The Component Digital Thread

Michael Durkan

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For 7yrs running, "TIME" is the #1 pressure facing companies.

53% of companies say they require additional resources to meet their business objectives for new products

35% of companies require multiple ECO's

on new product designs in order to achieve goals.

24% of companies engineering resources wasted.

Companies have to manually correct design or library data errors or inconsistencies.

31.8% of companies with a content strategy achieve 27.1% higher win rates

than those without a content strategy (CSO Insights).

21% of companies saw delays in manufacturing

due to data quality and/or inconsistencies in new product. This drives an

average of 2.9 re-spins

of a typical complex Product

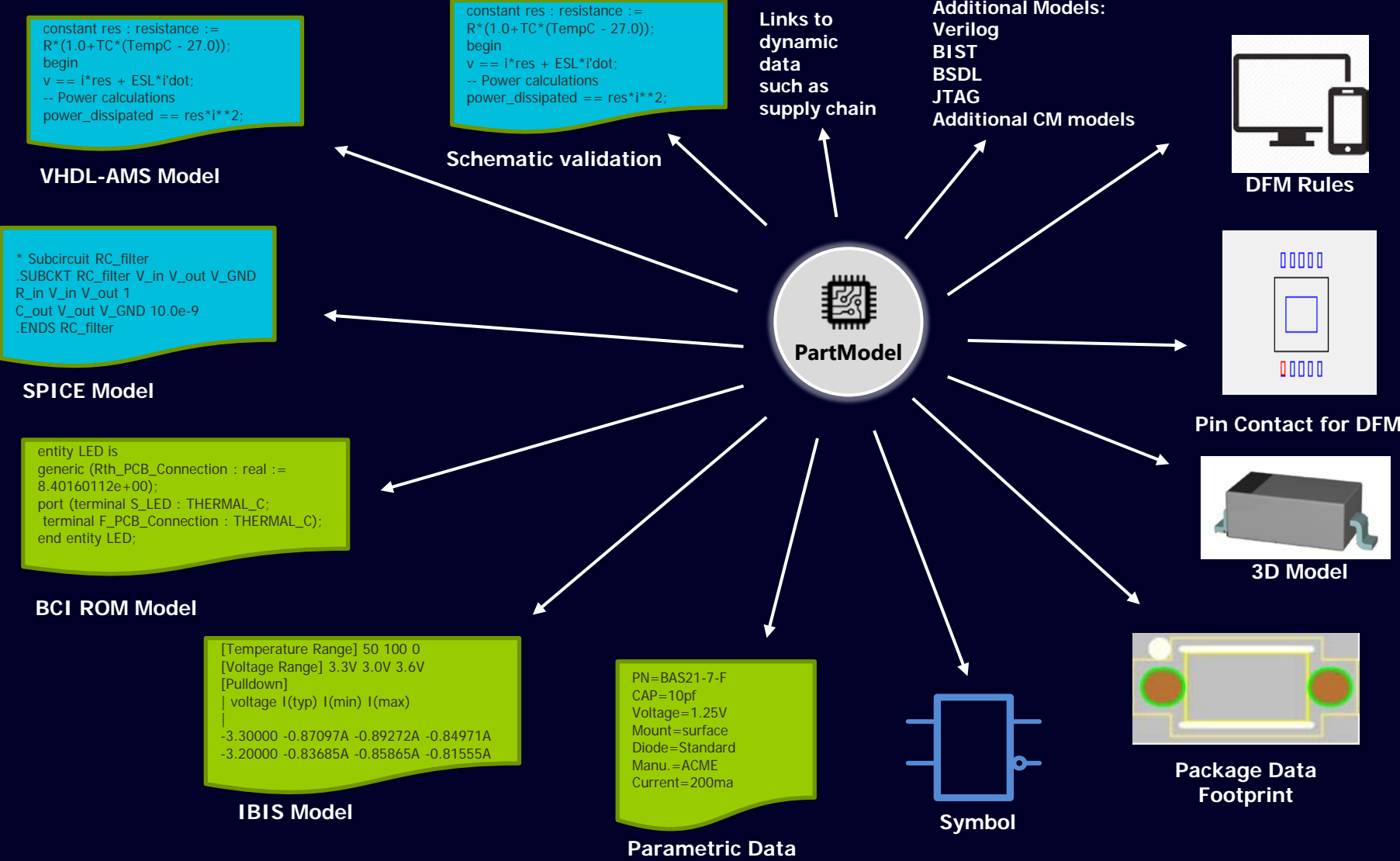before the product is ready for volume manufacturing.

32% of Companies

Require better collaboration across disciplines.

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Significant Human Effort to Create IP
Inefficient, error prone, non value-add

PN=BAS21-7-F
CAP=10pf
Current=200ma
Voltage=1.25V
Mount=surface
Diode=Standard
Manu.=ACME

Part Attributes

Thermal Profile

Acceptable/Allowed

Manufacturing Process

Symbol

Stencil Calculations

Footprint

3D Model

Pin Contact for DFM

Simulation

Acceptable

Design Density

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Value of Communicating the Part Electronically

- Allow part manufacturers to provide data to their customers and 3rd parties in a consistent software consumable format

- Provides sufficient detail for consumers to search, design, layout, analyze, simulate, manufacture and test.

