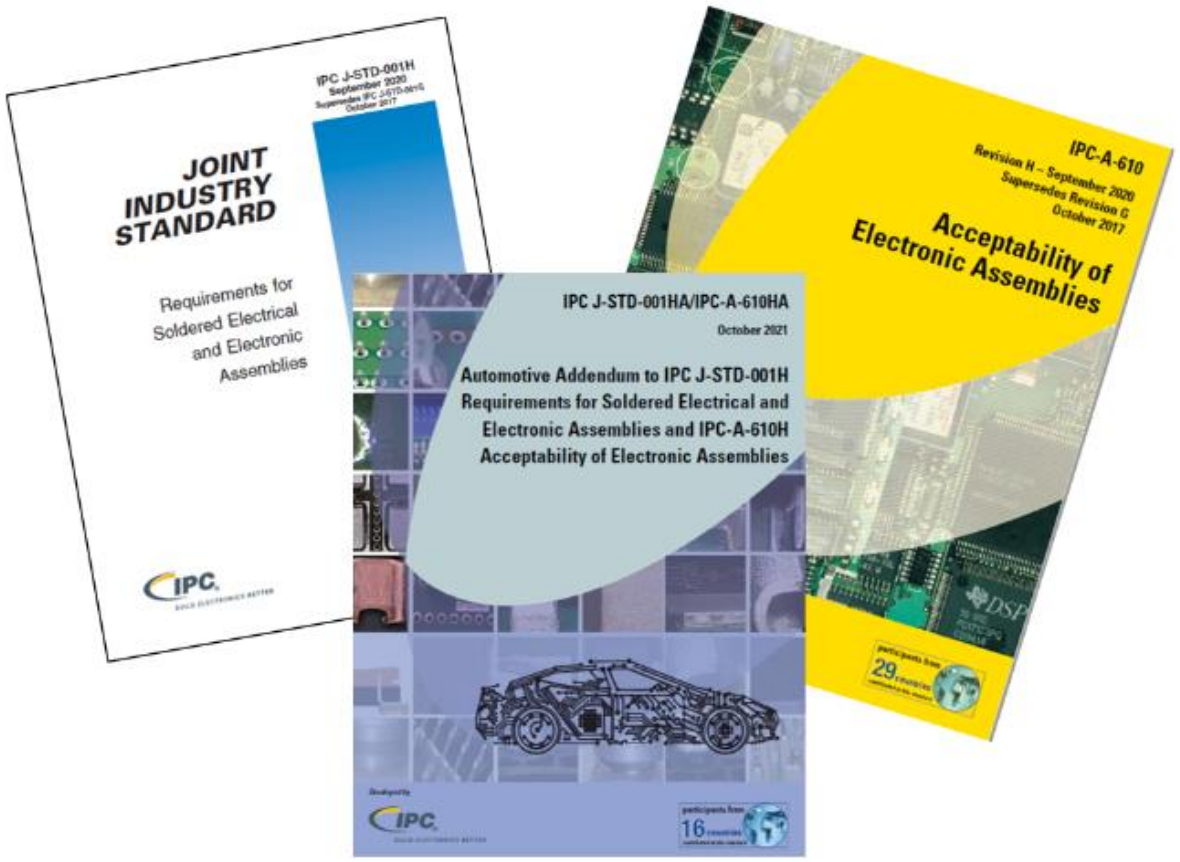
Addendums



Using the J-STD-001/IPC-A-610 Automotive Addendum requires the use of three documents to determine the criteria.

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Why Three Documents?

- J-STD-001
  - Describes materials, methods and acceptance criteria for producing soldered electrical and electronic assemblies.

- IPC-A-610
  - A collection of visual quality acceptability requirements for electronic assemblies.

- J-STD-001/IPC-A-610 Automotive Addendum
  - Addresses requirements to be used in addition to, and in some cases, in place of, those published in J-STD-001 and IPC-A-610 to ensure the reliability of mission-critical soldered automotive electrical and electronic assemblies in the field under harsh environments, considering the conditions of automated high-volume production.

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Contributors

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Vitesco Technologies

Toyota Motor North America

Continental Automotive

Elmatica AS

BMW Group

Collins Aerospace

Nissan Motor

Inovance Automotive Suzhou

ZF Automotive UK

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Use

0.4 Use

Table of Contents

The following topics are addressed in this Addendum.

The following reference numbers are to J-STD-001H Clauses that are modified or added in this Addendum.

1.1	Scope
1.3.1 (NEW)	Inspection Personnel and Product Requirements
1.6	Process Control Requirements
1.7	Order of Precedence
1.7.2 (NEW)	Conflict
1.8	Terms and Definitions

Where criteria are not supplemented, Class 3 requirements apply.

CLASS 3 High Performance/Harsh Environment Electronic Products

Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

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Conflicts and Conditions Not Specified

User approved drawings → J-STD-001HA → J-STD-001H → IPC-A-610HA → IPC-A-610H

- User-approved drawings always take precedence over the standards.
  - This includes inspection requirements identified on engineering documentation.
  - The inspector must have documentation, i.e., inspection instructions, process build requirements, and customer specification, for the product under inspection.

- Conditions not documented as defective or as a process indicator are considered acceptable unless it can be established that the condition affects user-defined form, fit or function.

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White Papers

- Two new white papers developed to help industry understand and use the requirements found in J-STD-001, IPC-A-610 and automotive addendum:

  - IPC-WP-027 Understanding Control and Assessment of Voiding in SMT Connections for Automotive Applications

  - IPC-WP-028 Guidance on Objective Evidence for Validating the Acceptability of Bubbles in Conformal Coating

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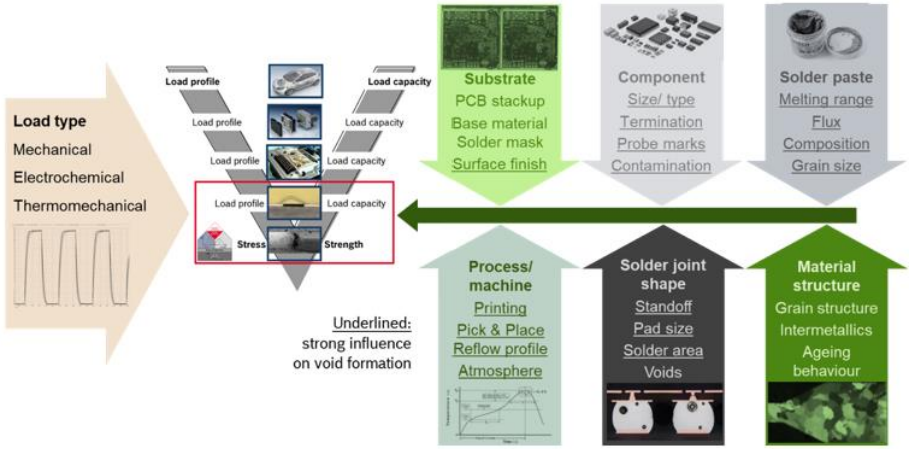
An Overview: IPC-WP-027

- Purpose:
  - Explain the voiding/solder coverage requirements in J-STD-001/IPC-A-610 Automotive Addendum.
  - Address the challenges of:
    - The impact of voiding on assembly reliability.
    - Typical x-ray inspection systems do not generally satisfy tight requirements on gauge repeatability and reproducibility.



Load types and load capability of solder joint reliability and voiding

Summary of voiding/solder coverage requirements in J-STD-001HA/IPC-A-610HA

Type of component/solder joint	Voiding v / solder coverage c / average solder coverage $\bar{c}$	Acceptability limit	Process indicator	Defect	Notes
Ball grid array components with collapsing balls	Voiding v	$v \le 30$ %	30 % $\le v \le$ 50 % (via in pad design)	$v > 30$ % (no via in pad design) $v > 50$ % (via in pad design)	a
Bottom termination components – thermal pads	Solder coverage c / average solder coverage $\bar{c}$	$c \ge 35$ %	35 % $\le \bar{c} \le$ 50 % average solder coverage	$c < 35$ %	a, b, c, d, e
Bottom termination components – I/O pins	Solder coverage c / average solder coverage $\bar{c}$	$c \ge 50$ %	50 % $\le \bar{c} \le$ 65 % average solder coverage	$c < 50$ %	a, e
Thermal pads of components with gull wing solder joints as quad-flat packages	Solder coverage c / average solder coverage $\bar{c}$	$c \ge 35$ %	35 % $\le \bar{c} \le$ 50 % average solder coverage	$c < 35$ %	a, b, c, d, e
Thermal pads of transistors as TO-252 (D-PAK™)	Solder coverage c / average solder coverage $\bar{c}$	$c \ge 35$ %	35 % $\le \bar{c} \le$ 50 % average solder coverage	$c < 35$ %	a, b, c, d, e
Rectangular or square chip components in stand off (2, 3 or 5 side termination)	Solder coverage c / average solder coverage $\bar{c}$	$c \ge 50$ %	50 % $\le \bar{c} \le$ 65 % average solder coverage	$c < 50$ %	a, e

[a] Shrinkage voids, planar micro voids (champagne voids), intermetallic microvoids, pinhole microvoids, and blowholes can typically not be detected in 2D X-ray imaging under mass-production conditions and are excluded from the criteria in this section.

[b] For certain designs, e.g. via in pad (microvia), it may not be possible to comply with the above threshold values. In such cases, it is the shared responsibility of design authority and manufacturer to provide objective evidence for thermal and electrical functionality as well as solder-joint reliability.

[c] If thermal planes of components are soldered directly on heat sinks, the thresholds for solder coverage are to be agreed between user and design authority.

[d] If the above defined connection area is not sufficient for thermal transfer for a particular component, it is the responsibility of the design authority to define a component-specific minimum connection area.

[e] As voiding levels can show a considerable scatter, the average solder coverage is also an important parameter. The average from a minimum sample of 25 solder joints of a given case size and part number from at least 5 different nonconsecutive panels should be analyzed.

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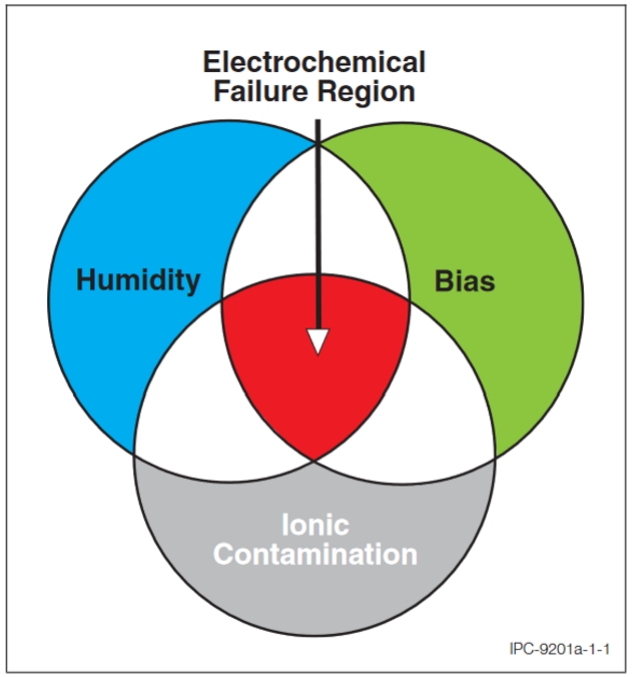
An Overview: IPC-WP-028

- Purpose: Provide guidance on obtaining objective evidence for validating the acceptability of bubbles in conformal coatings.
  - Experimental approach involves test boards.
    - IPC-9202 and IPC-TM 2.6.3.7 Surface Insulation Resistance
  - Field Records
  - Production Qualification Testing
- Includes new definitions found in J-STD-001J and IPC-A-610J.
  - Bubble: Air or other volatiles enclosed entirely, e.g., in a coating material of between component body and printed board surface.
  - Bridging Bubble: Air or other volatiles enclosed entirely, e.g., in a coating material or between component body and printed board surface, bridging between adjacent conductors.



Venn Diagram Illustrating the Variables Affecting Electrochemical Failure

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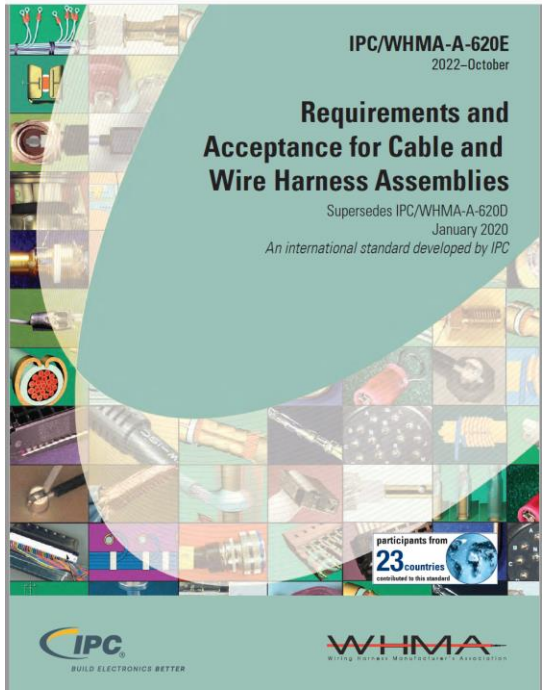
Additional Projects

- Additional automotive-related projects in early phases of development:
  - Addendum to IPC/WHMA-A-620
    - **High voltage** cable applications in the electric mobility industry.
    - 7-31FHV IPC/WHMA-A-620 High Voltage Cable Task Group



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HV CABLE ADDENDUM

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BUILD ELECTRONICS BETTER

汽车OEM案例

汽车OEM案例

CASE STUDY

通用汽车

致力于创造“零事故、零排放、零拥堵”的美好未来，为消费者提供更安全、更优化、可持续的出行解决方案。通用汽车及其子公司与合资企业在全球范围内销售凯迪拉克、别克、雪佛兰、GMC、宝骏及五菱等品牌的汽车产品。通用汽车及其合资企业在中国拥有员工总数逾58,000名，在中国生产和销售的乘用车和商用车产品包括别克、凯迪拉克、雪佛兰、宝骏及五菱等品牌，所提供的产品系列之丰富位居所有在华跨国汽车企业前列。

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汽车OEM案例

CASE STUDY

- 自2016年起，通用汽车中国与IPC密切合作，帮助通用汽车中国和合资企业的团队进行汽车相关标准的培训和认证，并将IPC标准应用于电气装配、产品设计和制造工艺之中。目前，大量的IPC标准在GM-SQ-SOR体系内贯彻使用。
- 在过去的5年里，通用汽车中国还通过研讨会和最佳实践研讨会等形式支持了IPC标准的更新，接待了200多家供应商和1,000多名与会者，学习如何利用IPC标准来提高质量水平。

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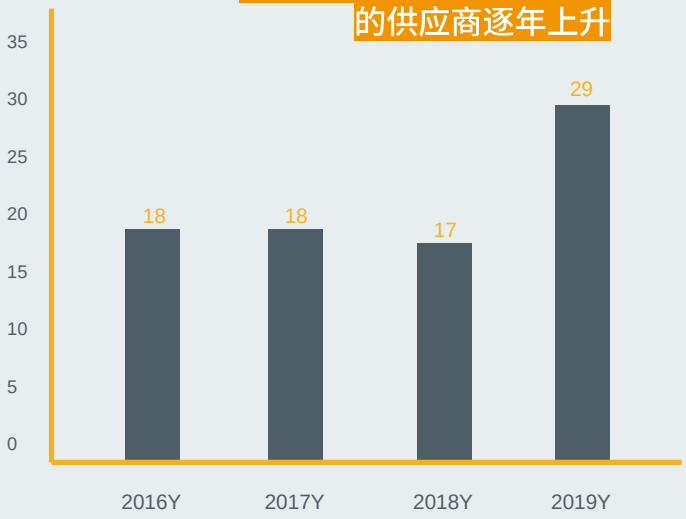
汽车OEM案例

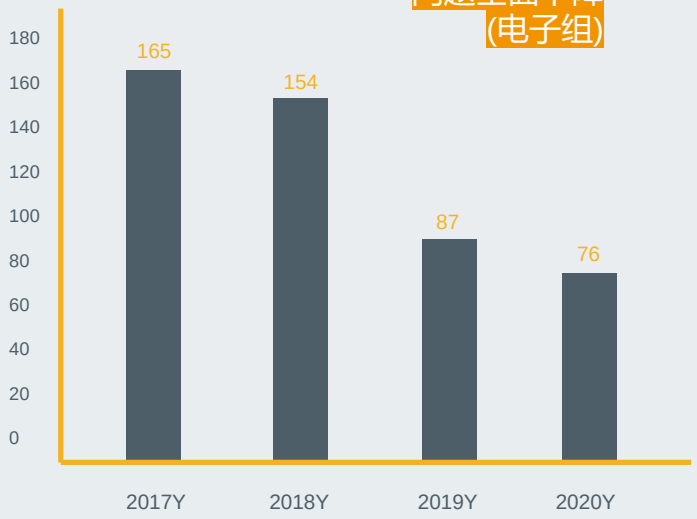
CASE STUDY

全面提升通用汽车中国电气化供应商的质量表现

2016-2019年，获得GM供应商质量优秀奖的供应商逐年上升



SPPS 供应时间质量问题全面下降(电子组)



