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Developing IoT Hardware ?

How to **Fail Fast** (or, Make it Fly!)

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"Fail"? "Fast"?? What???

"The prototype device of XXXX is as big as a standard hardback book, and will cost $2000 a test when it hits the market. ... The company's aim is to shrink it down to the size of a mobile phone, with a similar reduction in price."

(Source: An actual news report)

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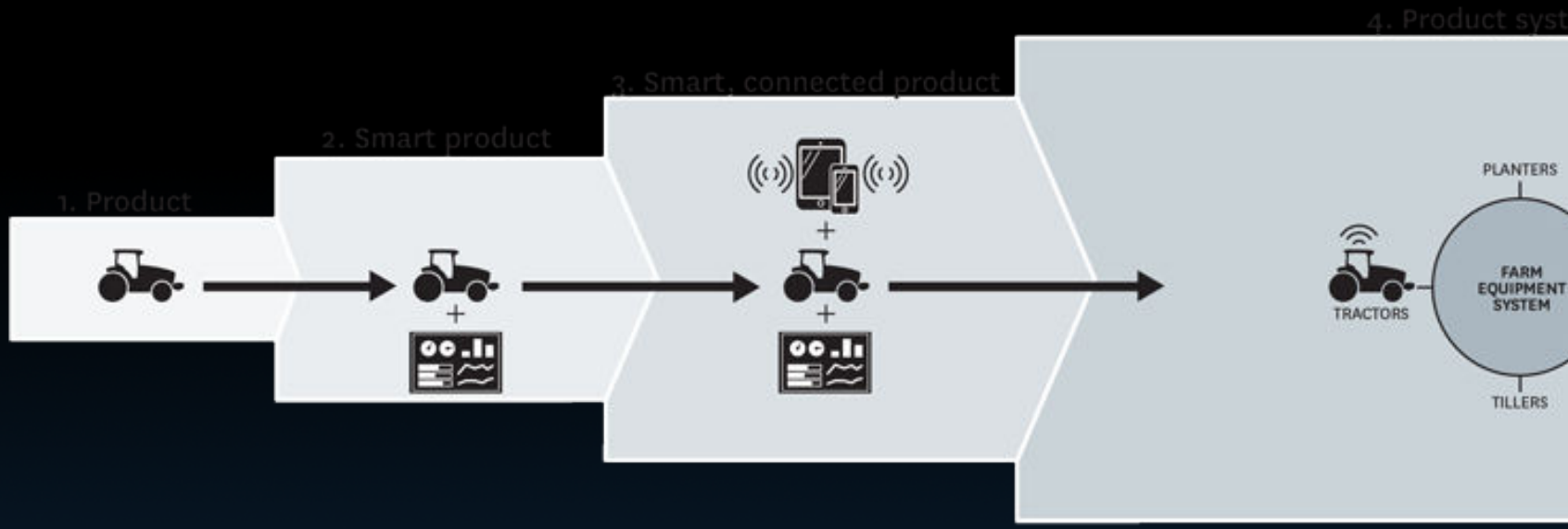
What is in my talk

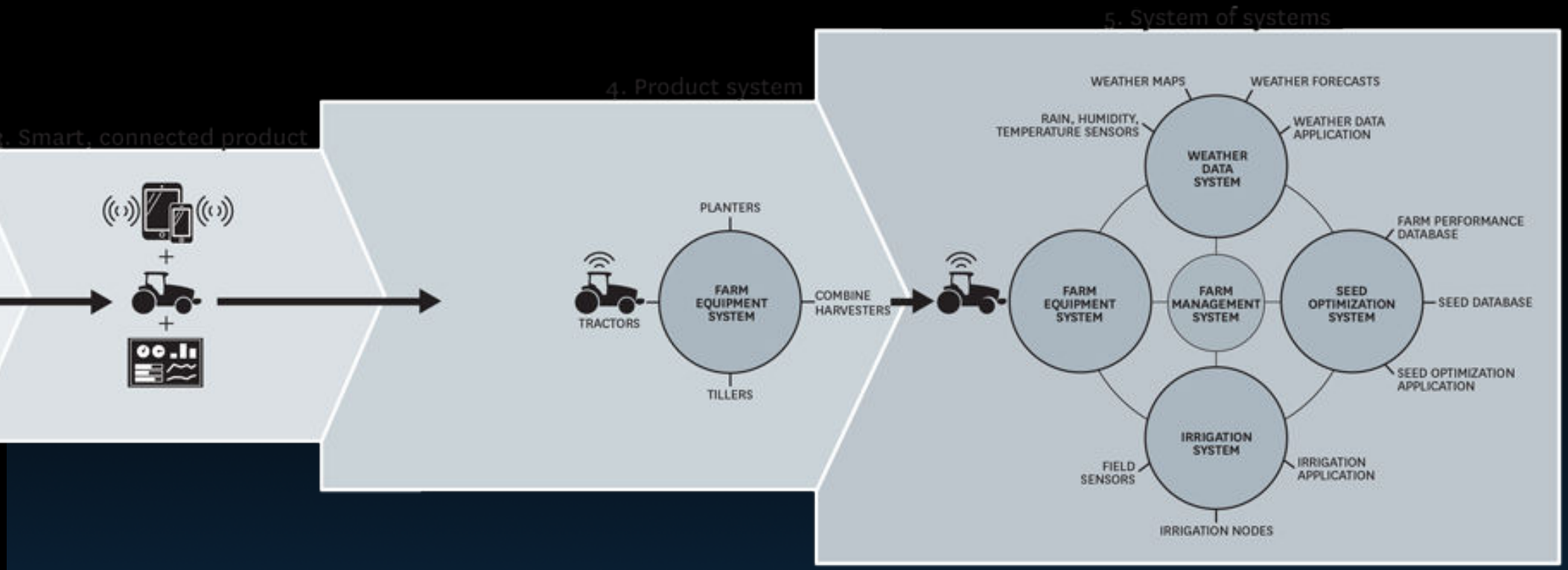
- Introduction
- IoT H/W Dev Strategy, Step by Step
- DFP (Design for Ease of Prototyping)
- Key risks in Prototyping & Testing
- How to navigate: Strategy, Process, Tools