- Reduce the burden of interpreting this information from a datasheet.

- Supports data for ALL software tools involved in a Product life Cycle

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The PartModel Fuels the Product Creation Process

```
constant res : resistance :=
R*(1.0+TC*(TempC - 27.0));
begin
v == i*res + ESL*i'dot;
-- Power calculations
power_dissipated == res*i**2;
```
VHDL-AMS Model

```
constant res : resistance :=
R*(1.0+TC*(TempC - 27.0));
begin
v == i*res + ESL*i'dot;
-- Power calculations
power_dissipated == res*i**2;
```
Schematic validation

Links to dynamic data such as supply chain

Additional Models:
Verilog
BIST
BSDL
JTAG
Additional CM models

DFM Rules

```
* Subcircuit RC_filter
.SUBCKT RC_filter V_in V_out V_GND
R_in V_in V_out 1
C_out V_out V_GND 10.0e-9
.ENDS RC_filter
```
SPICE Model

PartModel

Pin Contact for DFM

```
entity LED is
generic (Rth_PCB_Connection : real :=
8.40160112e+00);
port (terminal S_LED : THERMAL_C;
 terminal F_PCB_Connection : THERMAL_C);
end entity LED;
```
BCI ROM Model

3D Model

```
[Temperature Range] 50 100 0
[Voltage Range] 3.3V 3.0V 3.6V
[Pulldown]
| voltage I(typ) I(min) I(max)
|
-3.30000 -0.87097A -0.89272A -0.84971A
-3.20000 -0.83685A -0.85865A -0.81555A
```
IBIS Model

```
PN=BAS21-7-F
CAP=10pf
Voltage=1.25V
Mount=surface
Diode=Standard
Manu.=ACME
Current=200ma
```
Parametric Data

Symbol

Package Data Footprint

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The Electronics Value Chain Faces Challenges - Uniqueness of Each Domain

Chasms

Supply

Component Manufacturers

Distributors

Content Aggregators

Library Providers

Design

IC & Package Design

PCB Design & ECAD

Simulation

PLM

Manufacturing

PCB Fabrication

PCB Assembly

Test Services

EMS

Each domain requires BOM handling capabilities, along with Part & Library generation functionality

Trust & Traceability

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Bridging the Chasm in the Electronics Value Chain

Component Suppliers

Simulation

Part Promote

Part Model

Component Manufacturers

who provide standardized digital twins of their components eliminates the source of many errors and inconsistencies in their customers designs, enabling efficiencies and improved product reliabilities.

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Bridging the Chasm in the Electronics Value Chain

Component Suppliers

Electronic Design

Simulation

Part Promote

eCAD Authoring

Simulation

DFM

Part Search

Part Model

Part Model

Alternates

Risk

Quoting
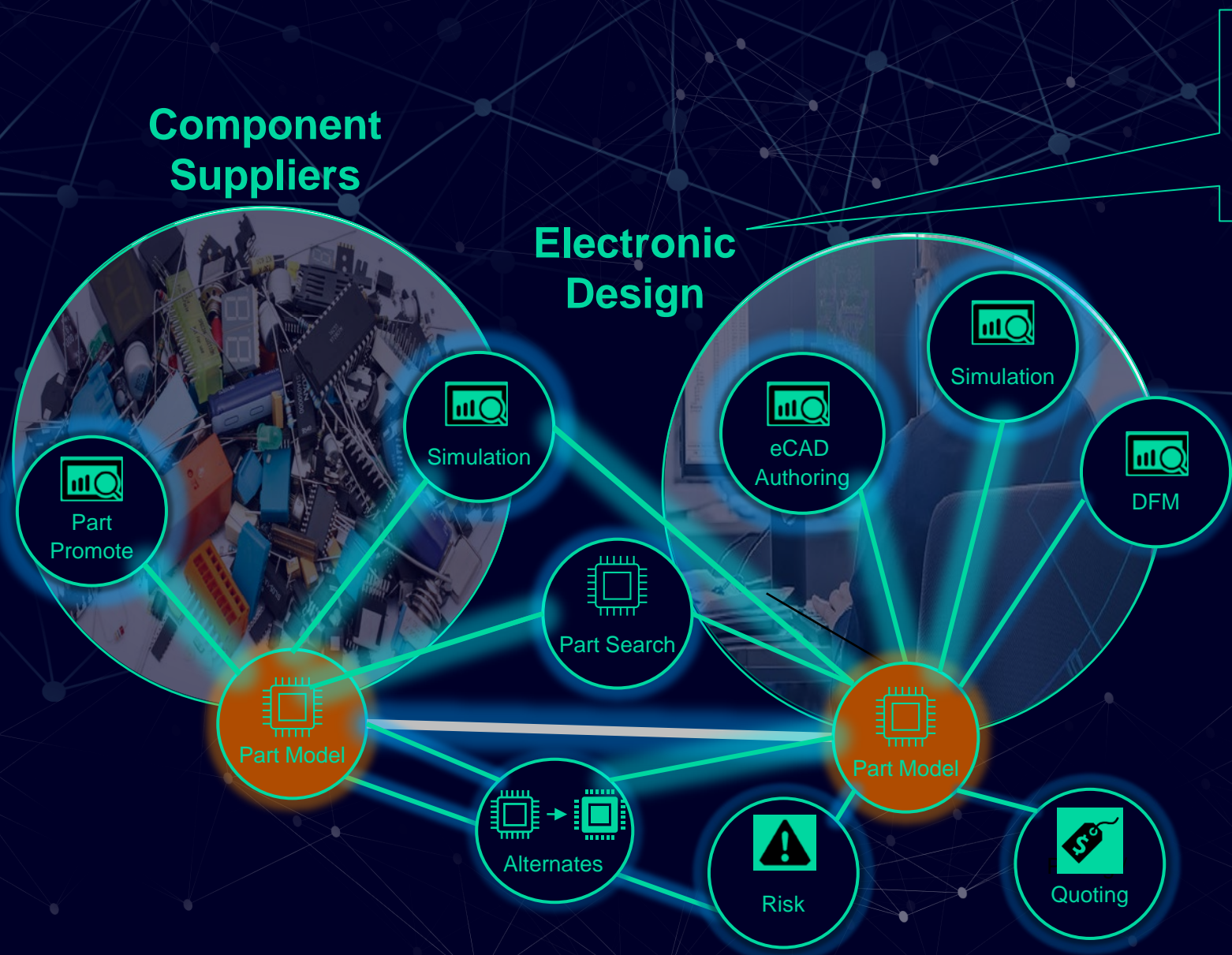
The digital twin of component data enabling automated validation throughout the process, eliminates non-value add tasks such as manual data entry, improves data integrity, and produces "Ready-to-Manufacture" validated BOM.