IPC® Validation Services LISTED

以下几家GM供应商企业还获得 IPC QML-610/001审核认证

MAGNA　PSA

AUTOMOTIVE INTERFACE SOLUTIONS　flex

“我们在中国的供应商在全球范围内为通用汽车提供部件，而IPC标准在提高我们供应商的质量表现方面发挥了重要的作用。通过在供应链体系贯彻IPC标准，2019年一共有29家电子组供应商获得通用汽车中国质量优秀奖，占比30%，打破了往年的纪录。未来，通用汽车中国将与IPC共同履行Build Electronics Better的承诺，推动电子行业的发展。”

— 通用汽车中国及上汽通用供应商质量与发展总监

顾明

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汽车OEM案例

CASE STUDY

丰田汽车

世界十大汽车工业公司之一，日本最大的汽车公司，创立于1933年，现在已发展成为以汽车生产为主；业务涉及机械、电子、金融等行业的庞大工业集团。丰田汽车公司有很强的技术开发能力，而且十分注重研究顾客对汽车的需求，因而在它的发展各个不同历史阶段都创造出不同的名牌产品,早期的丰田牌、皇冠、光冠、花冠汽车名噪一时，近来的克雷西达、雷克萨斯豪华汽车也极负盛名。丰田汽车公司总部在日本东京，现任社长丰田章一郎。年产汽车近500万辆，出口比例接近50%。

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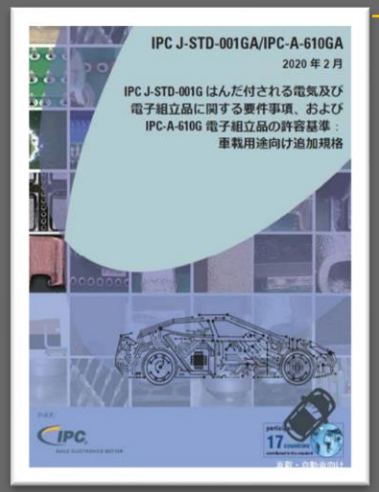
汽车OEM案例



丰田汽车公司正式采用了广泛接受的行业标准“IPC”，并制定了新的焊接可视质量标准；

作为新丰田标准（Toyota Standards: TS）的一部分，此份最新TS标准的发布也取代了丰田汽车公司先前内部使用的标准内容。

为什么选择IPC

很长一段时间以来，汽车行业中的焊接标准会因为不同的供应商而发生改变，例如：JIS、IPC或者丰田汽车的内部构建标准。然而，随着全球化进程的快速发展，IPC作为世界通用的电子产品质量的语言，已成为全球汽车行业的重要标准。因此，丰田汽车认为采用IPC标准会比之前的标准更有效。另一个方面，因为IEC标准也是出自于IPC标准，这也是丰田汽车选择使用IPC标准的原因之一。

IPC标准项目运用

随着供应商不断地问及丰田汽车的标准是否参照IPC标准，丰田认识到IPC已然成为全球汽车行业的实质性标准，于是开始研究并考虑参考IPC-A-610的新版本。制定了丰田将采用世界通用标准的政策，根据2021年2月发布的J-STD-001/IPC-A-610《汽车附录》的问题，丰田汽车推出了新的焊接视觉质量标准，并运用于丰田内部及外部管理中。

公司内外对IPC高度认可

丰田以IPC标准为核心的新技术标准已经建立并在内部部署。现在，新标准IPC正逐渐从丰田内部传达到公司外部。我们收到了主要供应商们的积极响应及反馈，新丰田标准（Toyota Standards: TS）可根据供应商的要求进行披露和审查。然后，供应商对其理解进行审查。

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汽车OEM案例

CASE STUDY

“当我们向供应商部署丰田内部标准及运用条件时，我们经常被问及这些内容与IPC标准的关系。我们拥有行业内生产汽车专用的半导体和设备所认可的供应商。通过这次采用IPC标准，供应商将能够有效地验证和确保其制造质量达到全球层级范围的标准。因此，我们希望与供应商建立“双赢的合作伙伴关系”。由于我们正处于一个百年一遇的转型期和“案例”时代，仅仅依靠过去的知识和经验是不够的。我们希望成为IPC全球网络的一员，以便我们能够在丰田汽车上实施各种技术，同时整合最新信息。”

— 丰田汽车公司开发过程与质量创新部

---Development Process & Quality Innovation Dept.

Mr. Masahiro Ishikawa

— 丰田汽车公司电子性能开发与工程部

---Electronic Performance Development & Engineering Dept.

Mr. Hisao Nishimori

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IPC

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IPC Factory of the Future

ipc.org

IPC Factory of the Future 未来工厂（智能制造标准）

IPC Factory of the Future Related Standards www.ipc.org/ipc-factory-future

IPC-2551 International Standard for **Digital Twins**
IPC-2551 数字孪生国际标准

IPC-HERMES-9852 The Global Standard for Machine-to-Machine Communication in SMT Assembly
IPC-HERMES-9852 表面贴装技术组装中机器对机器通信的全球标准

IPC-2552 General Electronic Components **Model Based Definition (MBD)** Standard
IPC-2552 通用电子元器件基于模型定义(MBD)标准

IPC-2581C Generic Requirements for Printed Board Assembly Products Manufacturing Description Data and **Transfer Methodology**
IPC-2581C 印制板组件产品制造描述数据和传输方法的通用要求标准

IPC-2591 Connected Factory Exchange (**CFX**)
IPC-2591 互联工厂数据交换（CFX）标准

IPC-1782A Standard for Manufacturing / Supply Chain **Traceability** of Electronic Products
IPC-1782A 电子产品的制造和供应链可追溯性标准

IPC-1783 International Standard for Component-Level **Authentication** (CLA) (UNDERDEVELOPMENT)
IPC-1783 组件级认证国际标准

IPC-1792 Standard for the Management and Mitigation of **Cybersecurity** Incidents in the Manufacturing Industry Supply Chain
IPC-1792 制造业供应链网络安全事件的管理和缓解标准

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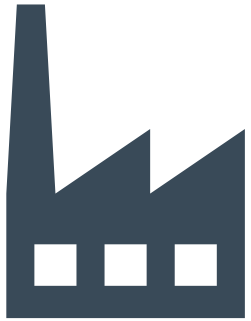
F2 Modernization Integration Levels
F2现代化整合层级

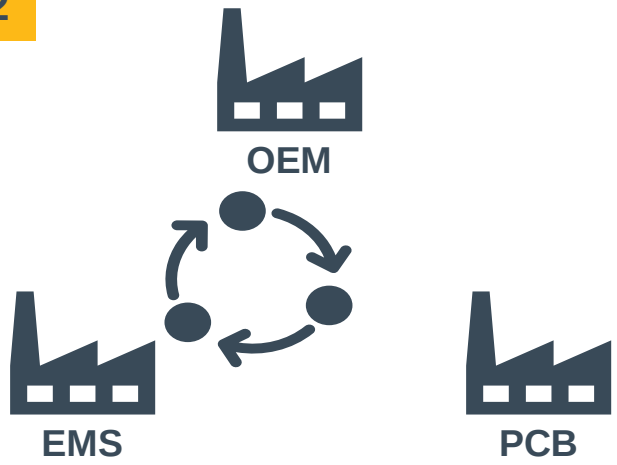
1



Individual Factory/Company
个体工厂/公司

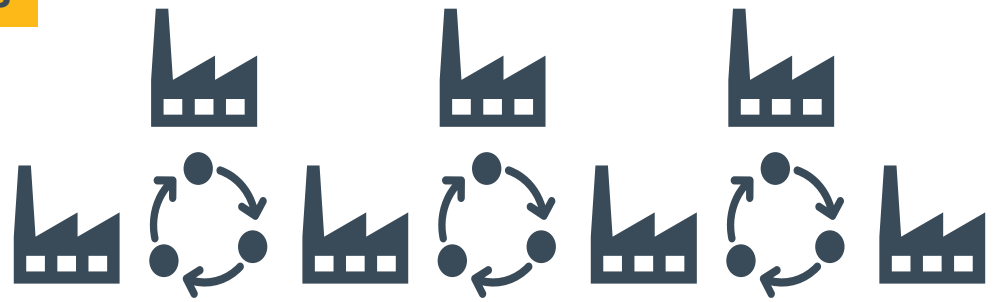
OEM, PCB, EMS,,
Components, Mechanicals
组件，机械

2



OEM Product Supply Chains
OEM产品供应链
New product introductions using trusted supply chain partners
引进新产品时使用可信赖的供应链合作伙伴

3



Electronics Manufacturing Industry
电子产品制造行业
Common Supply-base servicing multiple OEMs/markets
通用供应流程服务多个OEM/市场
Regional & Global Supply Chains
地区化和全球化供应链
Various Markets (Aerospace, Automotive, Consumer)
多样化市场（航空，汽车，消费产品）
Big and small companies (Tier 1 – Tier 5)
兼容大公司和小公司（层次1至5）

* **Current adoption level across industry**

Individual Company view
个体公司视角
New technologies & processes
新技术和流程，
Productivity, efficiency, ROI
生产力，效率，ROI

2013 - 2020

OEM-defined ecosystems
OEM主导的生态系统

Faster cycle times, quality/reliability
更快的循环节奏，质量/可靠性
Data driven supplier management
供应商管理通过数据驱动

2025

* **Not many are thinking about or addressing this**

Industry-wide view & transformation
整个产业的规模和转型
Modernized infrastructure for industry benefit
对行业有益的现代化基础设施
Excellent fit for IPC Industry leadership
完美适合IPC行业领军企业

2030

Complexity, coordination, industry standardization need increases
复杂性、协调性、行业标准化需求增加

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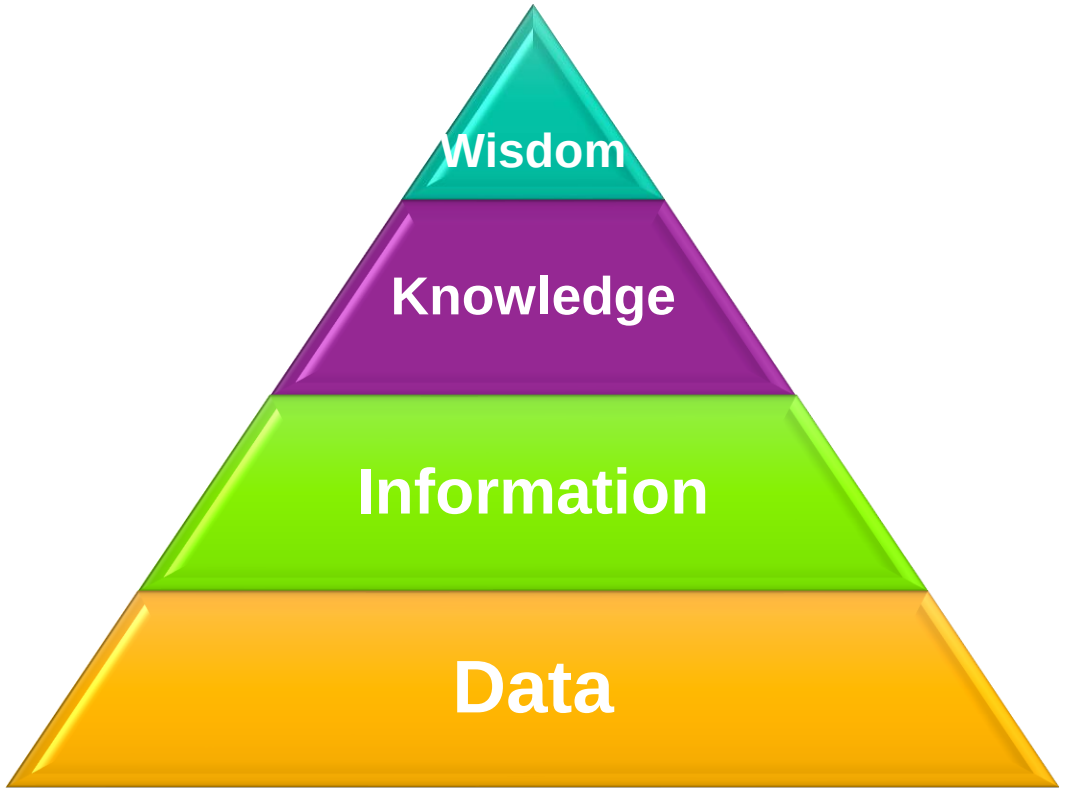
Hierarchy



智慧是对知识运用的能力，知识是智慧的基础(NLP, LLM)

知识是对信息的总结和提炼

信息需要依托数据来表达, 数据是信息的载体
信息是用来消除不确定性

数据是可以被记录和识别的一组有意义的符号

Where is the data?
数据在哪里，从哪里来?

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IPC-2581C Generic Requirements for Printed Board Assembly Products Manufacturing Description Data and Transfer Methodology

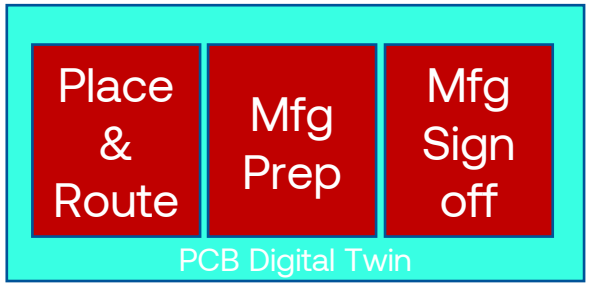
印制板组件产品制造描述数据和传输方法的通用要求标准

IPC DPMX

ipc.org

Manufacturing Hand off Challenges

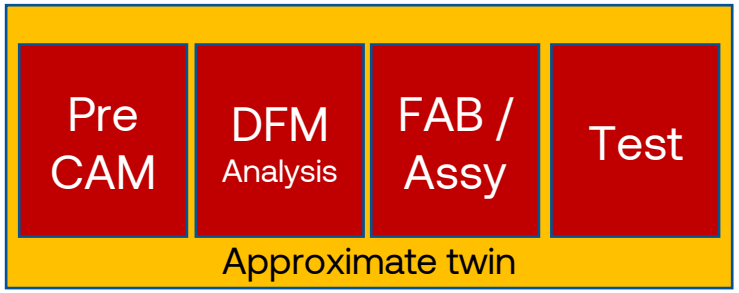
Design Divisions



Intelligent, Coherent data

Segregated, unintelligent data

Mfg Divisions



Reverse Engineered data

Time consuming &
risky to produce for Design divisions

Time consuming &
risky to consume for manufacturing divisions

Too many formats!
Data split into too many incoherent pieces
Not easy to digitalize
Not possible to do smart processing

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Current data formats are ineffici

No digitalization; no smart processing

Format	Description	Business impact
Gerber	Graphic picture, unintelligent • impossible for automatic processing	• Takes very long time to process • Business risk for stencil preparation • Difficult for digitalization
GenCAD/FATF	Obsolete standard Nobody maintains this standard	• Business risk • No support
ODB++	Proprietary standard Compatibility risk over time	• Business risk if you are not a customer of owner of standard
Centroid xy data (placement data)	Efficient content Can be out of sync with other data	• Takes time • Business risk for placement programming

Blocks the possibility for smart processing & digitalization

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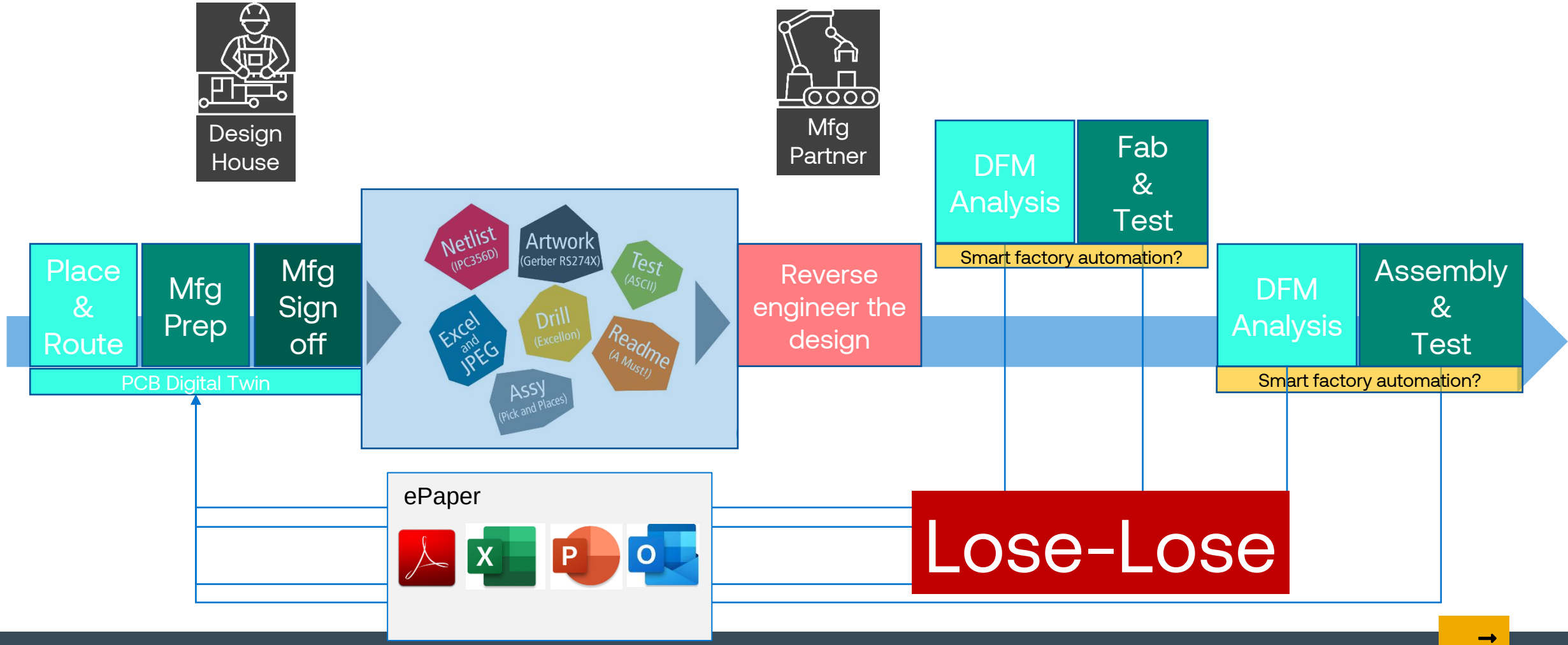
Manufacturing Feedback Challenges



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Hand-off from design house
From multiple formats to INTELLIGENT format

Why do we need to dump down the data?