Evolution of Products



(Source: Harvard Business Review)

Evolution of Products



(Source: Harvard Business Review)

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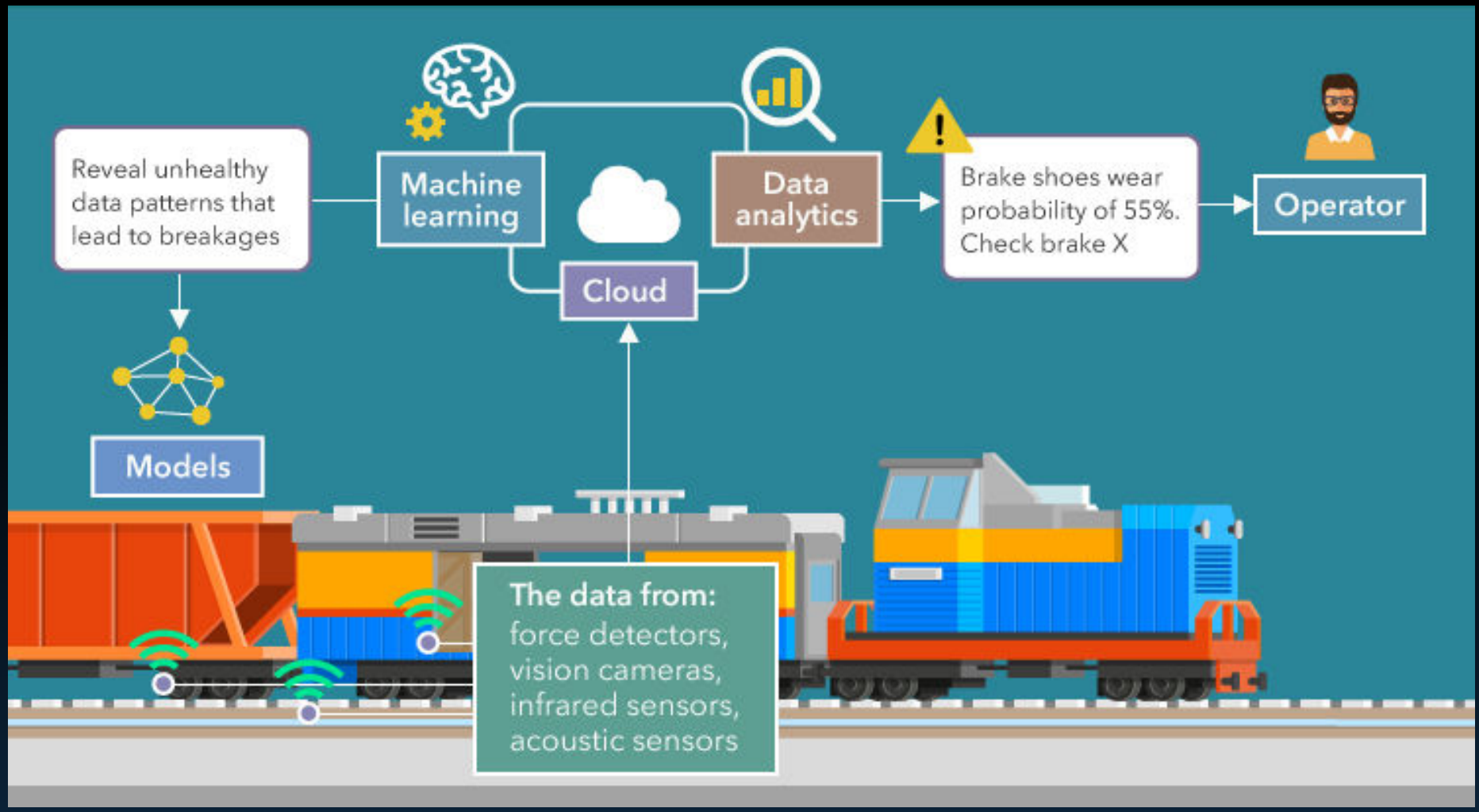
Verticals Touched by IoT

- Smart cities
- Healthcare
- Manufacturing
- Logistics
- Energy & Utilities
- Oil & Gas
- Agriculture
- Home Appliances
- Banking and Insurance
- Physical Security
- ...etc