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The PartModel Streamlines The Design and Manufacturing Process

High Level of Trusted Content
Easily Traceable directly back to source of generation at Component Manufacturer

Functional Simulation

Electro-Thermal Simulation

High-Speed SI Simulation

Part Model TruePart™
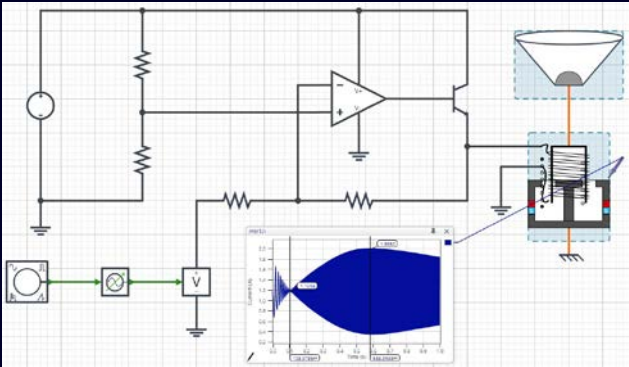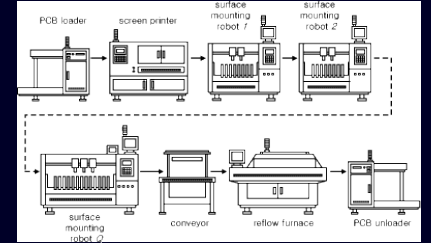
Calculated Manufacturing Processes with predictive Yield information

Optimized Stencil Calculations
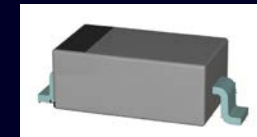
Parameterized 3D Models

Intelligent Symbols with Interface definitions, and supporting data to check for design constraints

Footprints created to Custom Rules

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Bridging the Chasm in the Electronics Value Chain

Streamlines design-to-manufacturing collaboration with component digital twin information, streamlines the manufacturing, verification and validation process that supports increased levels of Trust and improved product reliability.

Component Suppliers

Electronic Design

Electronic Manufacturing

- Simulation
- Part Promote
- Part Search
- Part Model
- Alternates
- Risk
- Quoting

- eCAD Authoring
- Simulation
- DFM
- Part Model

- Process Capabilities
- RFQ
- Pricing / Quoting
- Assembly
- BOM Scrubbing
- Part Model

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Digitalizing the Electronics Value Chain
Connecting with a component digital thread

TRUST & TRACEABILITY

SUPPLY

Running Out Of Stock

Order Pick Time

00 : 05 : 00

DESIGN

MANUFACTURING

TRUST & TRACEABILITY

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Bridging the Chasm in the Electronics Value Chain