Generation errors – Design House pays for it

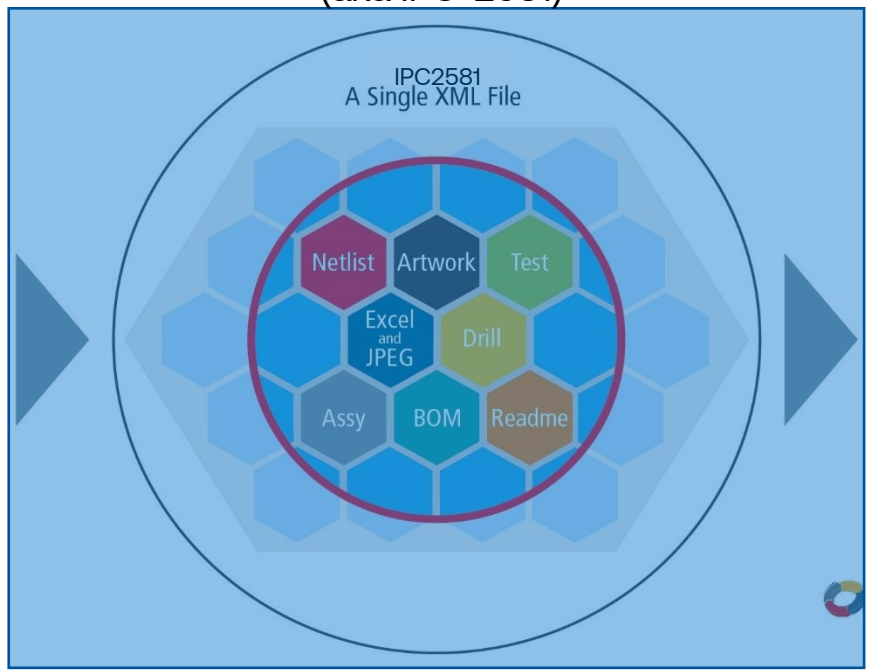
Reverse engineer the design

Why do we need to reverse engineer?

Reverse engineering errors – Manufacturing House pays for it

Hand-off based on 1980s based format

IPC Digital Product Model eXchange (DPMX)
(aka IPC-2581)



Intelligent design data hand-off
Enables industry 4.0
Go paperless with DPMX

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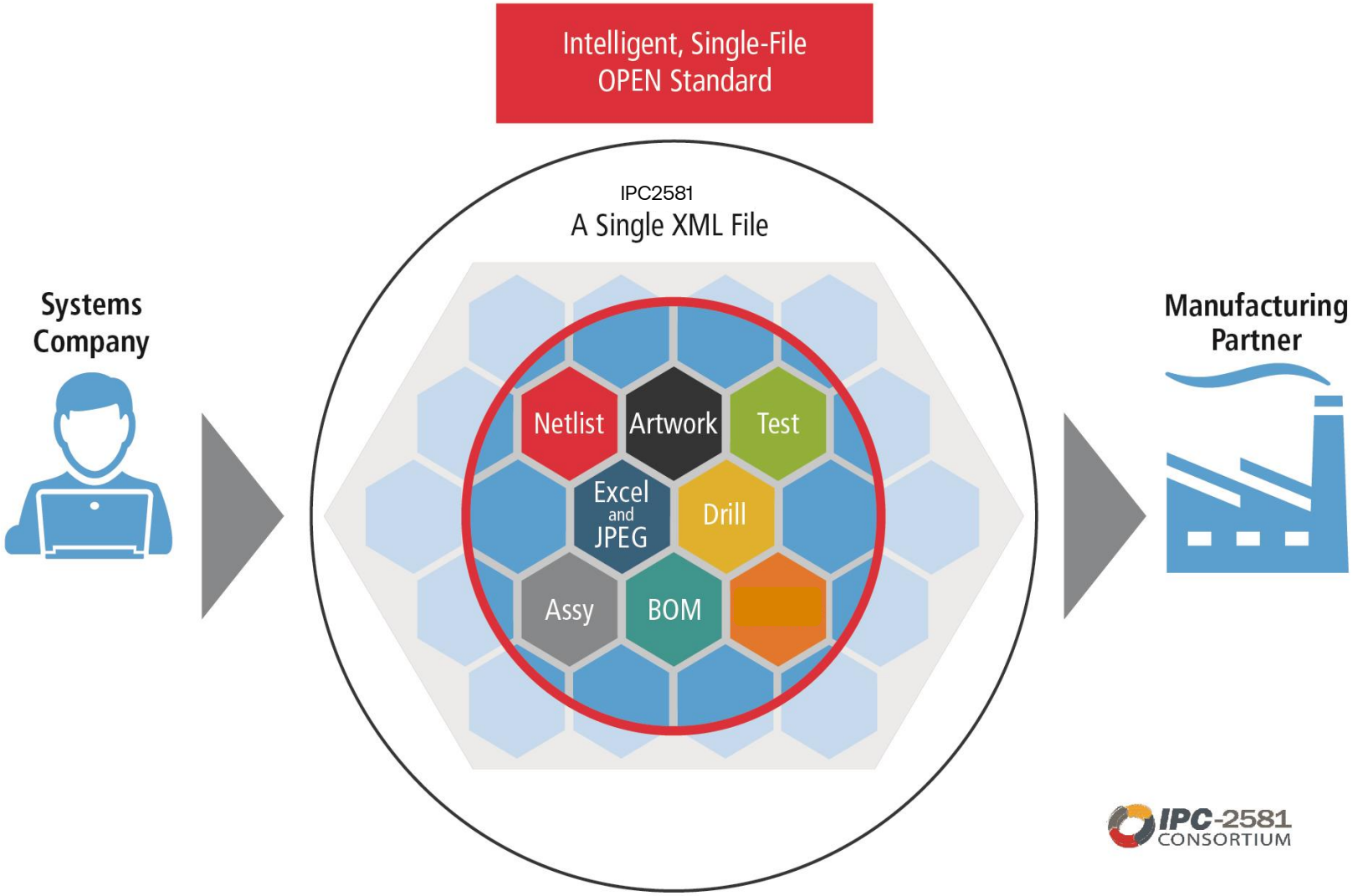
Simple, intelligent hand-off to manufacturing

Single file that is MACHINE READABLE and enables Industry 4.0



IPC Digital Product Model Consortium
Over 100 Corporate Members

Mission:

- Establish Design Best Practices
- Provide guidance for adoption
- Track tool support & usage

Statistics:

- >100 corporate members
- In production use at many companies
  - *Since Jan 1, 2016!*

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IPC-2552 General Electronic Components Model Based Definition (MBD) Standard

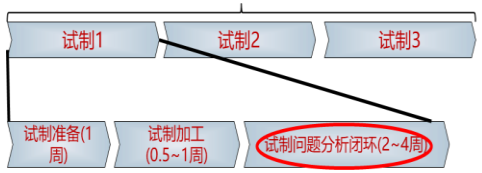
IPC-2552 通用电子元器件基于模型定义(MBD)标准

ipc.org

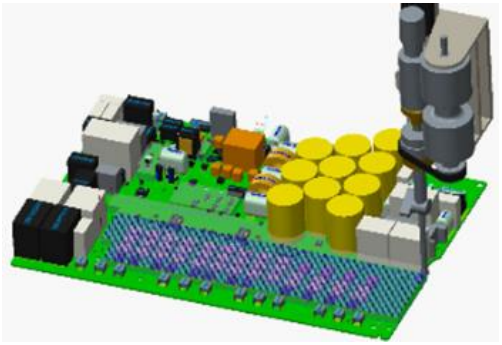
MBD标准开发背景

以实物验证为主，问题收敛慢，验证次数多，导入周期长

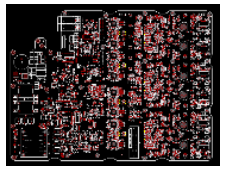
某终端产品试制周期占30%

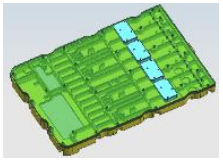
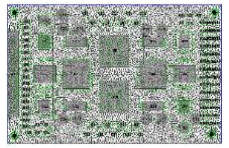


某终端产品试制中结构装配设计问题5轮才清零，且收敛慢



各专业领域“烟囱式”发展，文本信息传递，需要多次转化



PCB → 3D模型 → 模型简化 → 网格划分

二维转三维

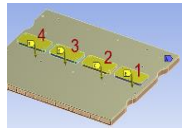
文本转三维，产生转化误差

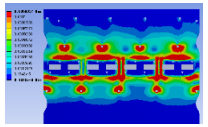
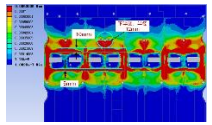
3D模型预处理周期长

仿真模型无法自动准确载入

仿真结论无法直接准确应用在PCB设计文件上面

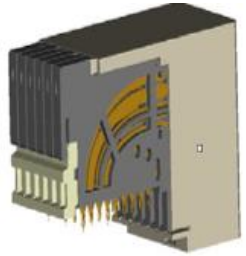
约束加载 → 提交运算 → 仿真结果 → 仿真结论



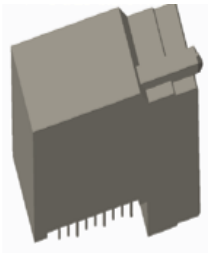



模型参数缺失，影响集成设计

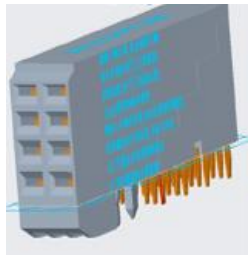
理想模型



实际模型



转化后的合规模型



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愿景展望:产品3D数字化设计完成DFX论证和虚拟试制,达到提质降本的目标

以元器件MBD模型和单板3D数字化模型为基础交付件，并进行单板DFX仿真&虚拟验证，减少实物试制；通过闭环制造系统，进行端到端设计改进和质量闭环，提升产品竞争力。

多轮验证清零

新产品研究&开发 → 工程工艺设计 → 新产品导入&试制 → EMS量产

AS-IS

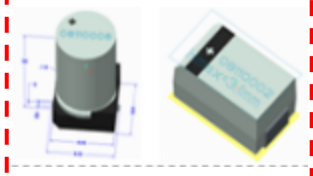
文件/文本	非结构化的工艺设计、无产品完整3D模型
实物验证	85%的DFM问题在试制&量产暴露
设备开环管控	设备单点开环控制，无法实时采集并反控

TO-BE

数字化	BOP、3D模型支撑虚拟仿真验证与数字化制造
仿真/虚拟验证	提前发现DFM问题，缩短试制周期
全连接闭环	制造数据实时闭环管控并前端优化

制造大数据AI闭环设计改进

器件3D建模

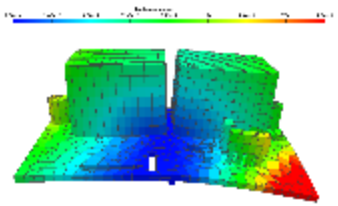


元器件建模

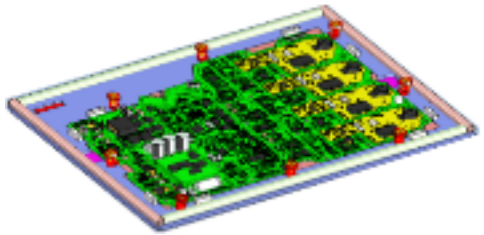
3D数字化样机设计

PCB与元器件匹配3D建模

仿真/虚拟验证



机械/热应力仿真



装配/工装虚拟验证:一版成功

实物试制&EMS

一次试制成功

元器件出厂数据无缝对接加工线体

VALUE

产品上市周期:缩短15~20%

减员增效: 一键编程&WI,降本20%

DFM/DFA问题减少40%+，量产6Sigma+品质

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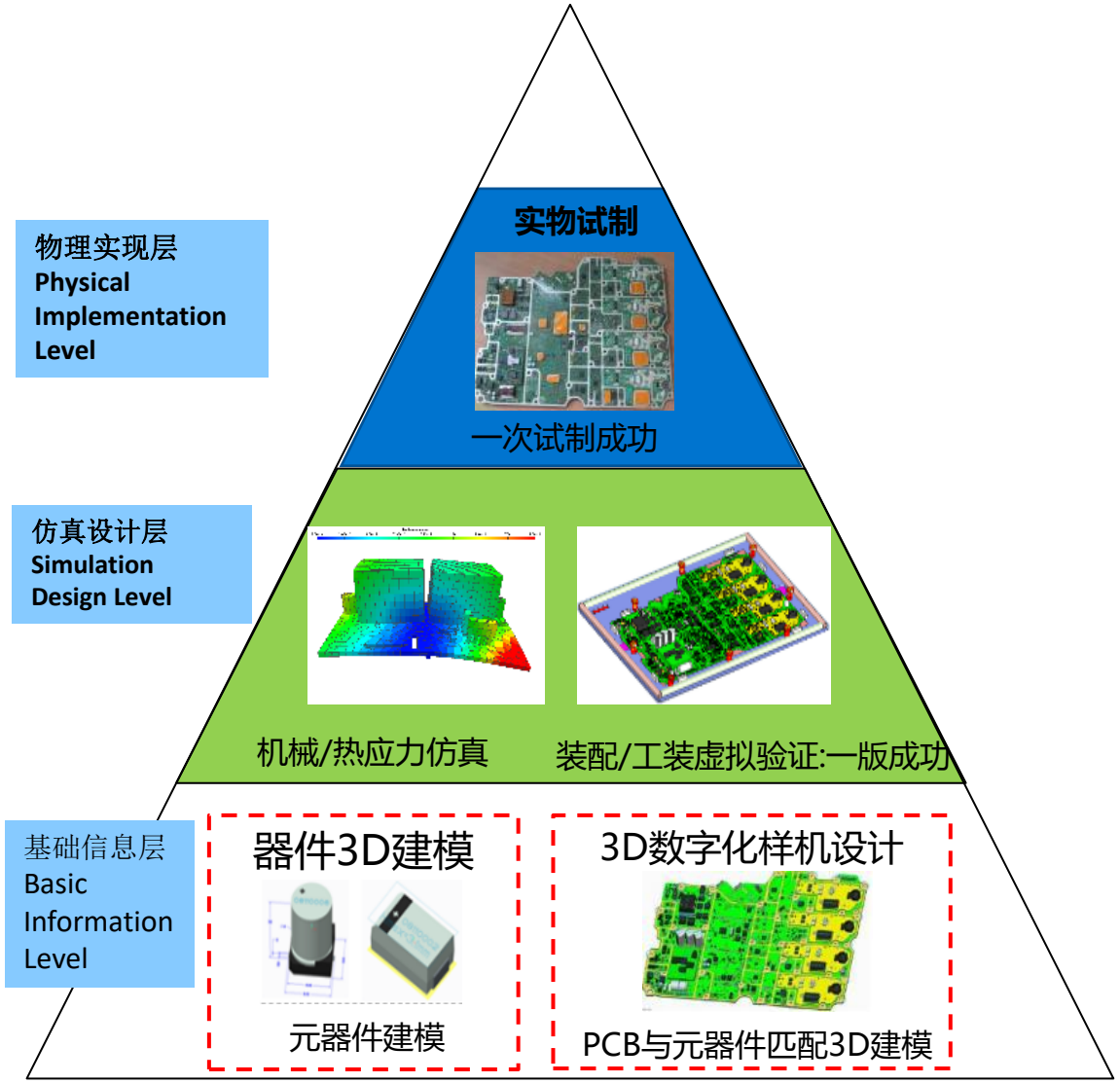
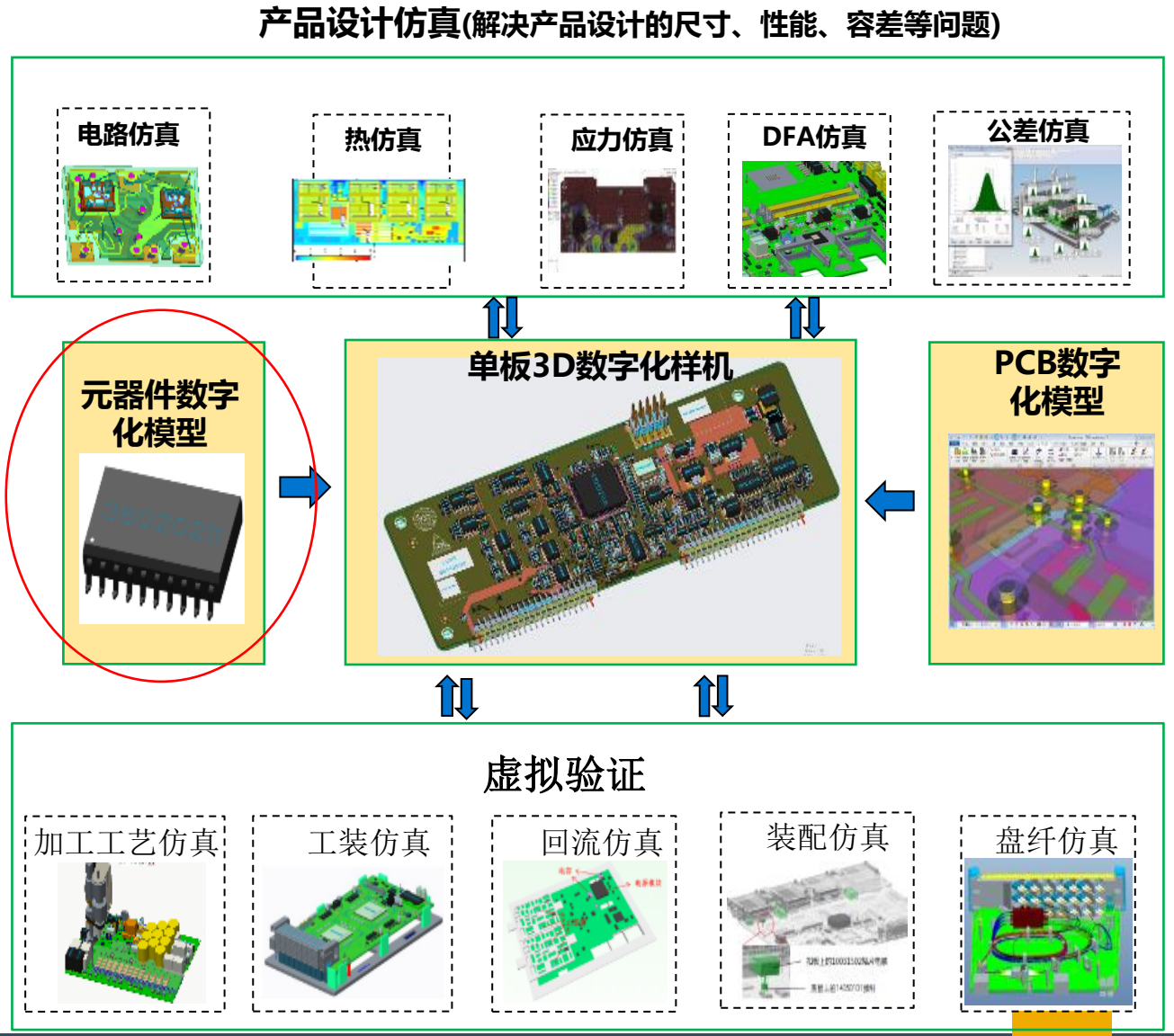
电子产品3D数字化设计目标