An Example



Predictive Maintenance in Railways. Source: ScienceSoft

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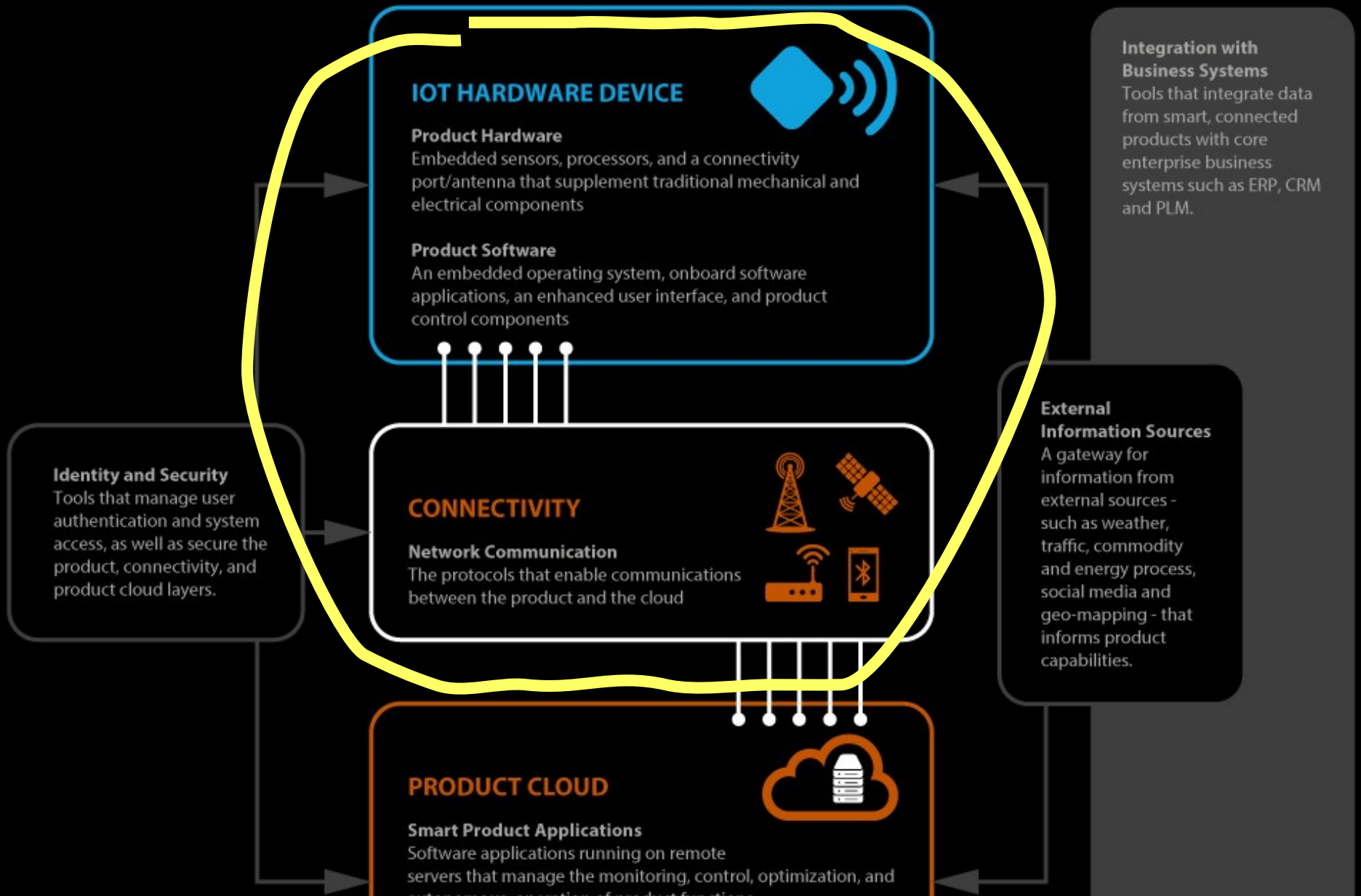
Technology Stack



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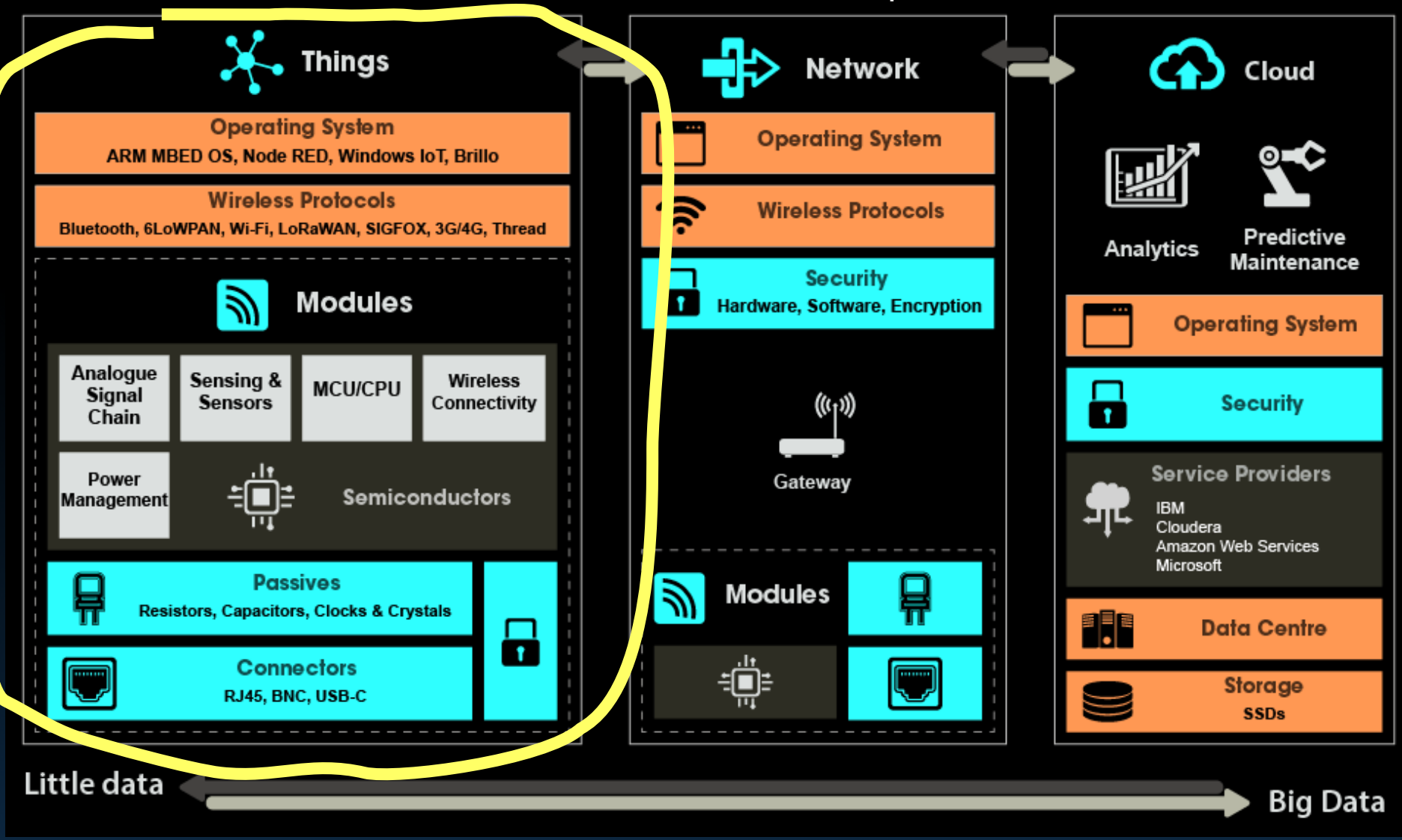
IoT Architecture