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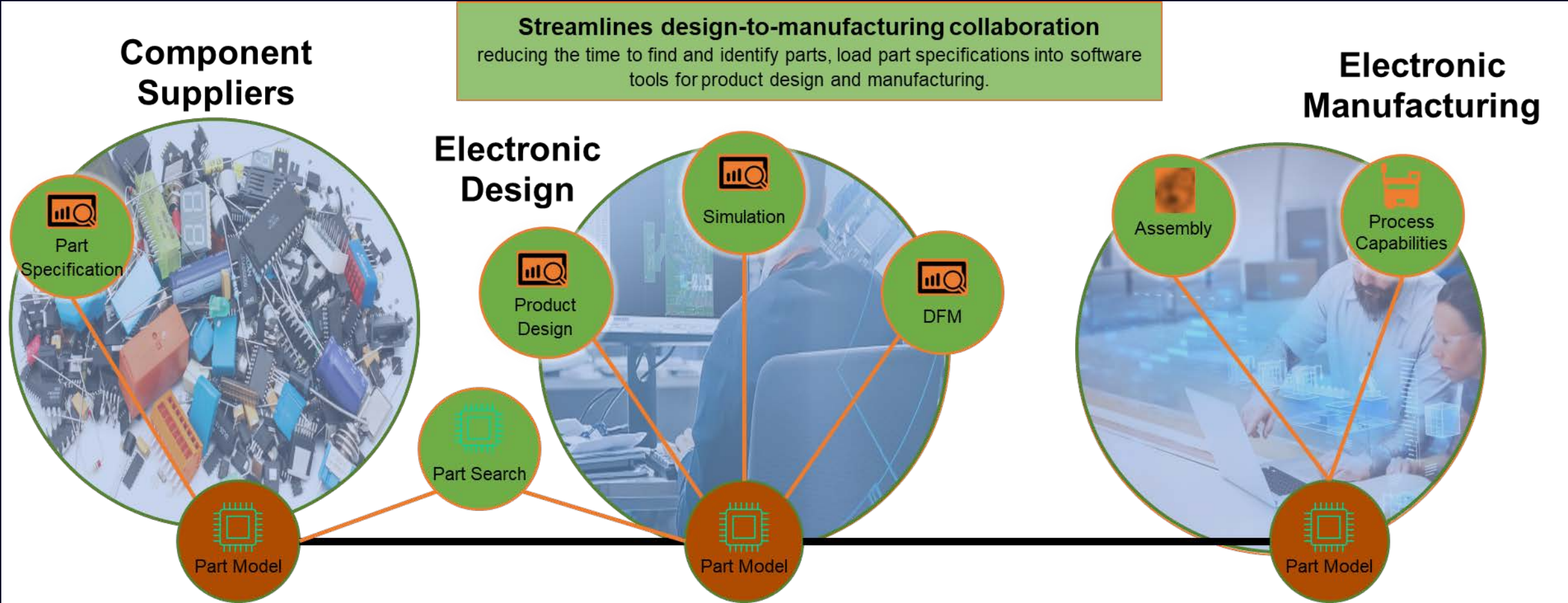
Component Digital Thread
Based on JEDEC JEP30 PartModel Standard
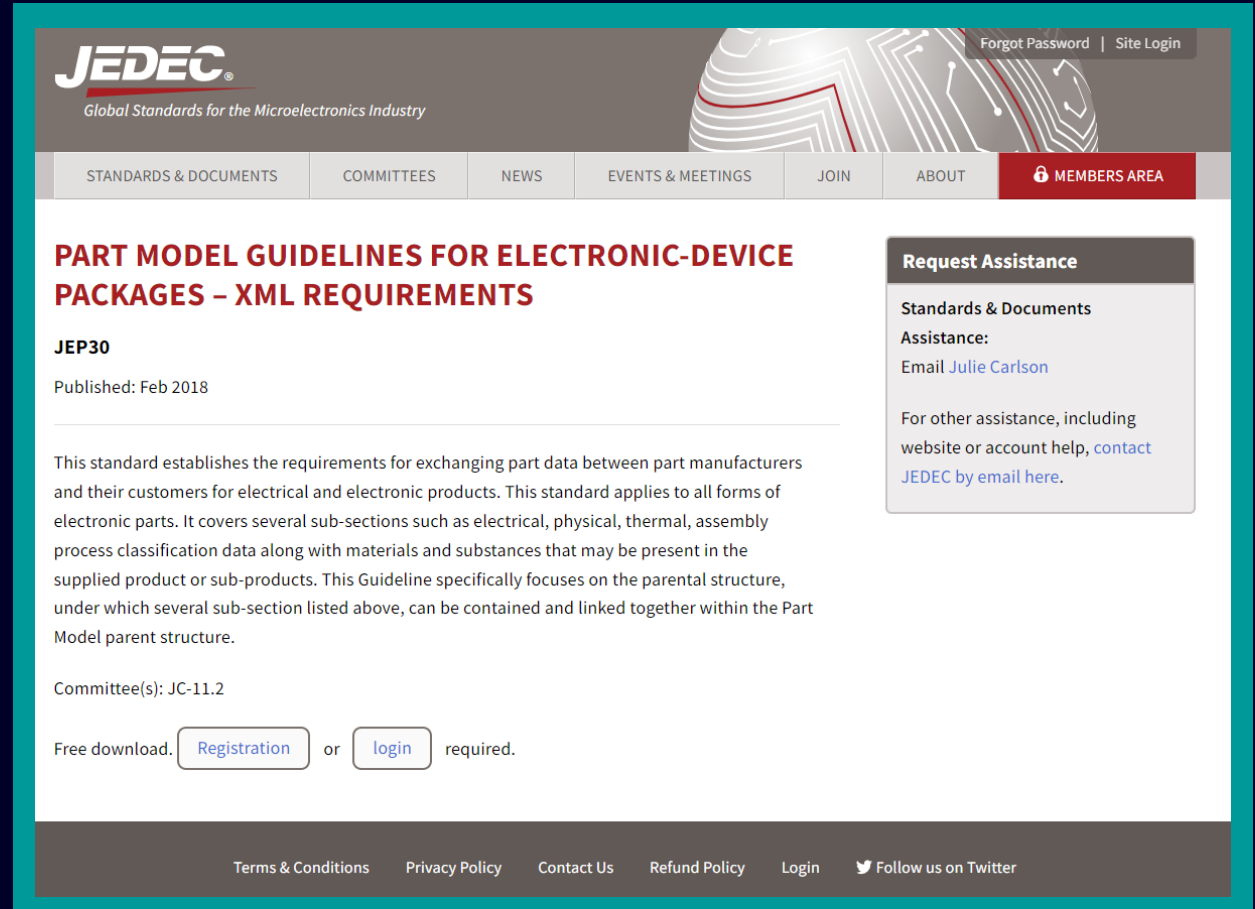
Digital PartModel container (digital twin)