构建板级数字化仿真/制造底座基石，实现一个设计完成所有DFX的设计与验证





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MBD总体架构

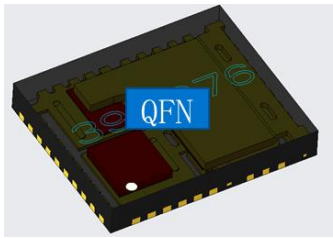
输出一份.2552的打包文件
Output a package file of.2552/MBD
Such As：ABC.2552

文本语义格式

子类	参数名
/	耐焊接次数
SMT焊接要求	耐热是否满足J-STD-020D
	SMT允许最高温度
	SMT允许持续时间
	217℃以上时间
手工焊接要求	手焊允许最高温度
	手焊允许接持续时间
SMT可吸附能力	可吸附面积
	吸附承压阈值
	是否通过可焊性测试
	是否通过锡须测试
	是否通过耐溶蚀性测试

- 适合网络化传输
- 同时适合人和机器的阅读和处理
- Xml文件的相关软件工具比较丰富

几何模型格式



- STEP在描述几何模型方面比较完善
- CAD领域广泛接受的数据交换格式
- 标准使用方的开发工具都能生成STEP文件，有利于标准推行应用

2-12B Committee Members

NO.	Name	Company Name
1	Xu, Victor	华为技术有限公司
2	Gao, Shuming	浙江大学
3	Sang, Zhiqian	杭州电子科技大学
4	Qian, Shengjie	上海望友信息科技有限公司
5	Shen, Yujian	新华三技术有限公司
6	Acheson, Edward B.	Cadence Design Systems Inc.
7	Chen, Zhiman	株洲中车时代电气股份有限公司
8	Chunguang, Huang	深圳市电巢科技有限公司
9	Diaconescu, Radu	Swissmic
10	Dickinson, Craig	Flextronics International
11	DiLello, Vincent	Cadence Design Systems Inc.
12	Ding, Tao	北京工业大学
13	Durkan, Michael	Mentor Graphics Corporation
14	Ford, Michael	Aegis Software UK
15	Golemme, Stephen	JITX Inc.
16	Han, Roc	中国科学院空间应用工程与技术中心
17	Hoffman, Terry	Cisco Systems Inc.
18	Hogan, Dan	Right-Minded Teamwork
19	Hsu, Ife	Intel Corporation
20	Hu, Zhaohua	独立顾问
21	Knowles, Caitlin	AFFOA
22	Korf, Dana	Nano Dimension
23	Lax, Craig	Septillion Technologies
24	Leeds, Geoffrey	Insulectro
25	Lin, Jinsong	上海湃睿信息科技有限公司
26	Liu, Charlie	OPS Excellence Consulting
27	Marktscheffel, Thomas	ASM Assembly Systems GmbH & Co. KG
28	Mehkri, Zohair	Flextronics International
29	Ming, Lim Lai	Jabil Circuit Sdn. Bhd.
30	Nie,Fugang	ZTE Corporation
31	Peretta, Pier Giuseppe	Cisco Photonics Italy
32	Perron, Sylvain	Cogiscan Inc.
33	Schultz, Daniel	Lockheed Martin Missiles & Fire Control
34	Shaw, Chris	Fujitsu Network Communications
35	Siebert, Tyler Joseph	Lockheed Martin Missiles & Fire Control
36	Smith, Simon	Individual
37	Sood, Bhanu	NASA Goddard Space Flight Center
38	Sun, Jason	深圳华为云计算技术有限公司
39	Walsh Cochran, Lucas Christopher	Lockheed Martin Missiles & Fire Control
40	Wan, Li	华中科技大学
41	Wang, Chenpeng	华为技术有限公司
42	Wang, Chuandong	新华三技术有限公司
43	Wang, Wei	新华三技术有限公司
44	Webb, Jarrod	Lockheed Martin Missiles & Fire Control
45	Wu, Shengyu	Shanghai RedEDA Co., Ltd.
46	Wu,Nemo	英伟达半导体（深圳）有限公司
47	Xue, Keliang	广州中望龙腾软件股份有限公司
48	Yang, Guangjing	云尖信息技术有限公司
49	Zeng, Xiangyu	上海湃睿信息科技有限公司
50	Zhang, Lvquan	华为技术有限公司
51	Zhu, Daoyun	北京数码大方科技股份有限公司
52	Zhu, Johnny	临在科技（上海）有限公司

技术组成员来自中国、美国、英国、瑞士、新加坡、德国

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BUILD ELECTRONICS BETTER

IPC-HERMES-9852

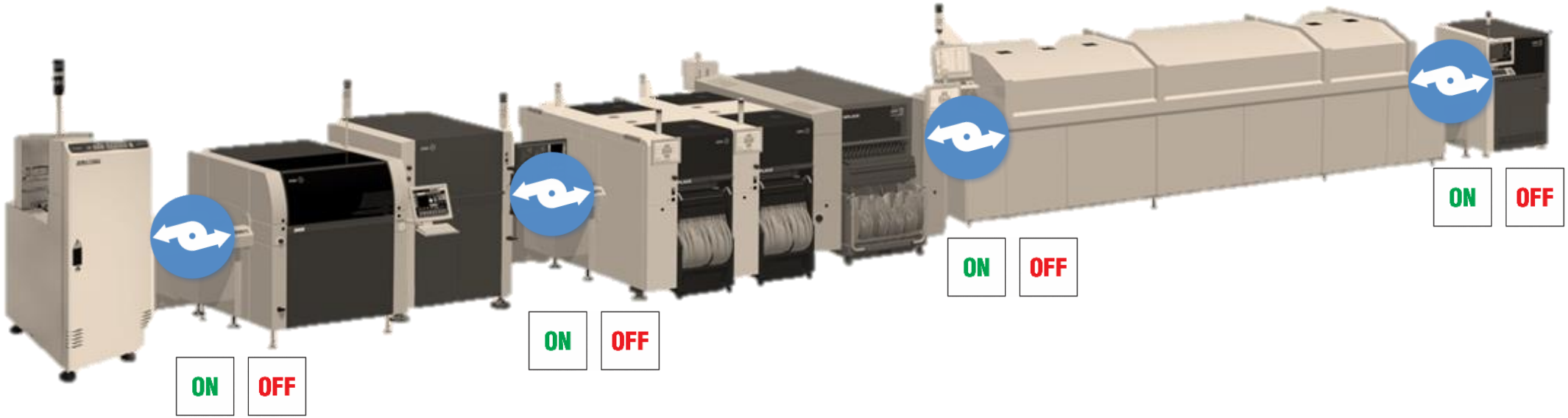
The Global Standard for Machine-to-Machine Communication in SMT Assembly

表面贴装技术组装中机器对机器通信的全球标准

IPC-HERMES-9852

ipc.org

Why a new interface?
Old Technology meets the Challenge of today



Challenges

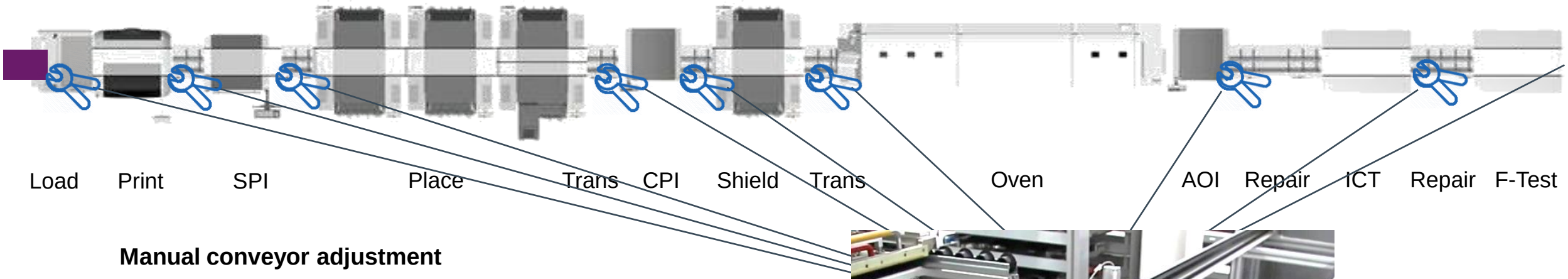
- Highly automated / digitalized industry with more need of data
- Full integration of the equipment
- Need of direct machine-to-machine (M2M) communication
- Need of simple integration into high-level systems (MES, IoT…)

Old M2M Standard

- Based on “signals”, no data at all
- Needs specific hardware
- Is expensive
- Restricts quick changes in line layout
- Can be hardly adapted to future needs

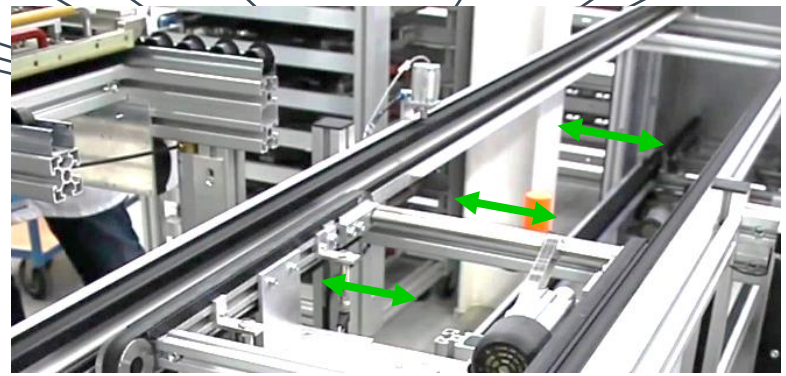
Why a new Interface…?
New Job Download = long Preparation Time

Example



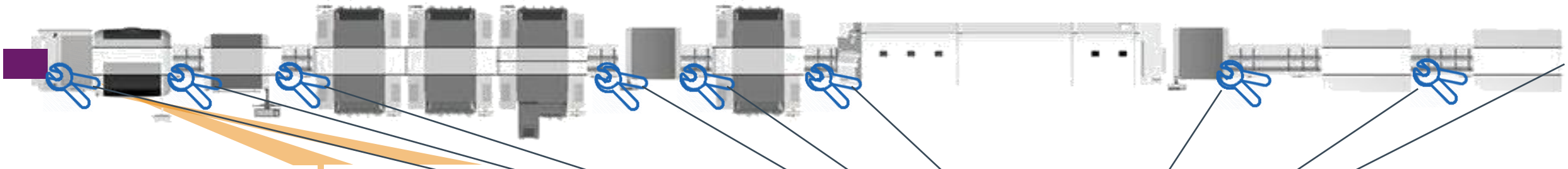
Manual conveyor adjustment

- Manual intervention to different equipment
- Manual input of new parameters (error prone)



Why a new Interface…?
New Job Download = long Preparation Time

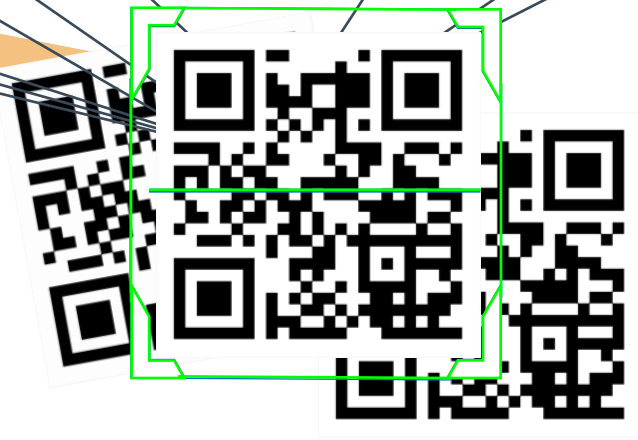
Example

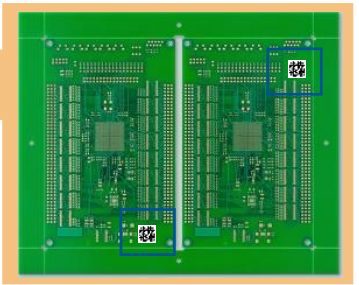


Load Print SPI Place Trans CPI Shield Trans Oven AOI Repair ICT Repair F-Test

Manual conveyor adjustment

Barcode reader adjustment



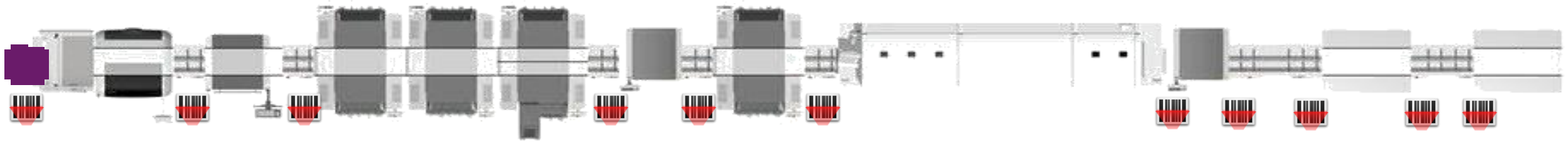


Why a new Interface...?