(From a Hardware Centric Perspective)



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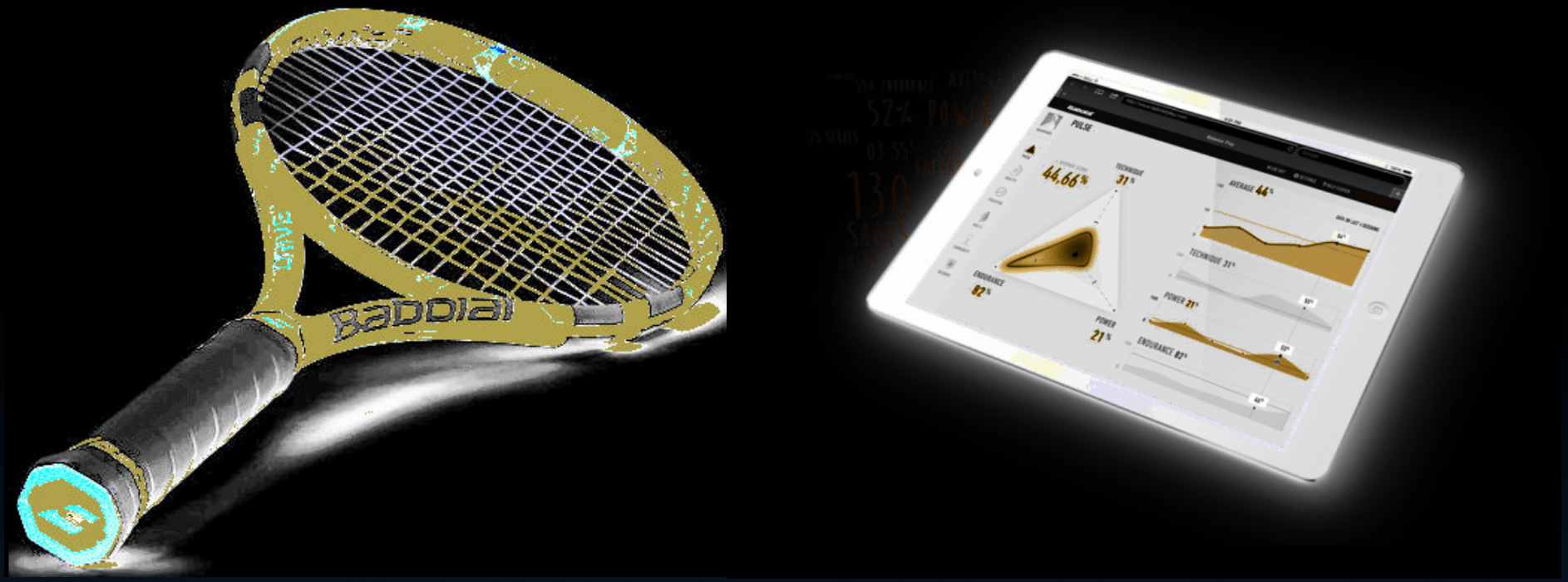
Some Statistics

60% of IoT initiatives stall at the Proof of Concept stage

Overall nearly three-fourths of Internet of Things initiatives
are considered a failure, while a third of all projects being completed
were not seen as a success

- Cisco Survey 2017

You have an idea.



(images courtesy Babolat)

Now what?