- Physical

- Electrical

- Thermal

- Assembly process classification

Users can validate their PartModel.xml files

against

https://www.jedec.org/sites/default/files/jep30partmodel/JEP30-10%20Part%20Model%20Schema%20Ver%201-0-0.xsd

https://www.jedec.org/standards-documents/docs/jep30

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Stakeholders contributing to the PartModel Standard Development

1. AIST
2. AMD
3. Apple
4. Bourns
5. Broadcom
6. Cypress Semiconductor
7. Diodes Inc.
8. Foxconn
9. Fuji Electric
10. Global Foundries
11. Hewlett Packard Enterprise Company
12. IBM Corporation
13. Infineon

14. Intel
15. Integrated Device Technology Inc.
16. Kingston Technology Company Inc.
17. Lenovo
18. Lotes Tech.
19. Macom
20. Microchip
21. Micron Technology
22. Microsemi Corporation
23. Mitsubishi
24. Molex LLC
25. NVIDIA Corporation
26. NXP Semiconductors

27. ON Semiconductor
28. Qualcomm Inc.
29. Renesas Electronics
30. Samsung
31. Siemens
32. SK Hynix Inc.
33. Smart Modular Technologies Inc.
34. Socionext
35. Sonoscan
36. STMicroelectronics
37. Texas Instruments Inc.
38. Toshiba
39. Vishay

Supported by Component Manufacturers, OEM's, and the EDA Industry

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High level Structure of the Part Model
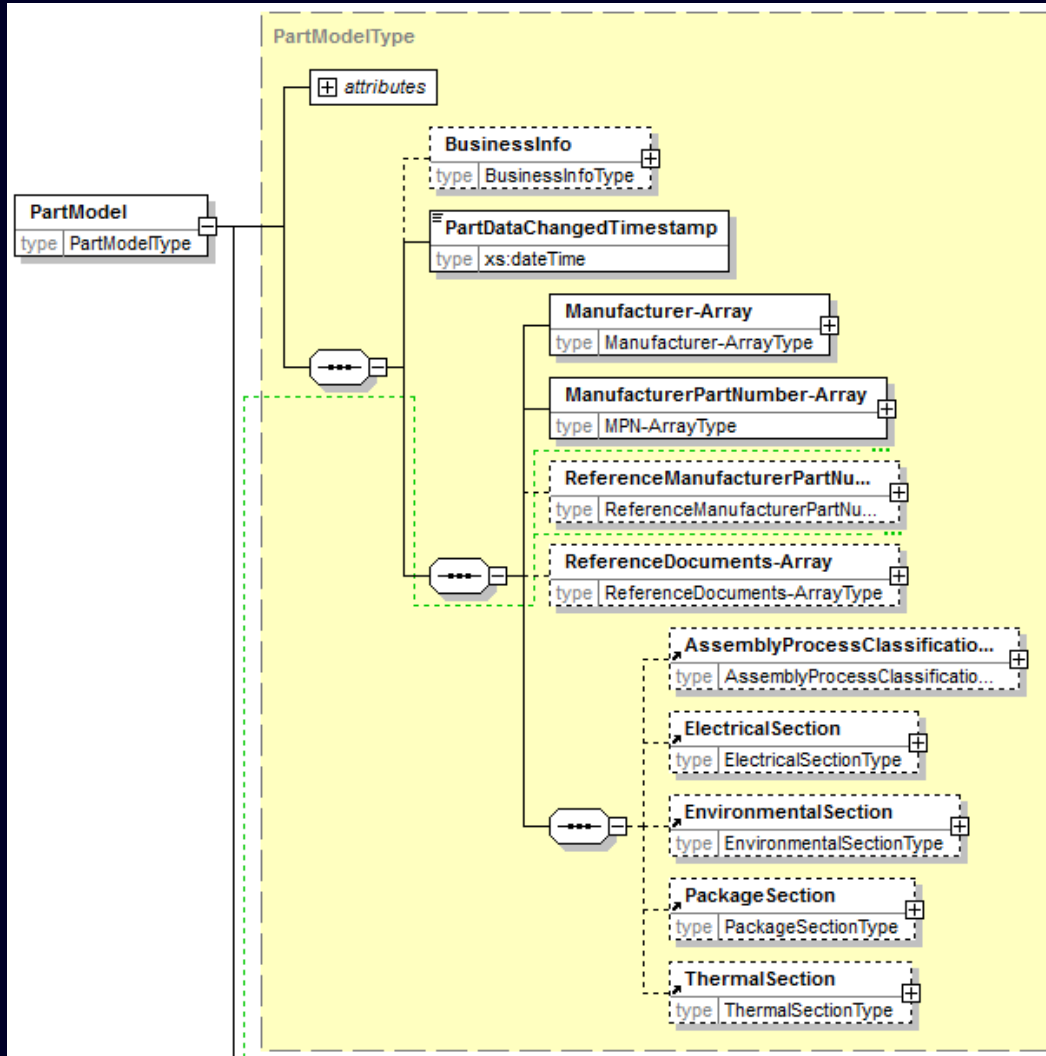
- Data is organized into different technical sections
  - Manufacturer Data
  - Manufacturer Part Number / Series
  - Technical Data
    - Assembly Process Classification
    - Electrical
    - Environmental
    - Package
    - Thermal