IPC-HERMES-9852 represents THE next generation horizontal communication standard and replaces IPC-SMEMA-9851

Why IPC-HERMES-9852?
Automated Data Transfer

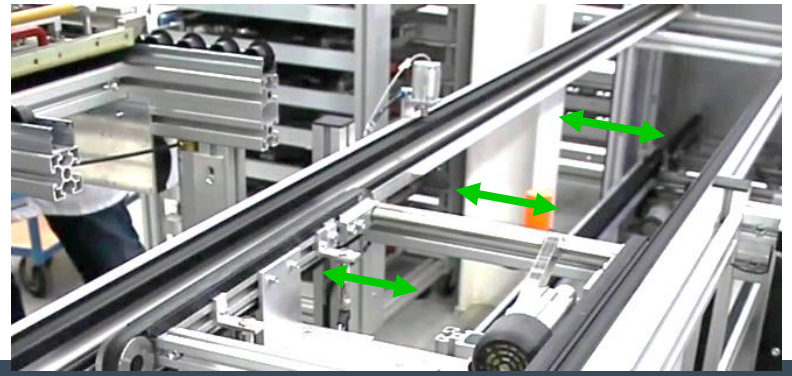
a b c Different boards widths in one line, at the same time and without operator intervention



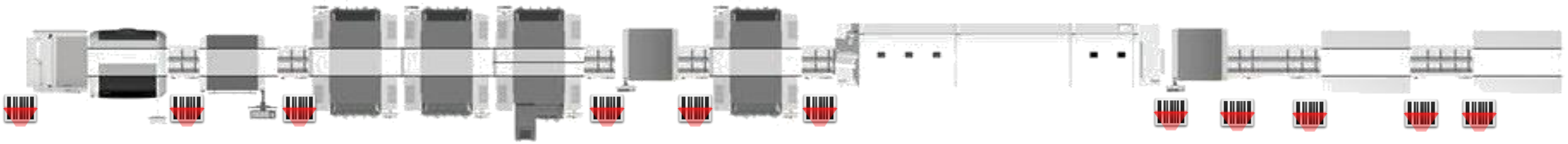
Protocol with board information

Load Print SPI Place Trans CPI Shield Trans Oven AOI Repair ICT Repair F-Test

- Manual conveyor adjustment
- Barcode reader adjustment
- High number of barcode readers



Why IPC-HERMES-9852?
Full Data Availability



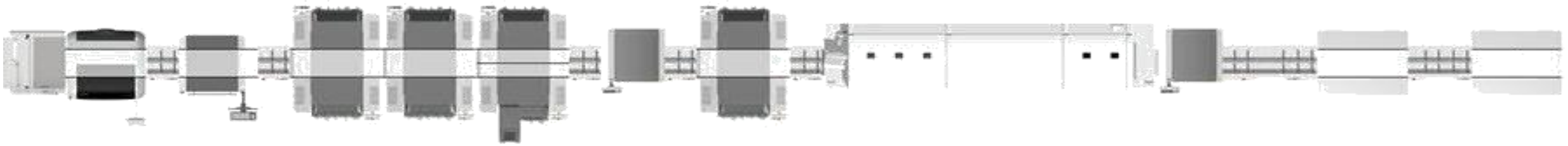
Load Print SPI Place Trans CPI Shield Trans Oven AOI Repair ICT Repair F-Test

- **Automated conveyor adjustment**
- **Board identification (barcode / RFID…) needed only once per line**
- **Speed optimization, load buffer adjustment…**

~~Barcode reader adjustment~~

~~Signal quality of code readers~~

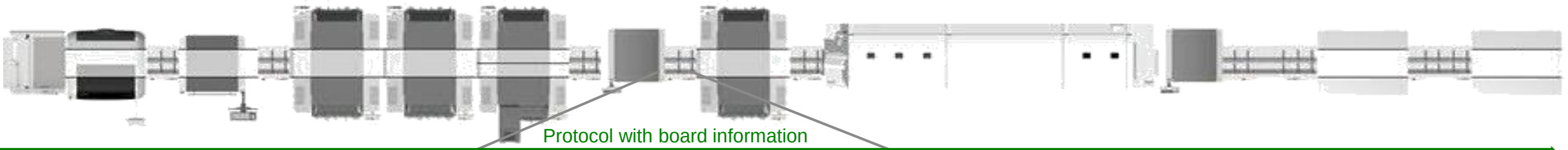
Why IPC-HERMES-9852?
Full Data Availability



Load Print SPI Place Trans CPI Shield Trans Oven AOI Repair ICT Repair F-Test

> Proven Ethernet. ONE Interface, ONE Standard!

Why IPC-HERMES-9852?
Protocol based



Protocol with board information

Upstream machine

- Board Id
- Failed Board
- Product Type Id
- Flipped Board
- Top Barcode
- Bottom Barcode
- Width
- Length
- Thickness
- Conveyor speed
- Top clearance height
- Bottom clearance height
- Board weight

Downstream machine

Machine ready

Board available

IPC®
BUILD ELECTRONICS BETTER

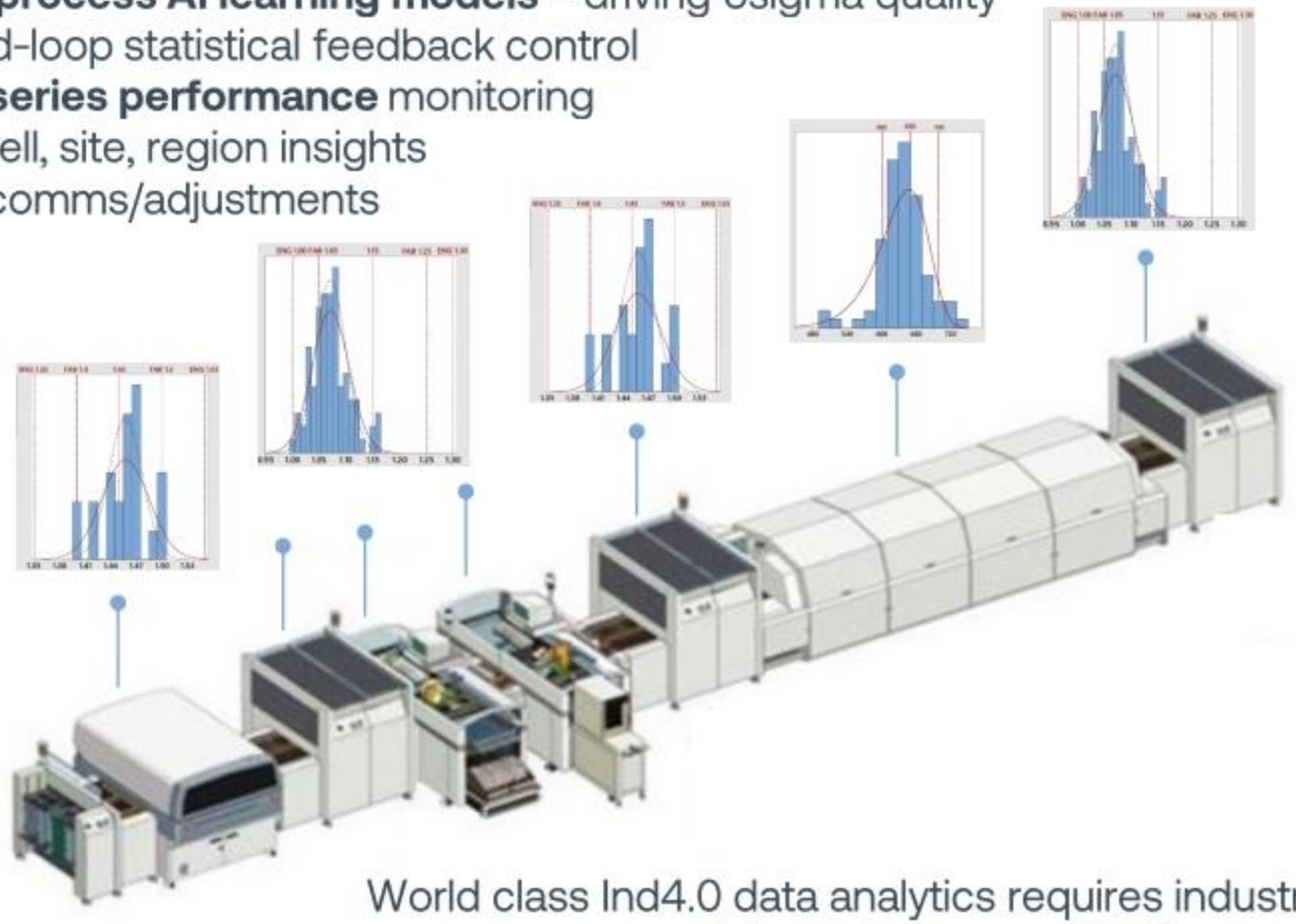
IPC-CFX-2591
Connected Factory Exchange
互联工厂数据交换标准

ipc.org →

Challenge: Achieve high quality, yield, throughput – Data Analytics

Manufacturing line – secure, real-time, big data sets (FEOL, BEOL)

- **Individual process control**, reports, Cp, Cpk, dashboards
- **Multi-process AI learning models** – driving 6sigma quality
- Closed-loop statistical feedback control
- **Time series performance** monitoring
- Line, cell, site, region insights
- M2M comms/adjustments



World class Ind4.0 data analytics requires industry-wide,
open-source machine data communication protocol eg) IPC-2591 CFX

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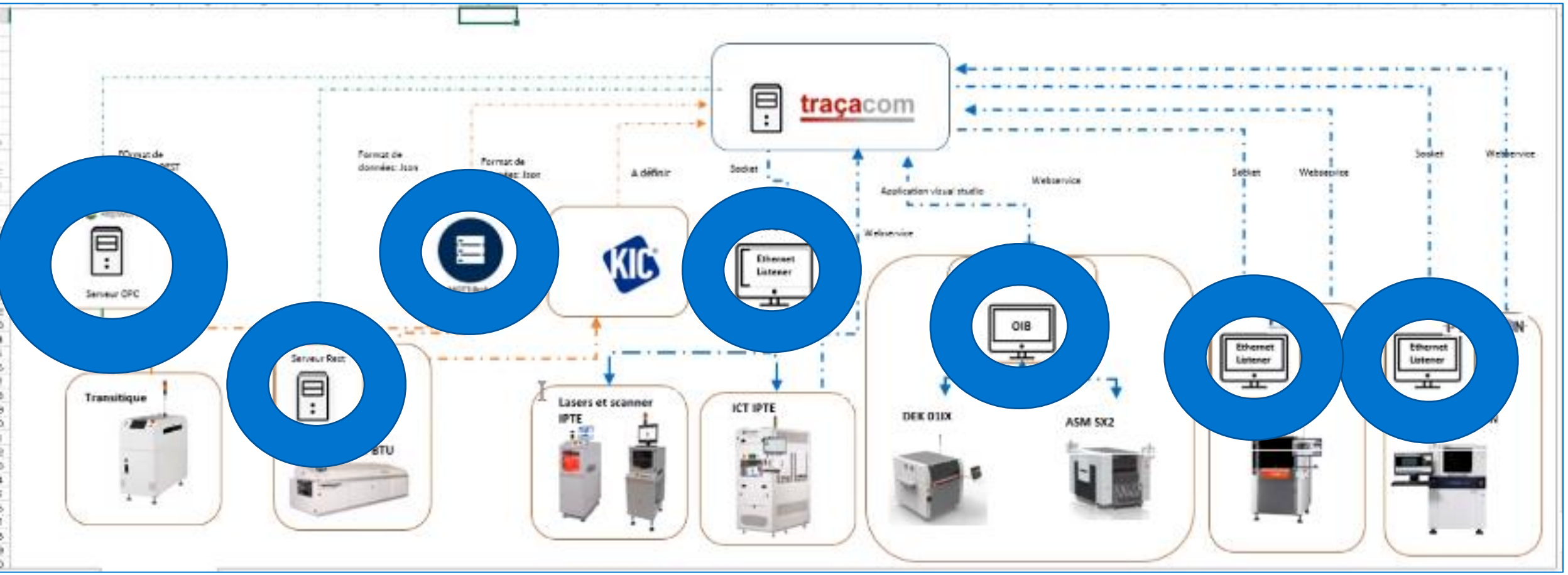
How many adapters to you have to buy/build?



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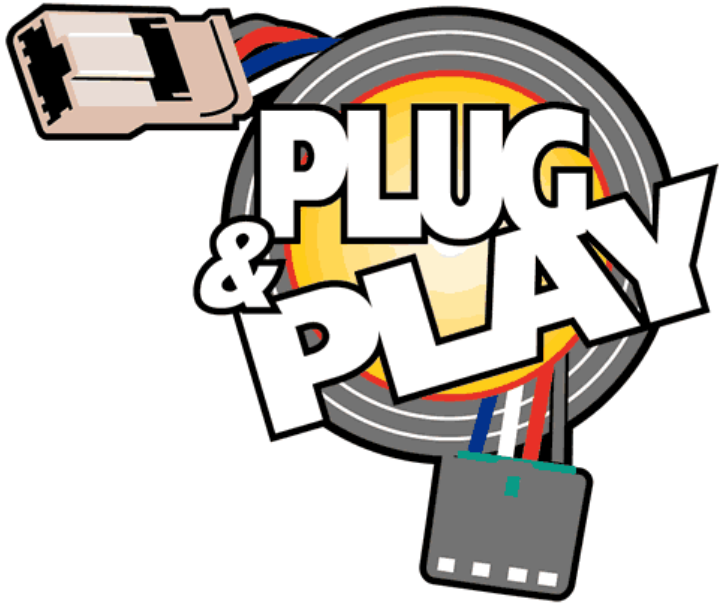
IPC CFX Committee's Vision



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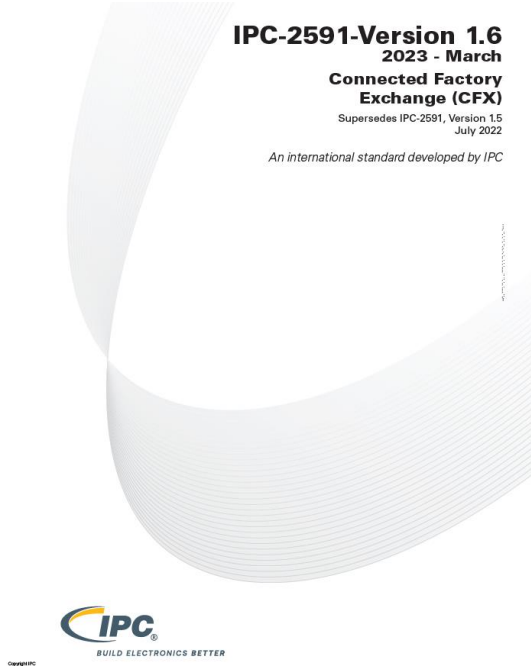
What is "CFX"

- Standard Name: "Connected Factory Exchange" (CFX) 互联工厂数据交换
- Developed by IPC 2-17 & 2-17CN Subcommittee
- 120+ companies participated

CFX Version History:

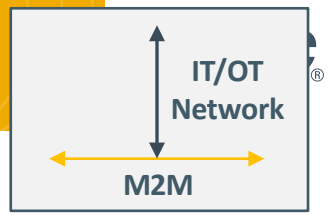
- v1.0 March 2019
- v1.1 January 2020
- v1.2 October 2020
- v1.3 March 2021
- v1.4 December 2021
- v1.5 July 2022
- v1.6 February 2023
- v1.7 August 2023



All CFX versions are backward compatible:

- *Solutions with mixed CFX support work together on the same network*
- *CFX version is communicated during connection, newer content is ignored by older instances*
- *Standard & SDK Documentation shows additions / changes to each version*

IPC-2591 Connected Factory Exchange (CFX) Architecture



Data Contextualization within IT/OT Network (options: MES, Routing Broker, Direct Networking)

Real-time dashboards, historical data mining, data analytics, operational reporting, traceability, alarms, notifications, SPC reporting, machine programming, task flow management, manufacturing process definition, BOM importing, PN management, design data importing, work instructions, document repository, revision controls, operator interfaces, etc.

CFX Open-Source Data Layer; enables (a) M2M and (b) machine to IT/OT network connectivity

M1 M2 M3 M4 M5 M(n)

Machine to machine (M2M) communications: native CFX direct messaging; no middleware or adapters needed

Physical Equipment – Connected Machine to Machine / Assembly Line

CFX M2M communication (any combination)

CFX Machine to IT/OT network

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A Common Manufacturing Language

Data Is Sent using AMQP

Advanced Message Queuing Protocol

- As secure as a bank
- Data encryption at source
- Broadcast & point to point

Data is Encoded using {JSON}


```
"CFX.Production.Work
"1.0",
amp": "2017-08-29T10:34:11.6757085
queID":                "346be717-6421-483
277b643",
ource": "MACHINE12345",
RequestID": null,
"MessageBody": {
  "ID": "db6e6191-515d-44b7-a092-cc94021d9f5e",
  "UnitCount": 2,
  "UnitLocations": [
    {
      "UnitIdentifier": "UNIT1112245",
      "LocationIdentifier": "1"
    },
    {
      "UnitIdentifier": "UNIT1112246",
      "LocationIdentifier": "2"
```


Ah! Now I understand!