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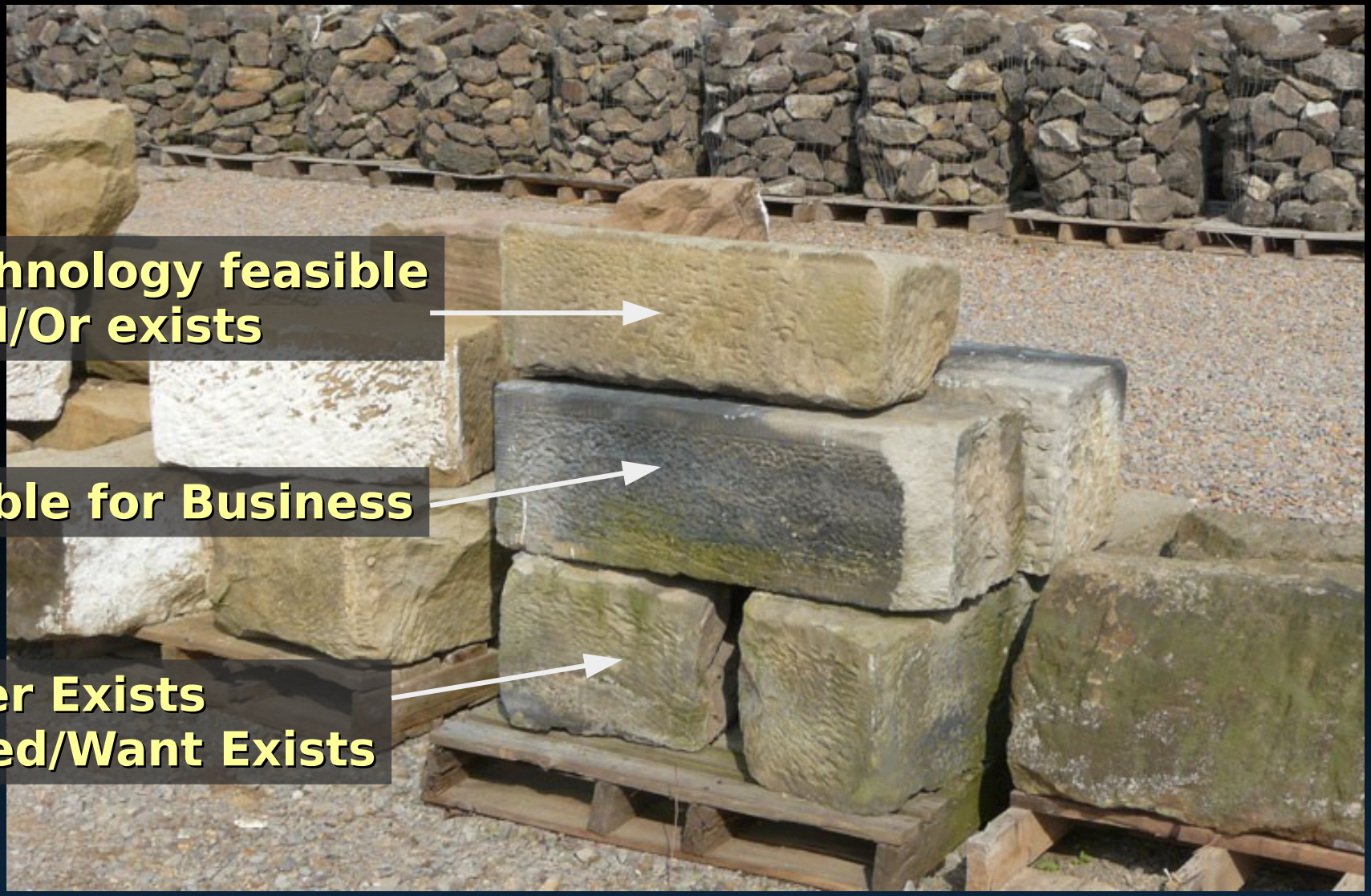
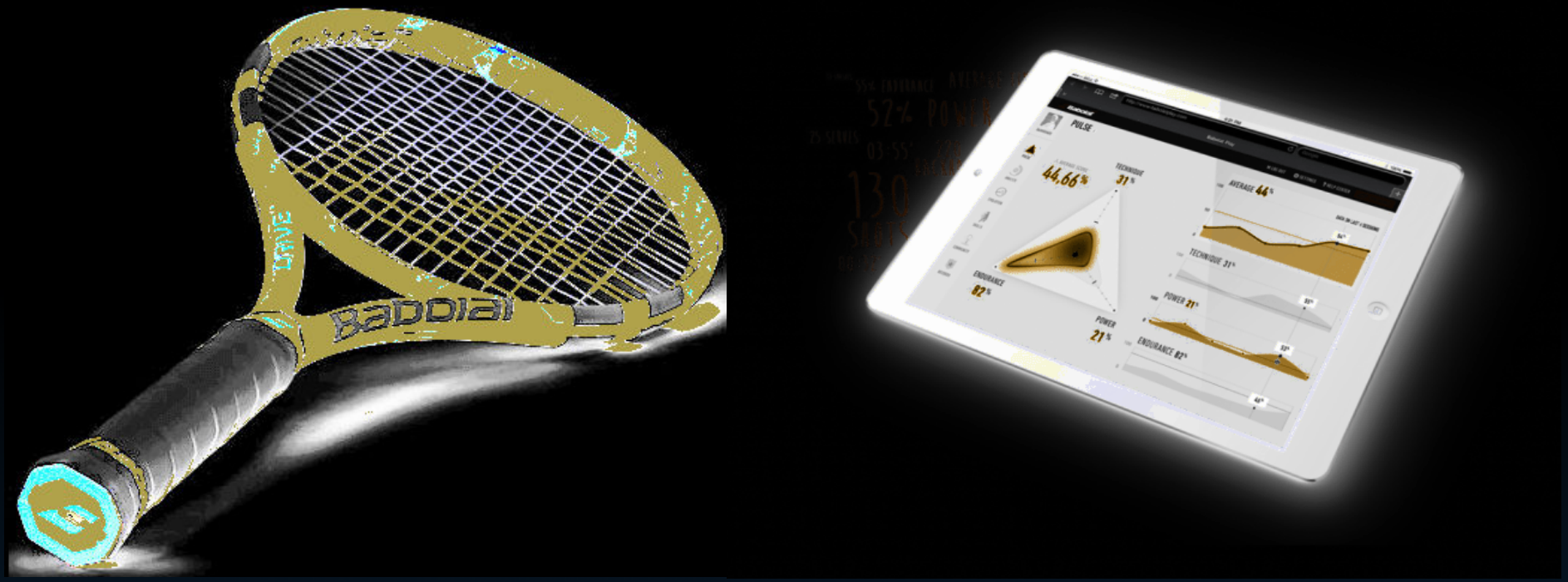
Foundation Stones



Idea → Concept → Reality



(images courtesy Babolat)

How to realize the idea?