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# PartModel Derived Value
at every stage in the product creation process

Product Creation Stage	Derived Value
Part Research	Parametric Search, Compare, Access to Parametric Data
Schematic Design	Schematic Symbols, Terminal Type and Properties, Interface Based Design
Schematic Validation	Device and Terminal specification and characteristics
Electrical Simulation	Electrical Attributes, Models,
Layout	Footprints, including full 3D models, Layout constraints
Routing	Library constraints, Net Constraints
Signal & Power Integrity	Electrical Attributes, Models
Thermal Simulation	Thermal Profile
Mechanical Analysis	Simplified 3D Models for Reliability validation
Design for Manufacturing	Compatibility to the Process, Validation of Design Rules for that Process
Manufacturing Process Preparation	Optimizing the Manufacturing process, Machine Libraries
Manufacturing Tooling	Stencil Design, Process Carriers and other tooling

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The Power of Standards (example)
Creating complex footprints per JEDEC and IPC standards (5 steps … or 1)

Part Datasheet
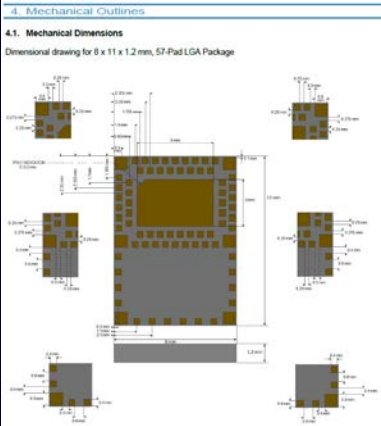
PartModel – Package Section JEP30-P100

1 Package Definition

2 Terminal Selection

3 Terminal Shape

1

XML
PartModel.xml

One step process
if PartModel
is available

Application Output

Multiple
Variations
depending on
Customer Rules

Can include, Pads,
Solder mask, Solder
paste, Clearances,
Keepouts, etc

Land Pattern

5 Terminal Numbering

4 Terminal Position

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Symbols with Intelligence driven by the PartModel