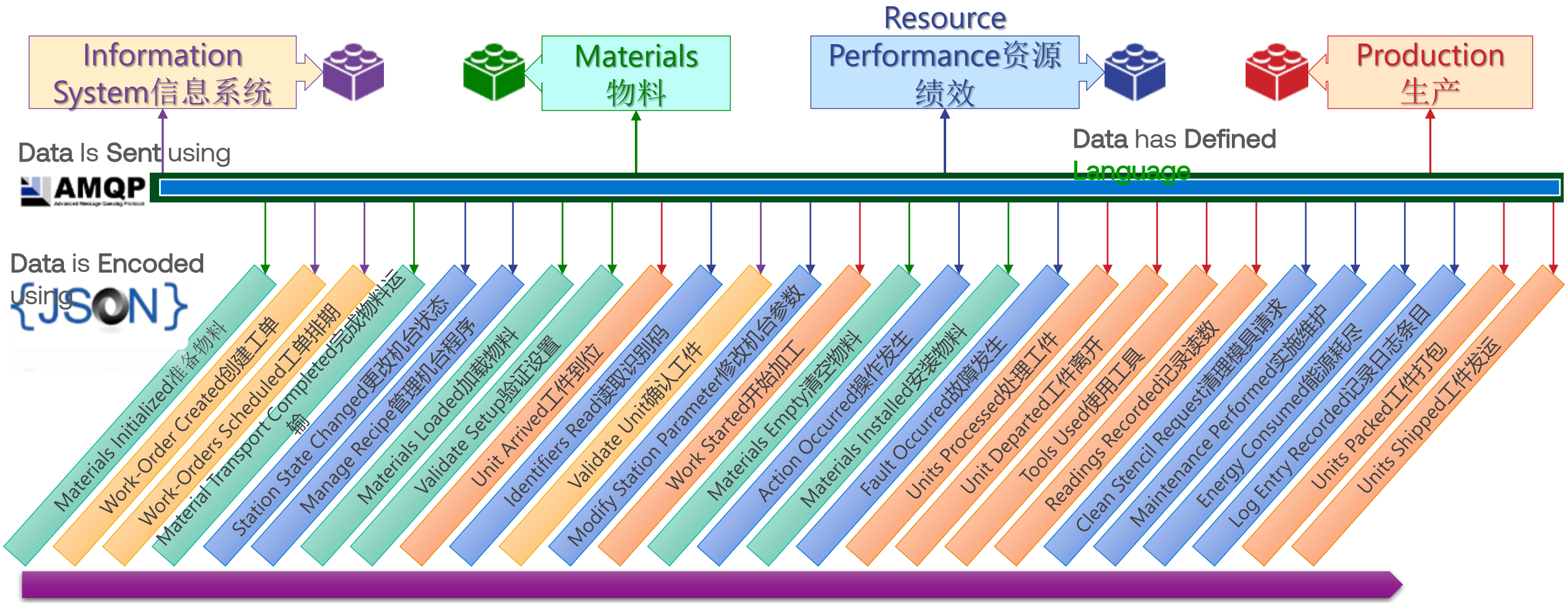
Data has Defined Language

- Modular topics and messages
- Specific message content
- The basis on which to build context

All 3 Critical Components Needed For “Plug & Play”实现“即插即用”的3个关键要素

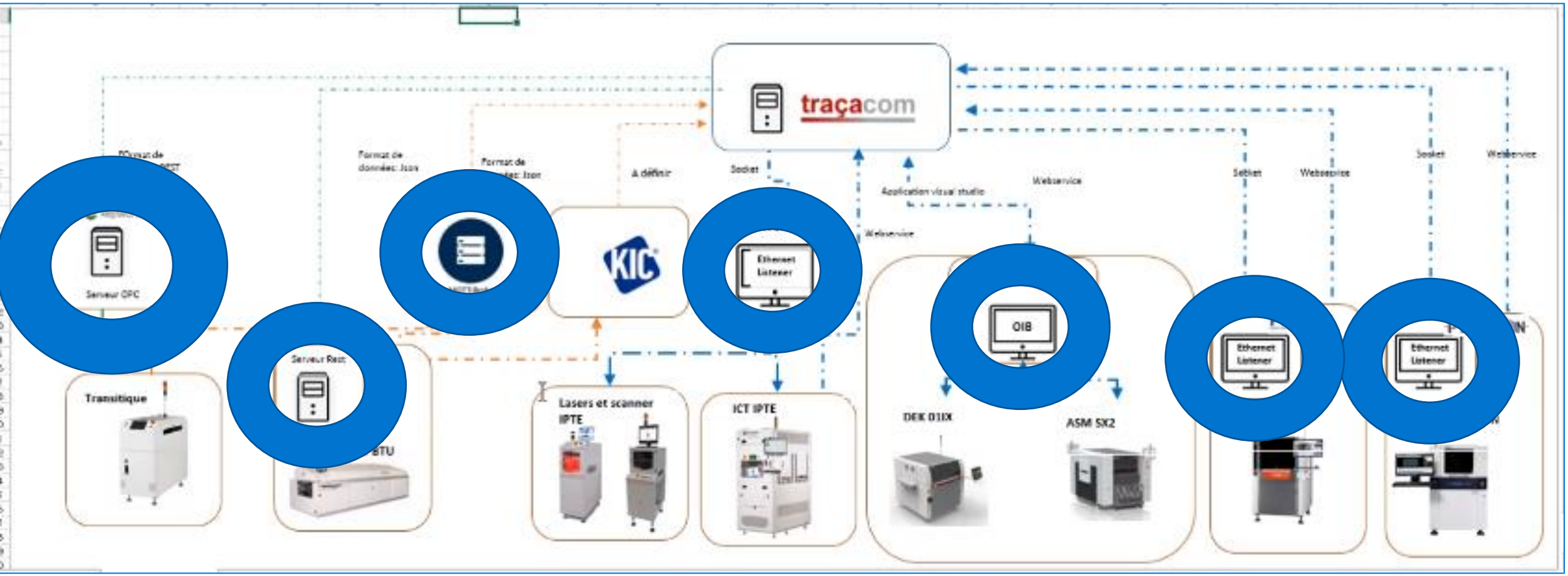
Digital Manfacturing IoT Standard
数字制造物联网标准

CFX Topics, Messages & Flow Concept



CFX also works seamlessly with The Hermes Standard (SMEMA) *CFX还与Hermes标准（SMEMA）无缝对接*

Remember all those adapters???



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Equipment Suppliers - 82

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Software Suppliers - 26

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Electronic Manufacturing Services Supporters of CFX - 32

adex ELECTRONIQUE
ARC TRONICS
BAE SYSTEMS
Celestica™
DigiProces
dorigo electronics manufacturing services
EBC
EMI 东莞捷盛电子有限公司 EMI (Dongguan) Asia Limited Electronics Manufacturing Services
East West design • manufacturing • distribution
essemtec A NANODIMENSION DIVISION
AZY
HTS High Technology Systems
HUAWEI
Insyte
LACROIX
LOCKHEED MARTIN
MB ELETTRONICA
mtc Manufacturing Technology Centre
NAS
PIONEER POWER SOLUTIONS
PPSI
SELCOM GROUP
Semes member of SERO EMS Group
Sunnytech
Vanguard ems Leading-Edge Electronics Manufacturing
VRI
vosch electronic
WESTSHORE Electronics
wistron
Worthington
ZENTECH MANUFACTURING, INC.
3DPHOTONiX

How to participate: Join IPC-CFX as a Committee Member, Supporter, or Partner

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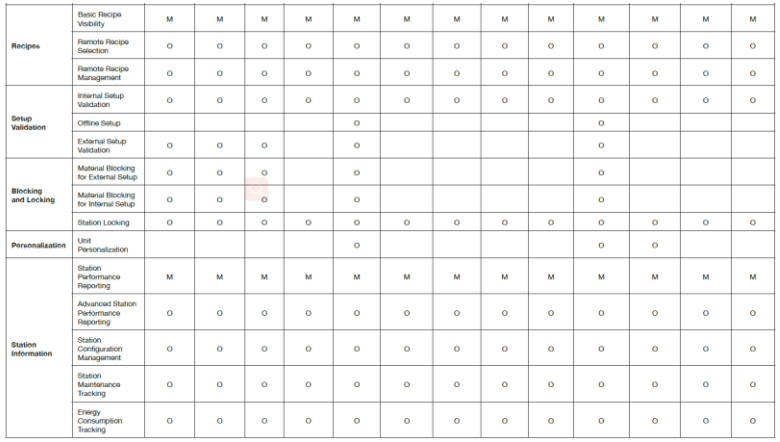
CFX Capability Requirements by Equipment Type

Table 6-1 CFX Capability Requirements by Equipment Type

Category	Capability	Endpoint Class												
		Generic Equipment Endpoint	Automated Labeler/ Laser Marker	Stencil Printer	Solder Paste Inspection (SPI)	SMT Mounter (Pick and Place)	Automated Optical Inspection (AOI/AXI)	Solder Reflow Oven	Reflow Profiling	Selective Solder	Through-Hole Component Insertion (THT)	Test Equipment	Conformal Coating	Cleaning
CFX Core	Core Communications	M	M	M	M	M	M	M	M	M	M	M	M	M
Track and Trace	WIP Tracking	M	M	M	M	M	M	M	M	M	M	M	M	M
	WIP Identification	MR	M	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
	Unit Initialization	O	M	O	O	O	O	O	O	O	O	O	O	O
	Panelized Unit Initialization	O	M	O	O	O	O	O	O	O	O	O	O	O
	Operator Tracking	O	O	O	O	O	O	O	O	O	O	O	O	O
	Equipment Data Tracking	O	O	O	O	O	O	O	O	O	O	O	O	O
	Unit Disqualification/ Scrapping	O	O											
	Detailed Activity Tracking	O	O	O	O	O	O	O	O	O	O	O	O	O
	Material Trace with Internal Setup	O	O	O		O		O	O	O	O	O	O	O
	Exact Material Trace with Internal Setup	O				MR					MR			
	Exact Material Trace with External Setup	O				M					M			
	Tool Trace	MR	O	MR		O			O	O	O	O	O	O
Process Interlocking	Process Route Validation	O	O	O	O	O	O	O	O	O	O	O	O	O
	Unit Status Validation	O	O	O	O	O	O	O	O	O	O	O	O	O
	Unit Trace Validation	O	O	O	O	O	O	O	O	O	O	O	O	O



Recipes	Basic Recipe Visibility	M	M	M	M	M	M	M	M	M	M	M	M	M
	Remote Recipe Selection	O	O	O	O	O	O	O	O	O	O	O	O	O
	Remote Recipe Management	O	O	O	O	O	O	O	O	O	O	O	O	O
Setup Validation	Internal Setup Validation	O	O	O	O	O	O	O	O	O	O	O	O	O
	Offline Setup					O					O			
	External Setup Validation	O	O	O		O					O			
Blocking and Locking	Material Blocking for External Setup	O	O	O		O					O			
	Material Blocking for Internal Setup	O	O	O		O					O			
	Station Locking	O	O	O	O	O	O	O	O	O	O	O	O	O
Personalization	Unit Personalization					O					O	O		
Station Information	Station Performance Reporting	M	M	M	M	M	M	M	M	M	M	M	M	M
	Advanced Station Performance Reporting	O	O	O	O	O	O	O	O	O	O	O	O	O
	Station Configuration Management	O	O	O	O	O	O	O	O	O	O	O	O	O
	Station Maintenance Tracking	O	O	O	O	O	O	O	O	O	O	O	O	O
	Energy Consumption Tracking	O	O	O	O	O	O	O	O	O	O	O	O	O

Table 6-1 CFX Capability Requirements by Equipment Type (cont.)

Category	Capability	Endpoint Class												
		Generic Equipment Endpoint	Automated Labeler/ Laser Marker	Stencil Printer	Solder Paste Inspection (SPI)	SMT Mounter (Pick and Place)	Automated Optical Inspection (AOI/AXI)	Solder Reflow Oven	Reflow Profiling	Selective Solder	Through-Hole Component Insertion (THT)	Test Equipment	Conformal Coating	Cleaning
Test and Inspection	Production Unit Inspection				M		M							
	Automated Optical Inspection (AOI/AXI)						M							
	AOI Component Offset Measurement						O							
	Solder Paste Inspection				M									
	Production Unit Test											M		
Specialized Processing	Solder Paste Reflow Processing							M						
	Solder Paste Reflow Profiling								M					
	Selective Solder Processing									M				
	Solder Paste Printing			M										
	Conformal Coating												M	
	Cleaning													M

IPC CFX Qualified Product List - 29

Manufacturers with Qualified Listing on the QPL

ALeader
ASMPT enabling the digital world
CKD
CYBEROPTICS Technology Leadership. Global Solutions.
essemtec A NANODIMENSION DIVISION
europlacer Surface Mount Intelligence
FLEXLINK a coesia company
FUJI innovative spirit
欧菲特 GENERALTEST
GKG
GOPEL electronic Enjoy Testing
HELLER INDUSTRIES
ITW EAE Electronic Assembly Equipment
KIC Making Ovens Smarter
KOH YOUNG TECHNOLOGY
MBtech
MIRTEC
Nordson
OMRON
PARMI
rehm THERMAL SYSTEMS
robotas optimising hand assembly
saki
sonic
TRI innovation
VISCOM vision technology
ViTrox
YJ LINK
振華興 ZHENHUAXING

Qualifications in progress

ACCULOGIC Let's Test
kurtz ersa
YAMAHA Revs Your Heart

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IPC CFX QPL – *Inspiring confidence and trust*

Developed by the Industry, for the Industry, Qualify your equipment to the IPC CFX Standard 2591

AOI/AXI	SPI	Pick & Place	Stencil Printer	Automated Labeler / Laser Marker	Test Equipment	Solder Reflow Oven	Through-Hole Component Insertion	Reflow Profiling	Cleaning	Generic
ALeader 神州视觉	ALeader 神州视觉	ASMPT enabling the digital world	ASMPT enabling the digital world	FLEXLINK a coesia company	欧菲特 GENERALTEST	HELLER INDUSTRIES	robotas optimising hand assembly	KIC Making Ovens Smarter	MBtech	YJ LINK
CYBEROPTICS	CKD	europlacer Surface Mount Intelligence	europlacer Surface Mount Intelligence	sonic	TRI innovation	ITW EAE Electronic Assembly Equipment				
GOPEL electronics Enjoy Testing	GOPEL electronics Enjoy Testing	essemtec A NANODIMENSION DIVISION	GKG	YJ LINK		sonic				
KOH YOUNG TECHNOLOG INTELLIGENT INSPECTION	KOH YOUNG TECHNOLOG INTELLIGENT INSPECTION	FUJI innovative spirit	FUJI innovative spirit			rehm THERMAL SYSTEMS				
MIRTEC	MIRTEC		ITW EAE Electronic Assembly Equipment							
PARMI	PARMI									
saki	saki									
TRI innovation	TRI innovation									
VISCOM vision technology	VISCOM vision technology									
振華興 ZHENHUAXING	振華興 ZHENHUAXING									
OMRON										
Vitrox										
Nordson										

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IPC

BUILD ELECTRONICS BETTER

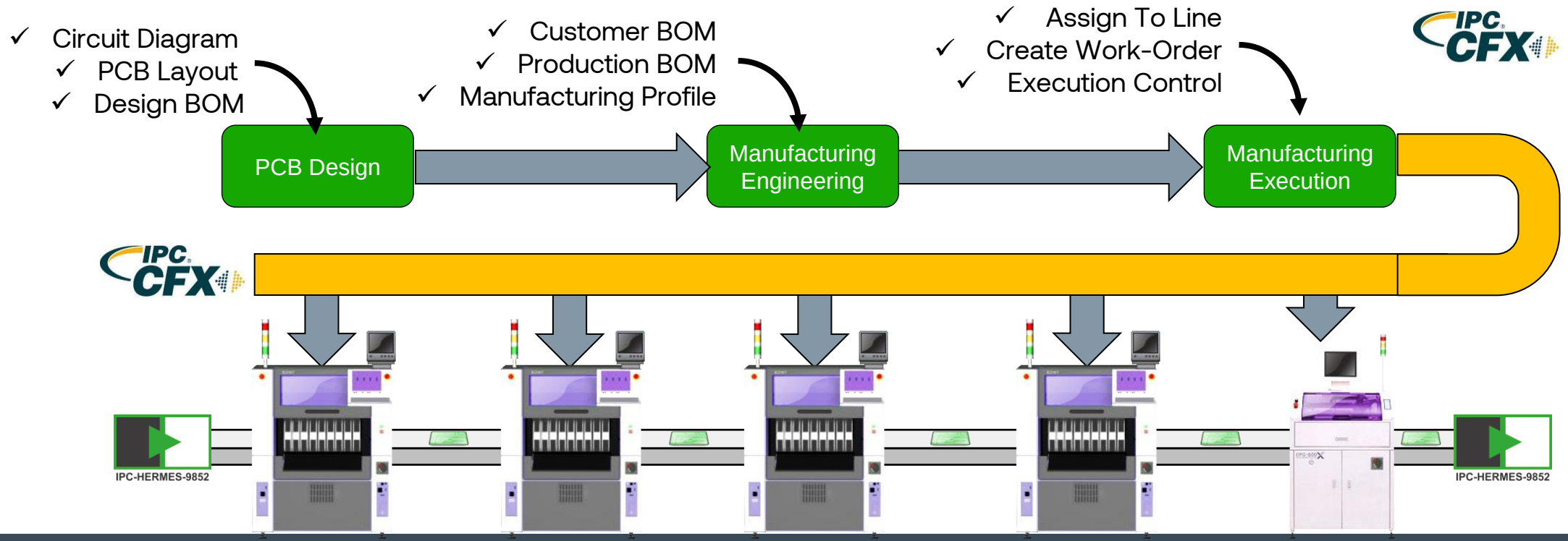
应用场景案例

DPMX and CFX - Design Through Manufacturing 4.0 Flow

- No human “touch” of data
- Manufacturing attributes added to DPMX file
- DPMX delivered to machines by CFX Message
- Machine vendors parse DPMX file