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Steps

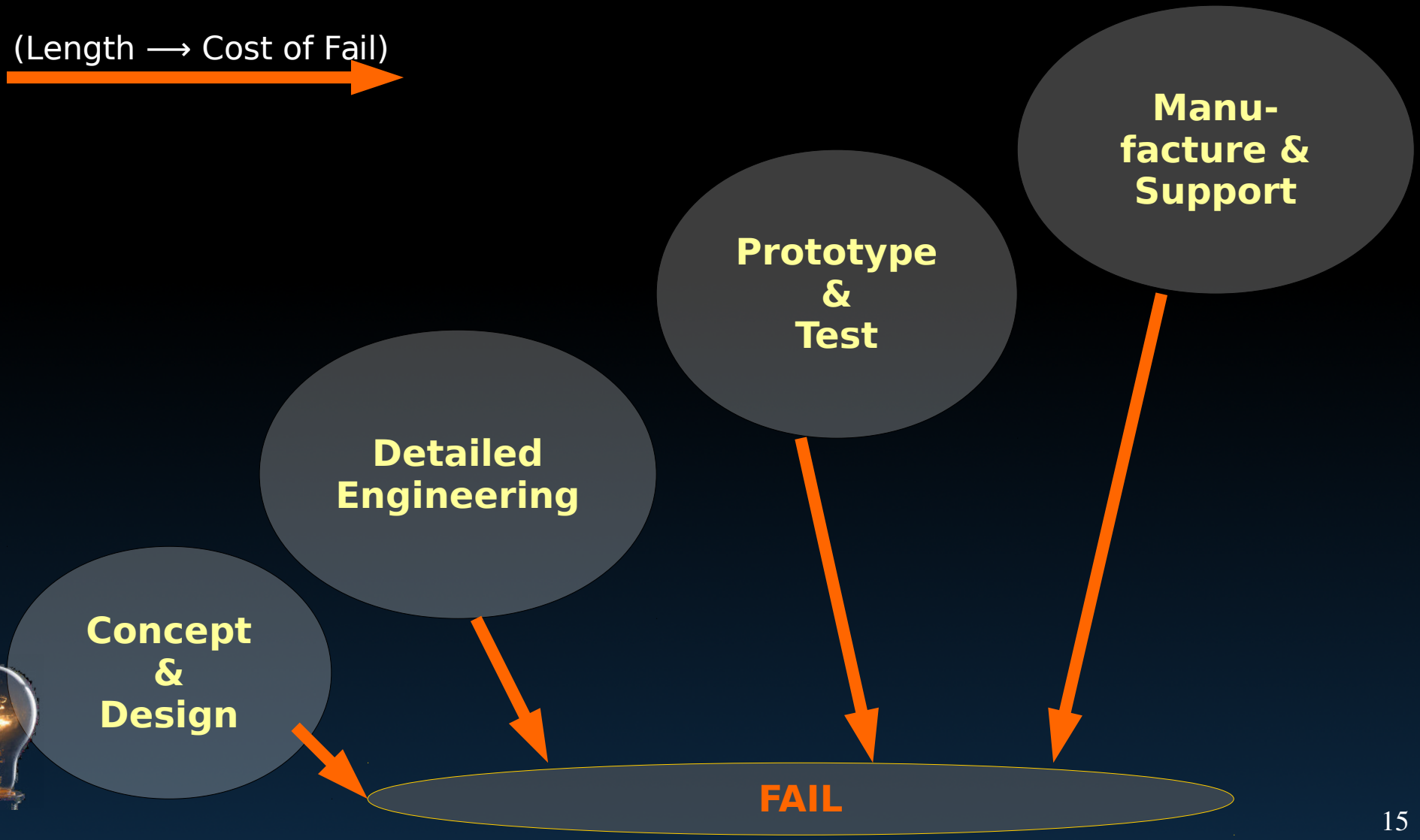
Concept & Design

Detailed Engineering

Prototype & Test

Manu-facture & Support

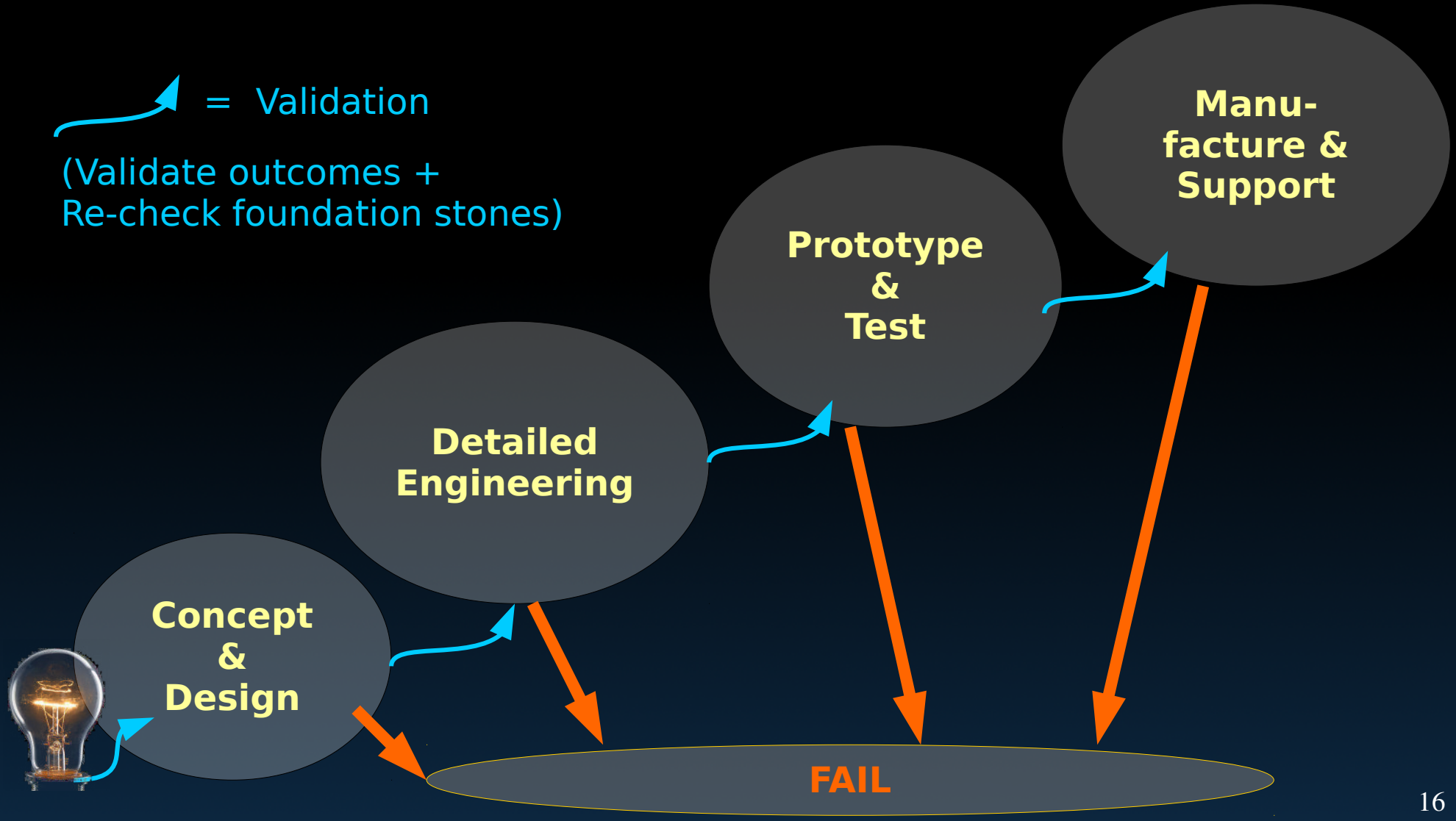
Why “Fail Fast”?