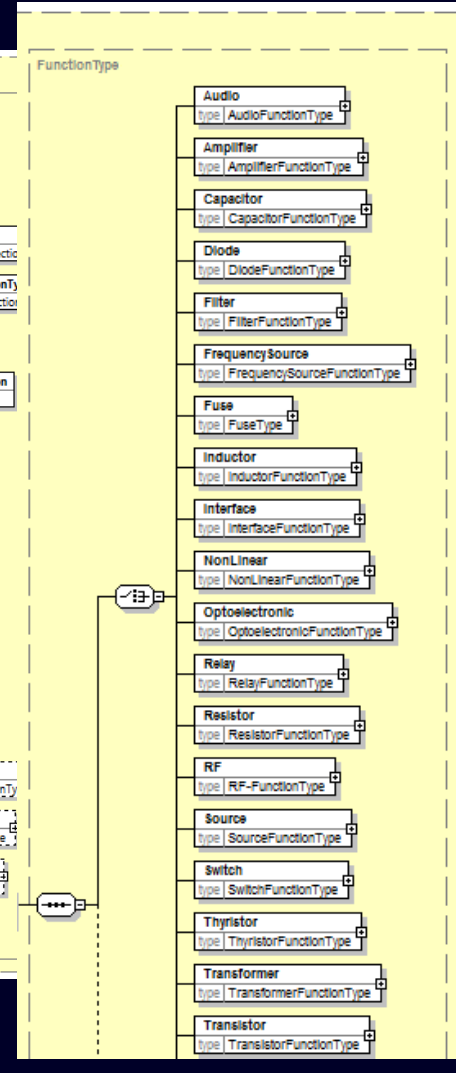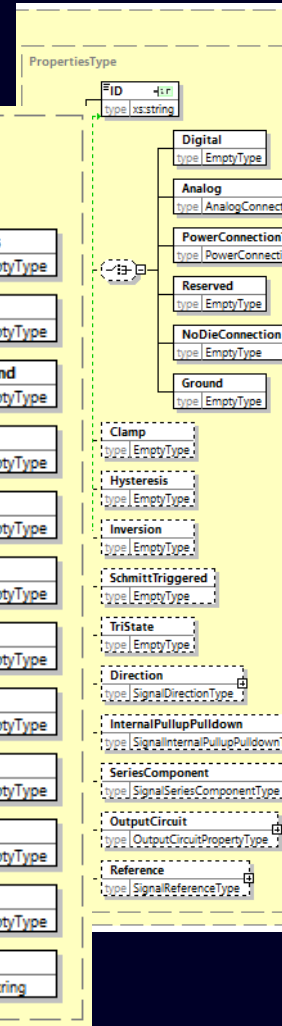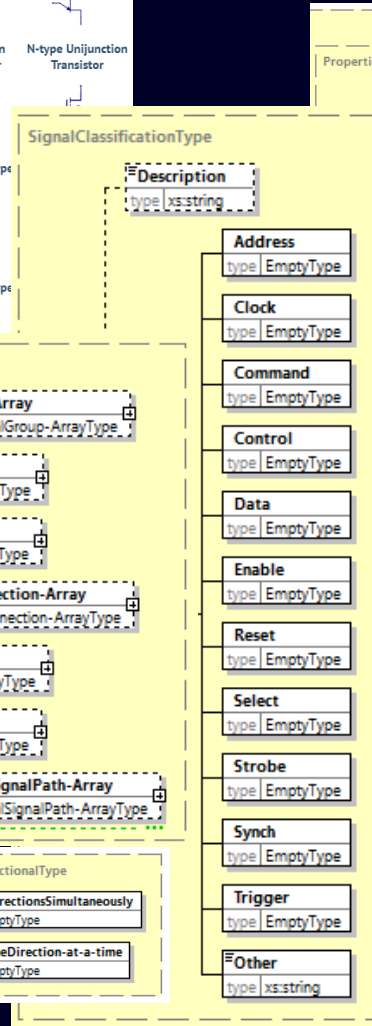Hundreds of Standardized Symbols based of pre-defined standardized Functions
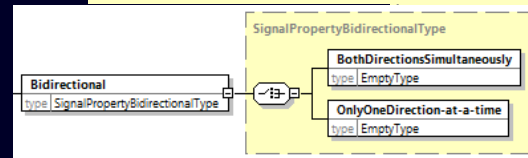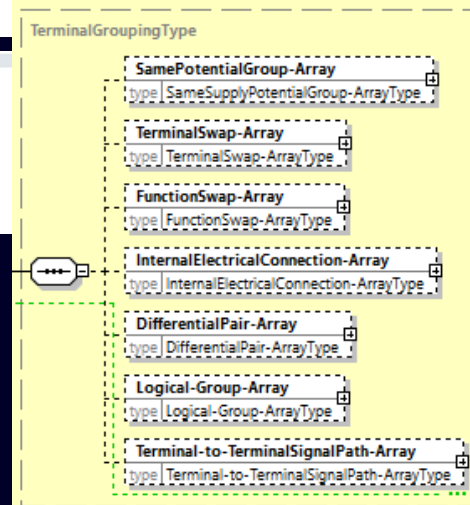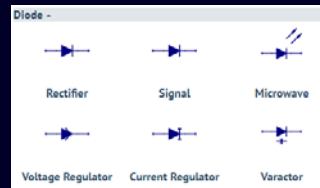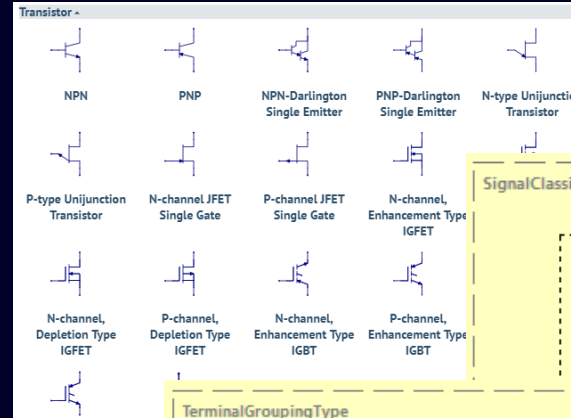
Terminal Properties

- Function
  - Digital, Analog, Power connection, Reserved, No Die Connection, Ground
- Output Circuit definition
  - Clamp, Hysteresis, Inversion, Schmitt, TriState.
  - Bipolar, Unipolar, Programmable with additional drill down details
- Internal connection
  - Pull-ups, Pull-downs, Programmable
- Direction
  - Input, Output, Bidirectional, Programmable

Terminal Function

- Digital Signal
  - Address, Data, Clock, Command, Control, Enable, Reset, Strobe, Select, Synch, Trigger, etc..