IPC-2581

IPC-2591



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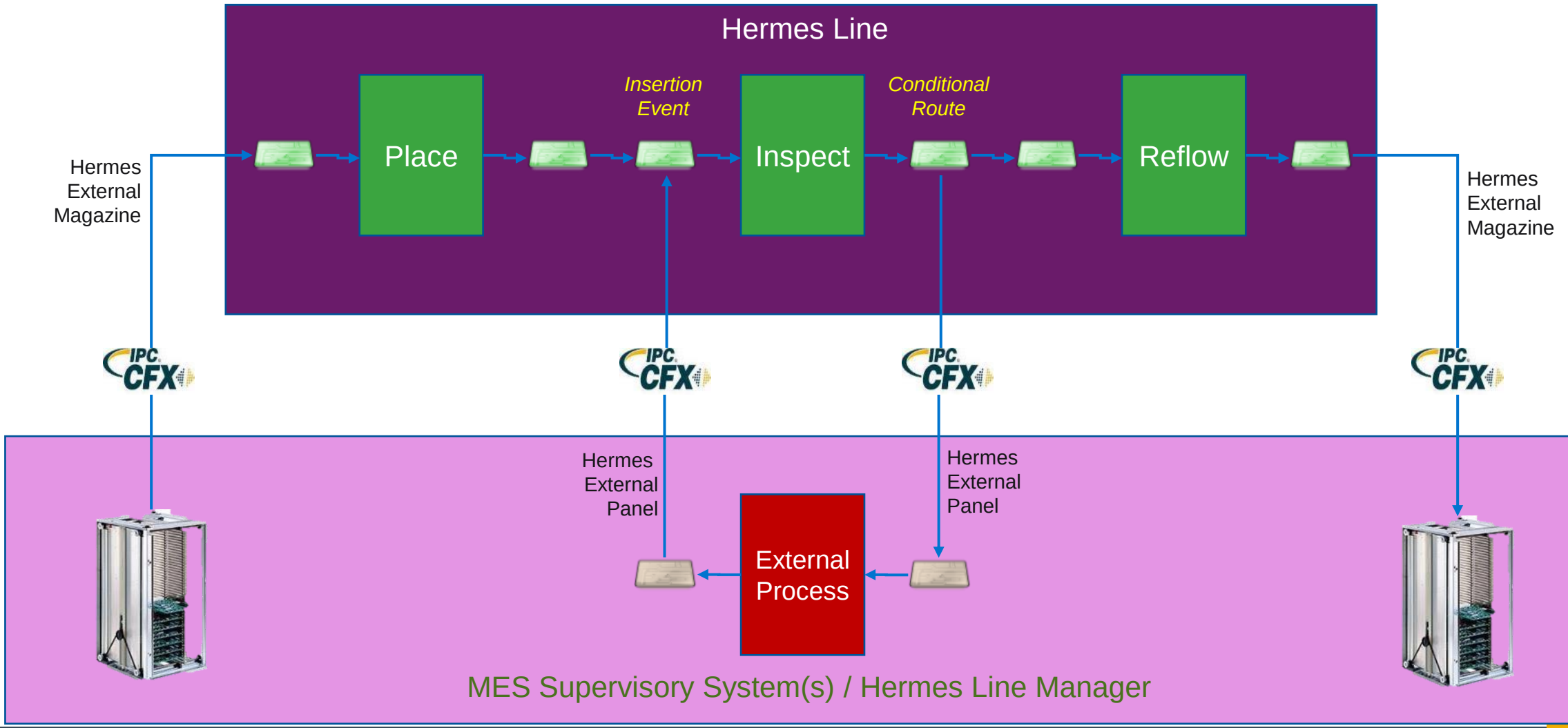
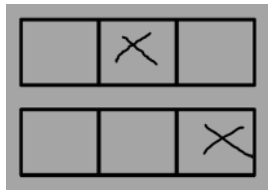
Hermes – CFX Interoperability



Hermes - Managing “Bad Marks”

Objective:
Transfer known bad mark information between MES and machine, so that no or only one machine must detect it by itself

Board with 6 subpanel, 2 bad marks



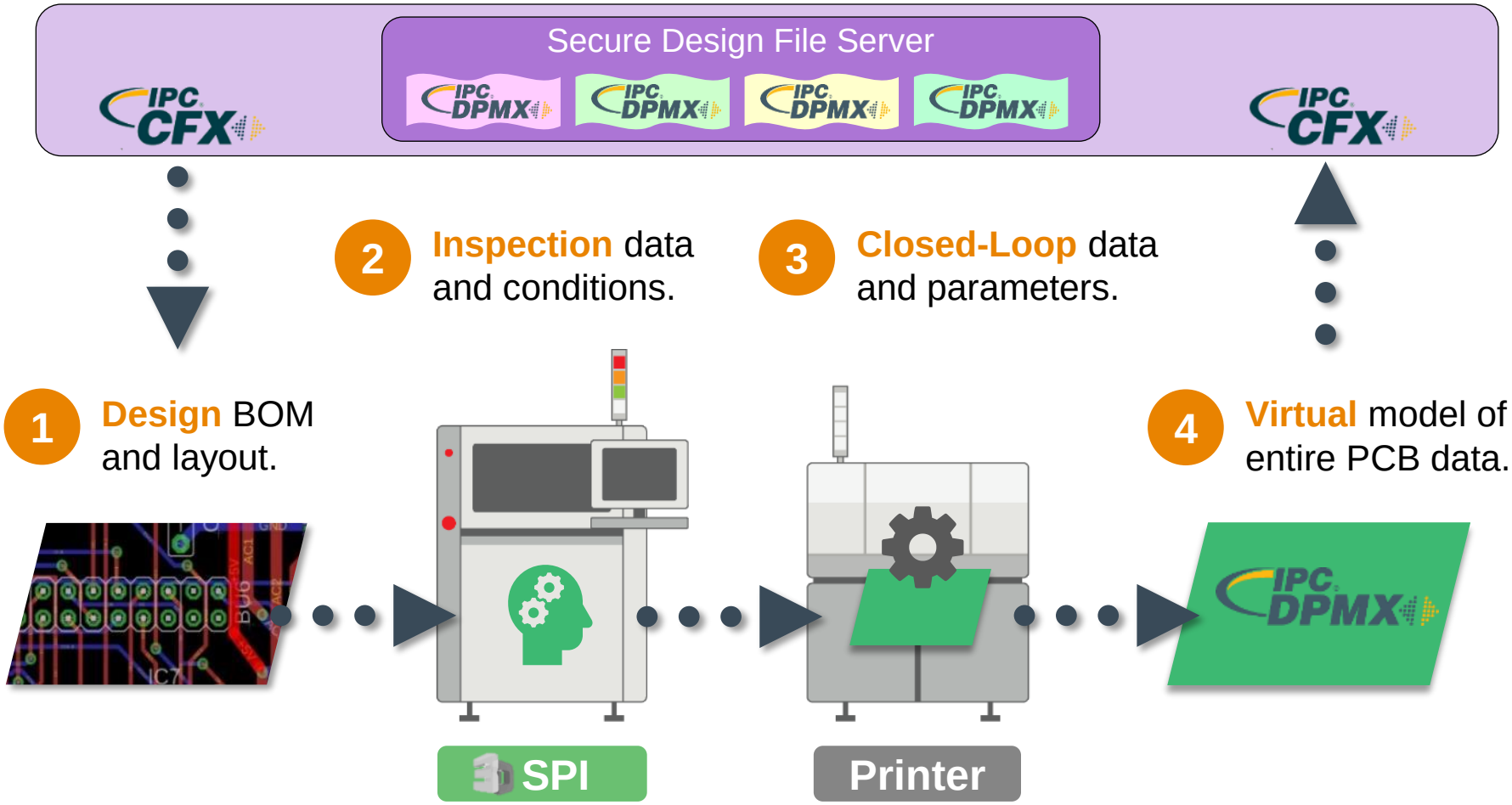
MES	
SubPanel1	OK
SubPanel2	XOUT
SubPanel3	OK
SubPanel4	OK
SubPanel5	OK
SubPanel6	XOUT

Multiple situations:
- Bad marks known before SMT process (data from supplier/previous process)
- Bad marks detected by first inspection process (SPI)

Proposal
Simply add **Skipped** status to ValidationResult (MES -> Machine)
and TestResult (Machine -> MES)

ValidateUnitsRequest/Response
+ UnitsInspected (via Broker)

DPMX + CFX Smart Solutions



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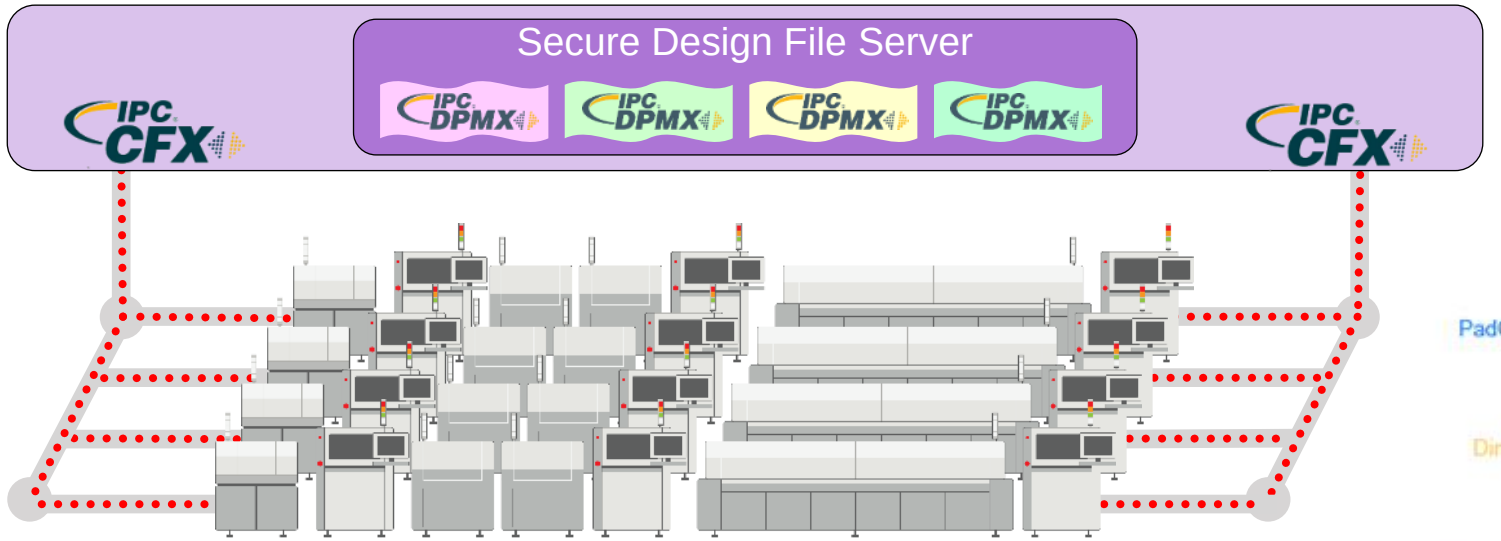
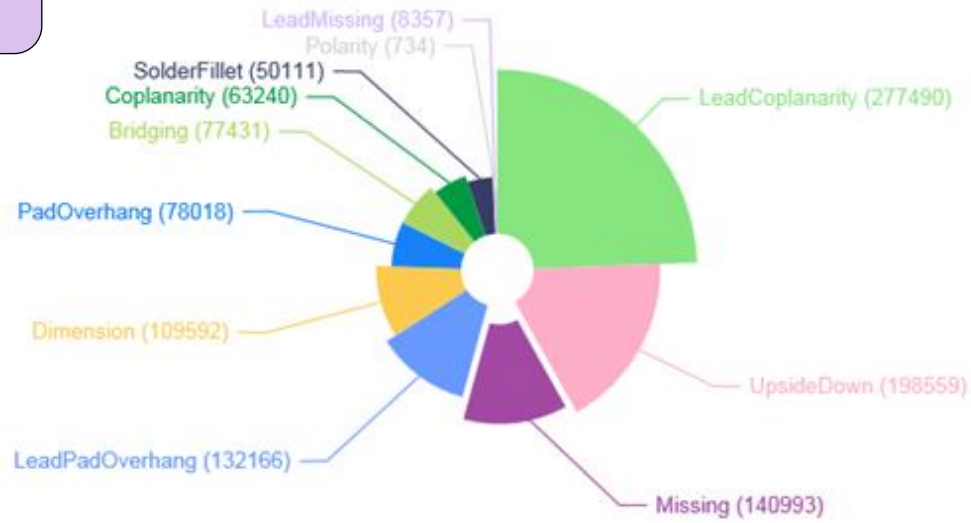
DPMX + CFX Smart Factory

> Share and transfer product information across multiple lines seamlessly.
> Ensure the same information is used for the creation of the product.
> Collect accurate model information to calculate production metrics.
> Monitor and validate inspection conditions for quality assurance.





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CFX: Smart Factory Superhighway

Interoperable Applications

Smart MES

Smart Energy

Smart Maintenance

Analytics

Closed Loops

Machine Learning

Any Other AI

CFX Smart Factory Superhighway

Interoperable On-Ramps

Native CFX

Legacy Box

PLC

OPC-UA

MT-Connect

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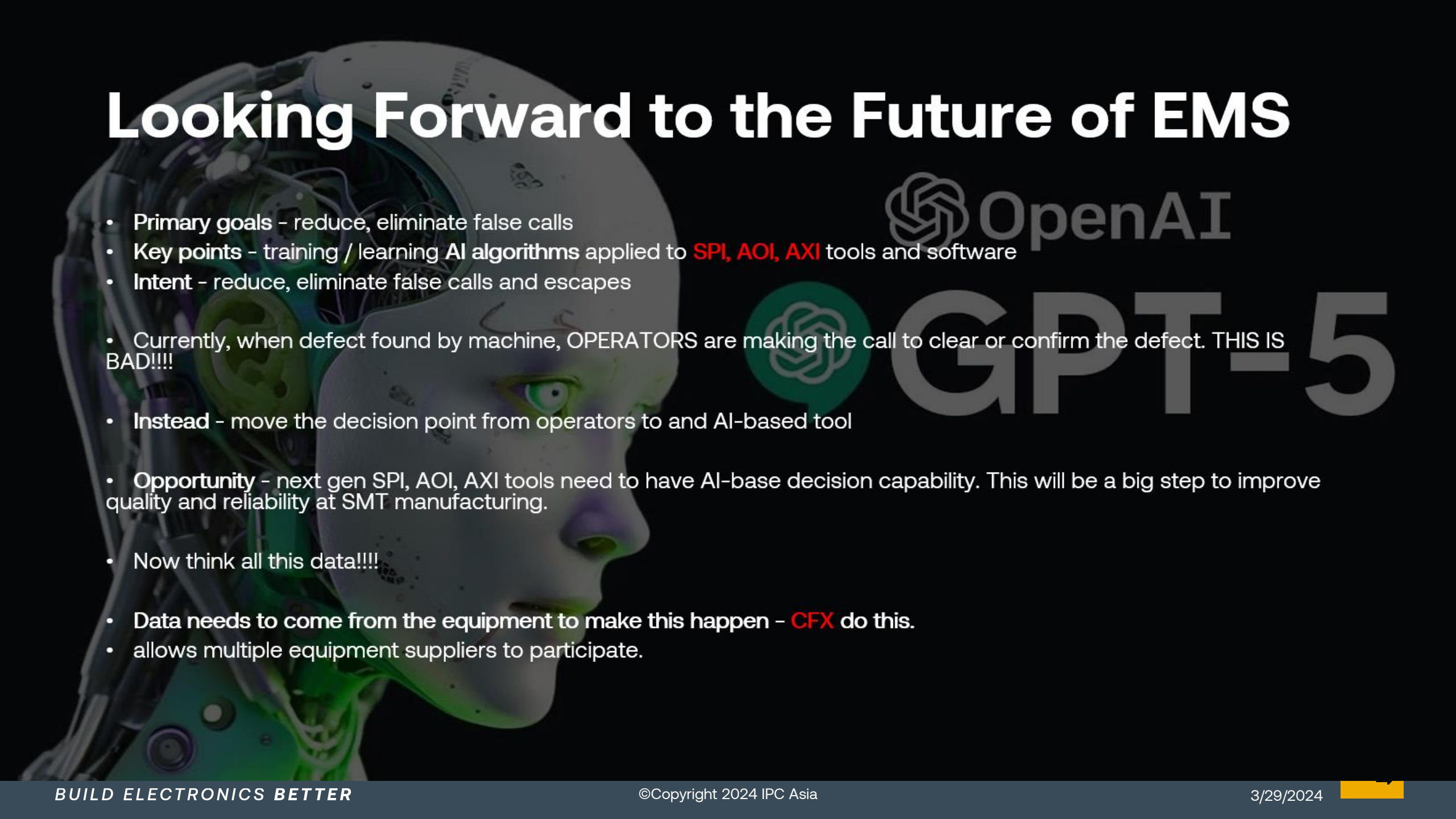
Looking Forward to the Future of EMS



- **Primary goals** - reduce, eliminate false calls
- **Key points** - training / learning **AI algorithms** applied to SPI, AOI, AXI tools and software
- **Intent** - reduce, eliminate false calls and escapes

- Currently, when defect found by machine, OPERATORS are making the call to clear or confirm the defect. THIS IS BAD!!!!