Terminal & Function Grouping

- Terminal Swap, Function Swap, Differential Pairs, Same Potential Pairs, Internal Connections, Logical Group based on Bus, Function or other criteria, Terminal-to-Terminal Signal Paths

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Use and references across the industry

- Improves Product Reliability and assurance to Design because it directly tackles the problem of manual induced errors that contributed to that 24% of wasted engineering resources repairing errors and inconsistencies in the design process.
- Supports a key requirement from the DOD by providing a deep integration of tools across domains
- Increases the difficulties for aggressive threats to be applied in the design space by digitally loading qualified data directly to the software tools compared to manual approaches that exist today.
- Referenced by IPC in their Traceability Standards
- Recommended by GSA TIES
- Standard is being expanded to include
  - Product Change Notices,
  - Product Discontinuance, and
  - Digital Signatures

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Collecting Part Data For Software Tools

Without Part Model

- End user reads datasheets and enters values into their specific software application. This is a manual process.
- End user downloads vendor specific spreadsheets from part manufacturer or distributor and then enter that information into the software application. This can be either manual or automated, but the automation depends on manufacturer formats
- Software vendor manually creates databases and shares with end users
- 3rd parties manually read datasheets and sell access to end users to software application specific format.

With Part Model

- Import from industry standard format

When no PartModel is available, manual error prone effort is repeated 1000's of times per part. With PartModels available, software tool vendors and end users will reduce costs and improve quality by importing PartModels directly to their workflows.

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Thank You!

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Part Model Structure JEP30-10

- Parent Schema
  - JEP30 Part Model Guideline
  - JEP30-10 Part Model Schema
- Assembly Process Classification
  - JEP30-A100 Part Model Assembly Process Classification Guideline
  - JEP30-A101 Part Model Assembly Process Classification Schema
- Electrical
  - JEP30-E100 Part Model Electrical Guideline
  - JEP30-E101 Part Model Electrical Schema
- Package
  - JEP30-P100 Part Model Package Guideline
  - JEP30-P101 Part Model Package Schema
- Thermal
  - JEP30-T100 Part Model Thermal Guideline
  - JEP30-T101 Part Model Thermal Schema

The JEDEC Committee JC11 manages the development of the JEP30-10

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Assembly Process Classification Section JEP30-A101 (JEDEC JC14)

- Assembly Process Classifications
  - Reflow
  - Wave
  - Other Process Limitations
    - Post Assembly
    - Assembly Level Cure Bake Condition
    - Assembly Level Moisture Bake
    - Thermal Cycling
    - Thermal Exposure-to-Neighboring Rework

- Moisture Sensitivity Levels
- Floor Life
- Bake
- Storage Temperature

The JEDEC Committee JC14 manages the development of the JEP30-A100/A101

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Electrical Section JEP30-E101 (JEDEC JC16)

- Part Classification
- Symbol Data – Terminal (Pin) List
- Function Mapping
  - Discrete's to Complex Interfaces
- Electrical and logical specification, incl., simulation models
- Reference Circuitry

- Terminal Details
  - Terminal Map
  - Terminal Properties
  - Terminal Function
  - Terminal Grouping
    - Differential Pairs
    - Terminal and Function swapping
    - Logical grouping, etc
  - External Circuitry requirements

The JEDEC Committee JC16 manages the development of the JEP30-E100/E101

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Package Section JEP30-P101 (JEDEC JC11)

- Package
  - Outline
  - Specific Features
  - Shape
  - Mounting Preparation
  - Body Direction
  - Terminal Count
- Part Access Direction
- Clearance Regions
- Keepout Regions
- Recommended Footprint Patterns

- Terminal
  - Type
  - Position
  - Terminal Location
    - Standard Array,
    - Circular Array
    - Random Array
  - Shape
  - Numbering Patterns
- Grounding and Thermal Via requirements

The JEDEC Committee JC11 manages the development of the JEP30-P100/P101

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Thermal Section JEP30-T101

- Temperature Rating
- Thermal Graphs
- Thermal Metrics
  - Theta
  - PSI
- Thermal Resistance Array
- Thermal Capacitance Array

- Network Models
  - DELPHI Models
    - Core Networks
    - Connection Networks
  - Two-Resistor Models
- Node Array
  - Rectangular Node Face
  - Cuboidal Node Volume

The JEDEC Committee JC15 manages the development of the JEP30-T100/T101

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