- **Instead** - move the decision point from operators to and AI-based tool

- **Opportunity** - next gen SPI, AOI, AXI tools need to have AI-base decision capability. This will be a big step to improve quality and reliability at SMT manufacturing.

- Now think all this data!!!!

- **Data needs to come from the equipment to make this happen** - CFX **do this.**
- allows multiple equipment suppliers to participate.

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The Rise Of "AI" Software

- **"HI" Human Intelligence:**
- Creative, imaginative, innovative
- Domain expertise
- Limited attention span...

- **"AI" Artificial Intelligence:**
- Focused, repetitive, reliable, scalable
- Automation through algorithms
- Known the causes of issues

Smart = HI + AI

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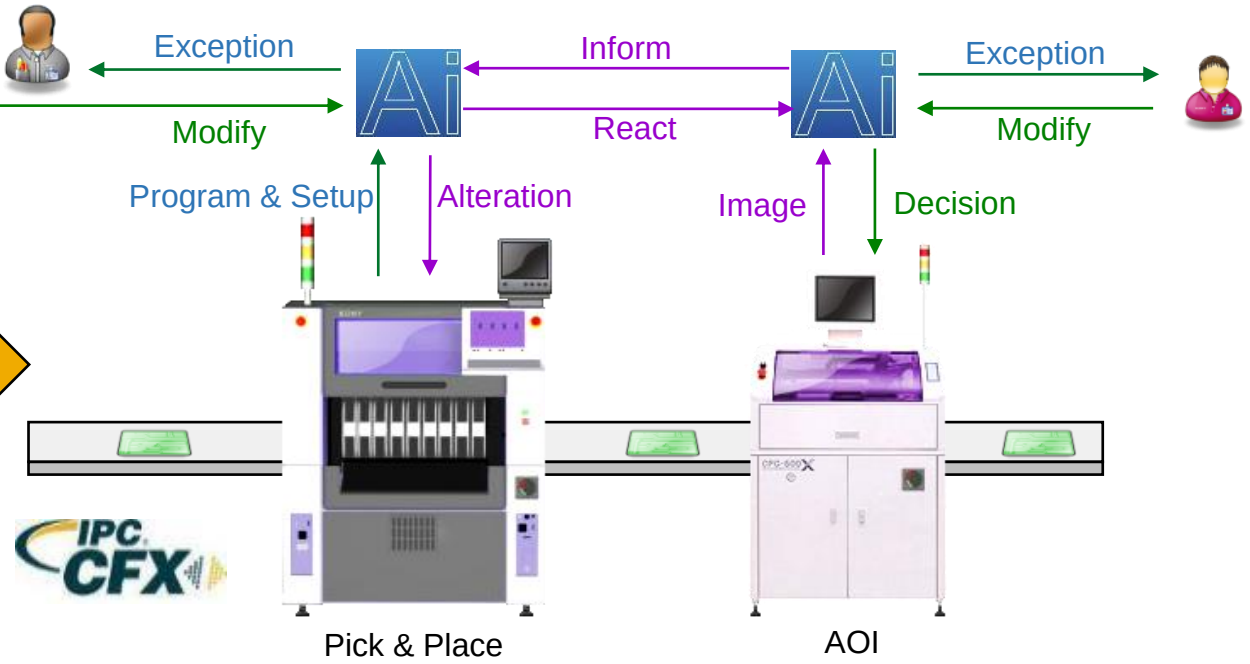
Machine Learning & Closed Loop Software

Inclusivity of Factory-Based Context, Reducing Human Involvement

Factory

- Schedule Changes
- Material Changes
- PCB Batch Changes
- Prior Process Events

Contextualized Events



Goal: Interoperability To Eliminate Effects Of All Causes Of Variation -> Zero Defects

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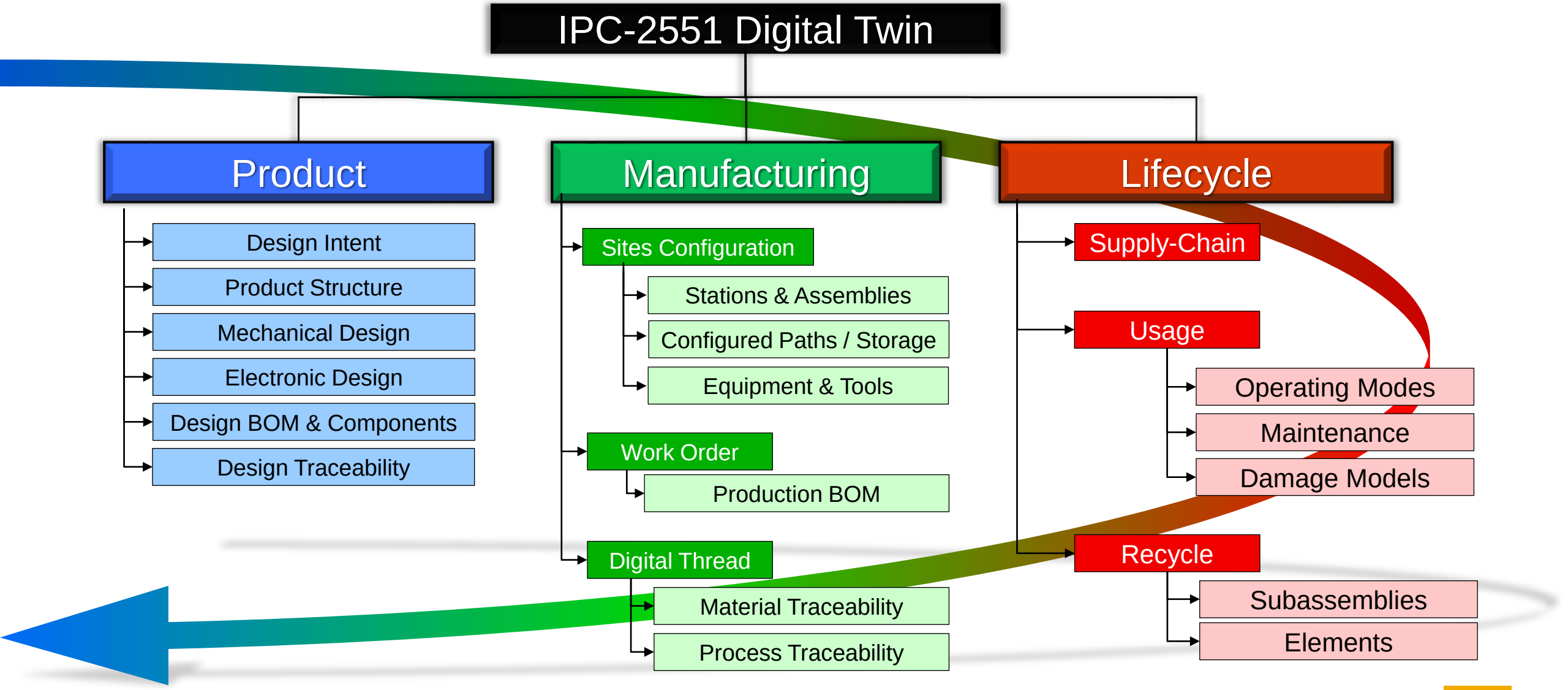
Interoperability Does Not Stop With MBD,DPMX,CFX



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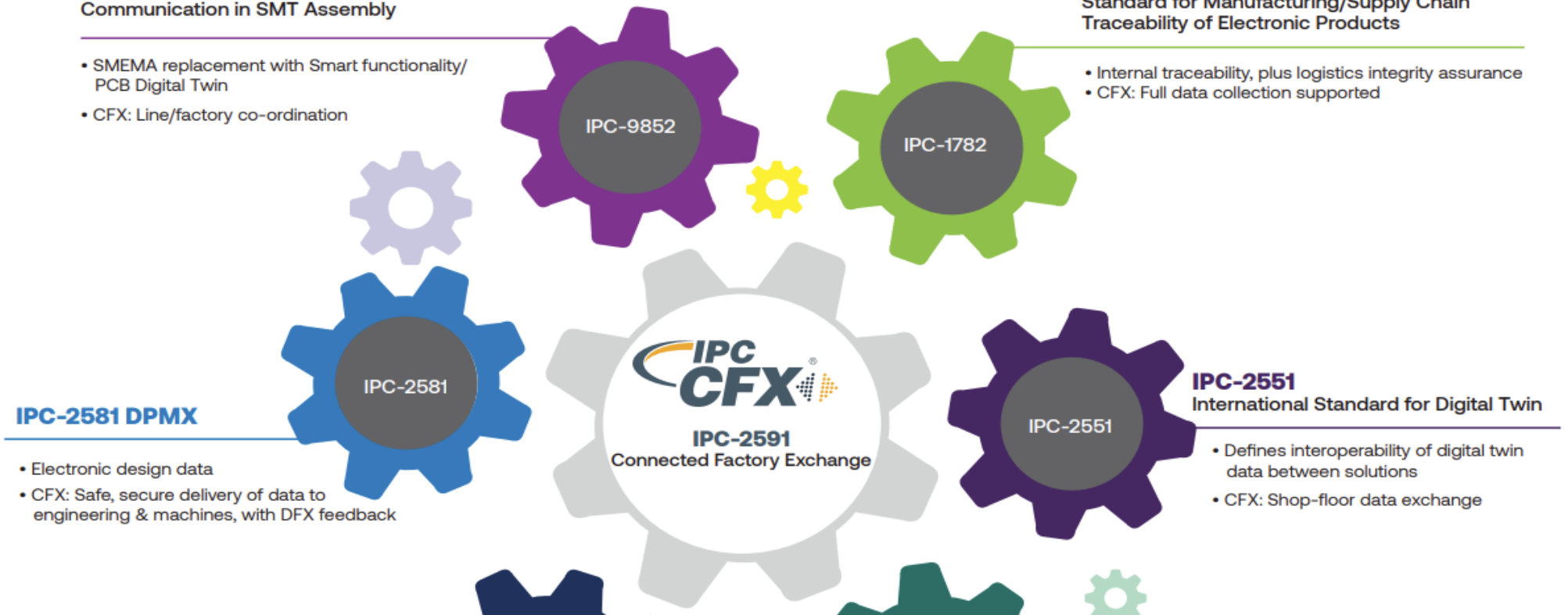
Foundational to enable Factory of the Future & Digital Transformation of Electronics Manufacturing



IPC-HERMES-9852
The Global Standard for Machine-to-Machine Communication in SMT Assembly

- SMEMA replacement with Smart functionality/ PCB Digital Twin
- CFX: Line/factory co-ordination

IPC-1782
Standard for Manufacturing/Supply Chain Traceability of Electronic Products

- Internal traceability, plus logistics integrity assurance
- CFX: Full data collection supported

IPC-2581 DPMX

- Electronic design data
- CFX: Safe, secure delivery of data to engineering & machines, with DFX feedback

IPC-2551
International Standard for Digital Twin

- Defines interoperability of digital twin data between solutions
- CFX: Shop-floor data exchange

IPC/DAC-2552
Standard for Model Based Design (MBD) for Digital Twin Factories

- The complete 3D physical & functional modelling of materials
- CFX: Communicate data to engineering and machines

IPC-1792
Standard for Cybersecurity in the Manufacturing Industry Supply Chain

- How to manage cybersecurity incidents in manufacturing
- CFX: The knowledge of what products may be affected

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IPC CFX Demo Line @productronica South China

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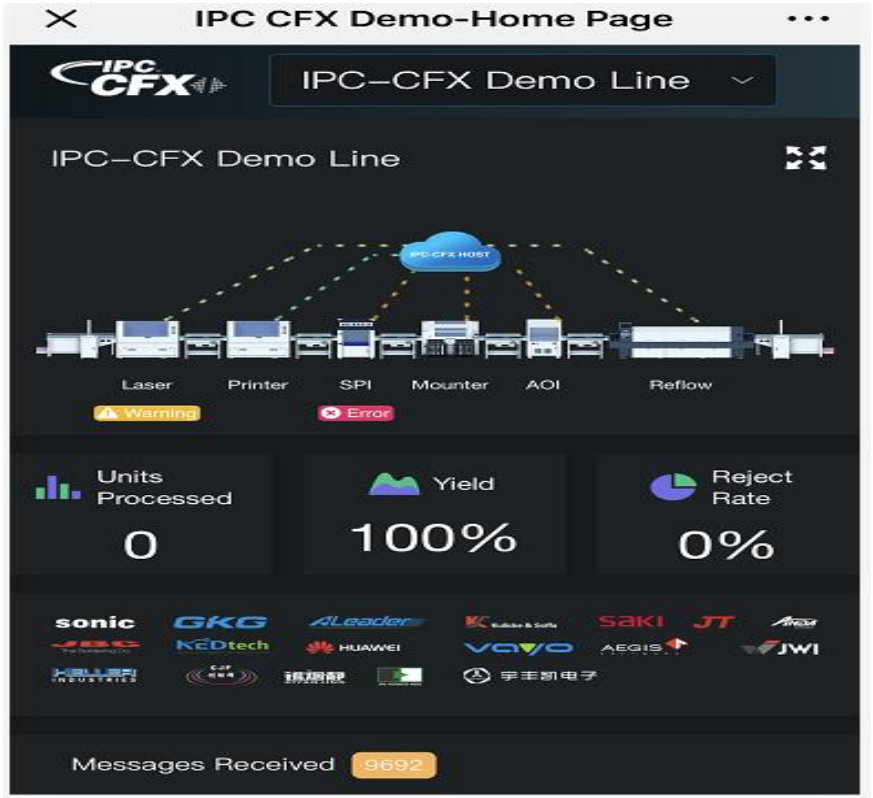
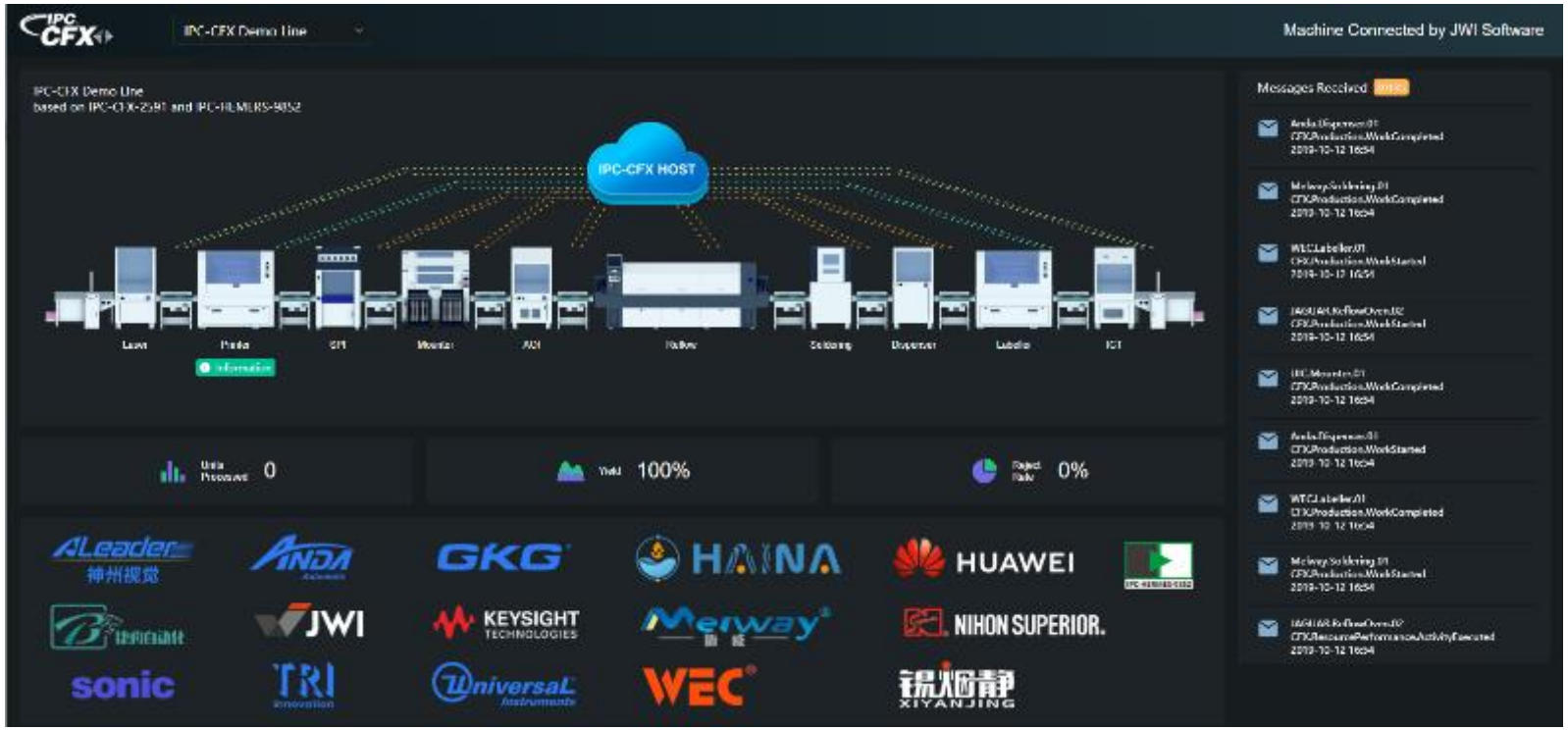
IPC CFX Demo Line Application



http://ipc.devicemate.cn



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Thank you!

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