Validate + "Fail Fast"

= Validation

(Validate outcomes +
Re-check foundation stones)



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2. IoT Hardware Development Overall Strategy, Work Items & Steps

... Or, How to make it fly!

Overview of issues and work items in:

Concept & Design

(of your IoT Hardware)

- Hardware Form Factor
  Size, shape, weight
- Connectivity
  ZigBee? LoRa 433MHz? NB-IoT?
- Power Constraints
  Battery Life, Sleep %, Energy harvesting...
- Environmental
  Industrial? EMI? IP20? or IP69K?
- Regulatory, Legal etc
  Healthcare? Food Safety?

Overview of issues and work items in:

Detailed Engineering

- Subsystems, boundaries, interfaces
- Component Selection, Qualification
- Schematic Design, Simulation
- DFP (Design for ease of Prototyping)
- Interconnects and Harnesses
- Physical Design
  - PCB Form factors, # layers, flex or not?
  - Mech. Design, Thermal Design, Enclosures
  - Design PCBs – Layout and Route

Overview of issues and work items in:

Prototyping, Testing

- Build prototypes
  - Module-based prototyping (early stage)
  - Incremental prototyping
  - Allow h/w – s/w co-design
  - Generate early feedback
- Test
  - Isolate subsystem-wise and test
  - Integrate, assemble
  - Measure, verify design goals

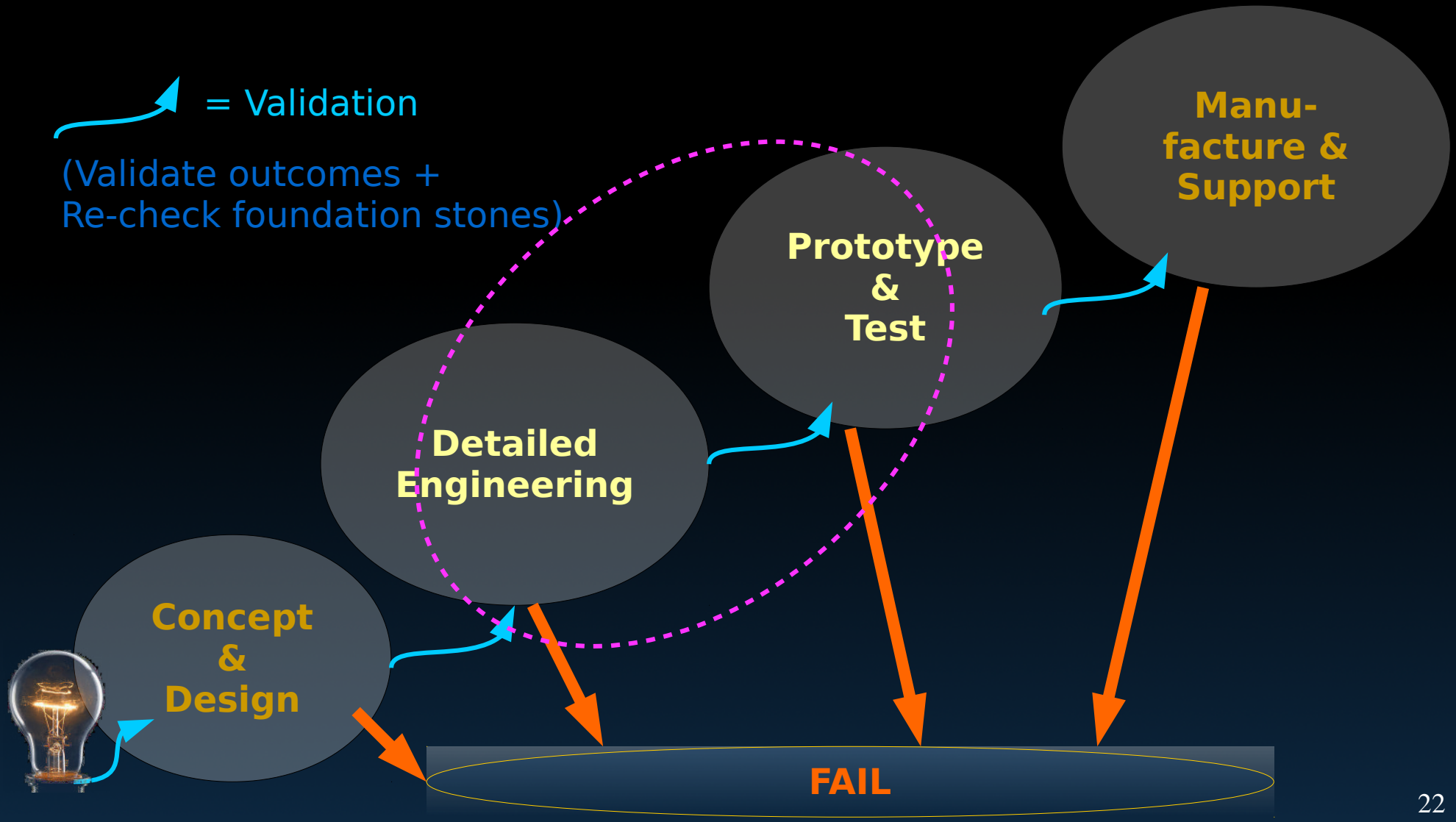
Overview of issues and work items in:

Manufacturing, Support

- DFM – Design for Manufacture
- Optimize BoM & Inventory
- Optimal process
- Modular assembly & Test
- Traceability & Tracking
- Spares & Fulfillment ...

(Insight)

Proto & Test is a key activity!



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Importance of P & T

(Protyping & Testing)

- Source of signals
  - “Fail Fast” signals
  - Directs further stages / iteration
- P & T Cycle time is crucial
  - Repeated activity
  - External Dependencies can be very critical
- Right Strategy, Tools, Methods!

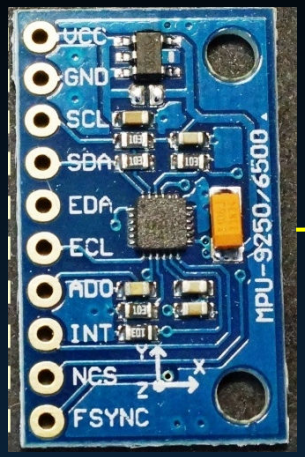
Start with DFP

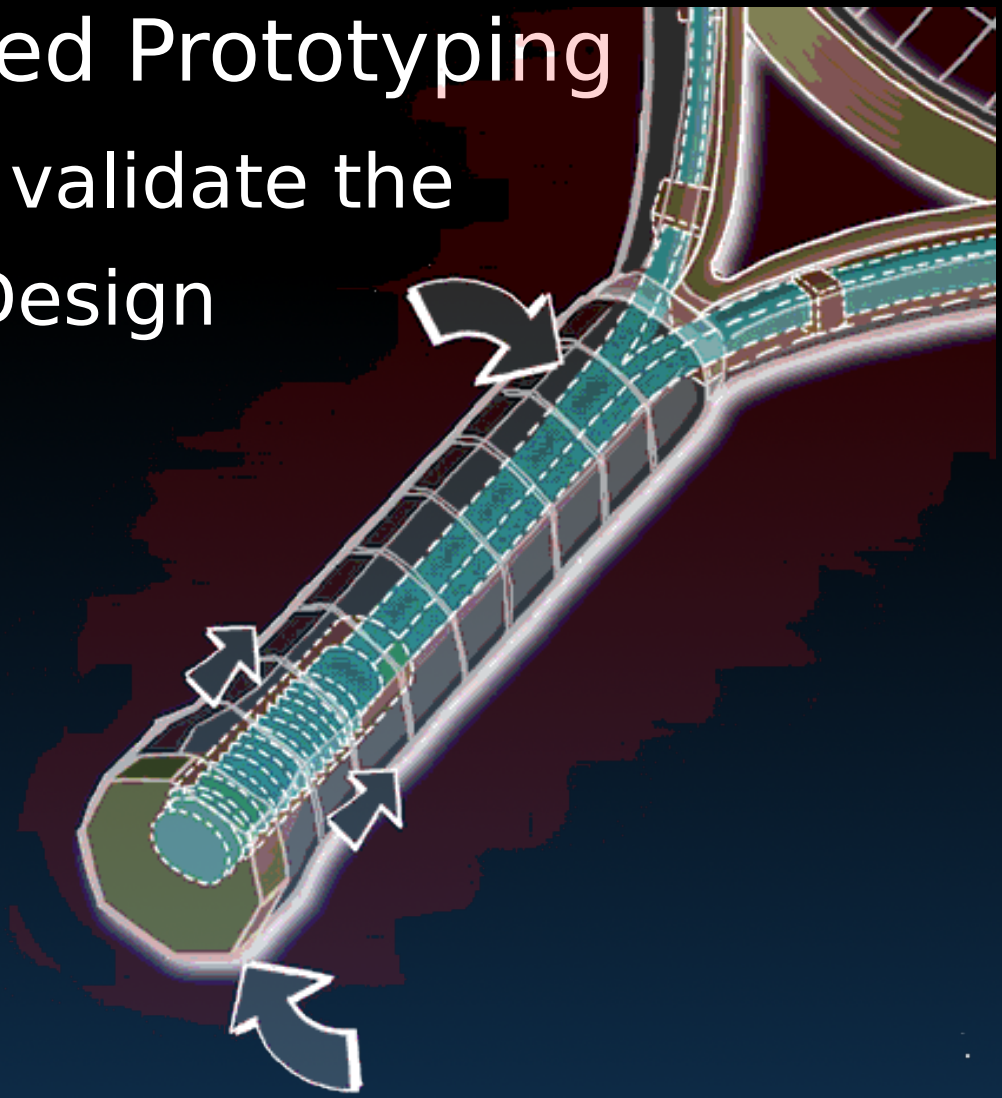
(Design For ease of Prototyping)

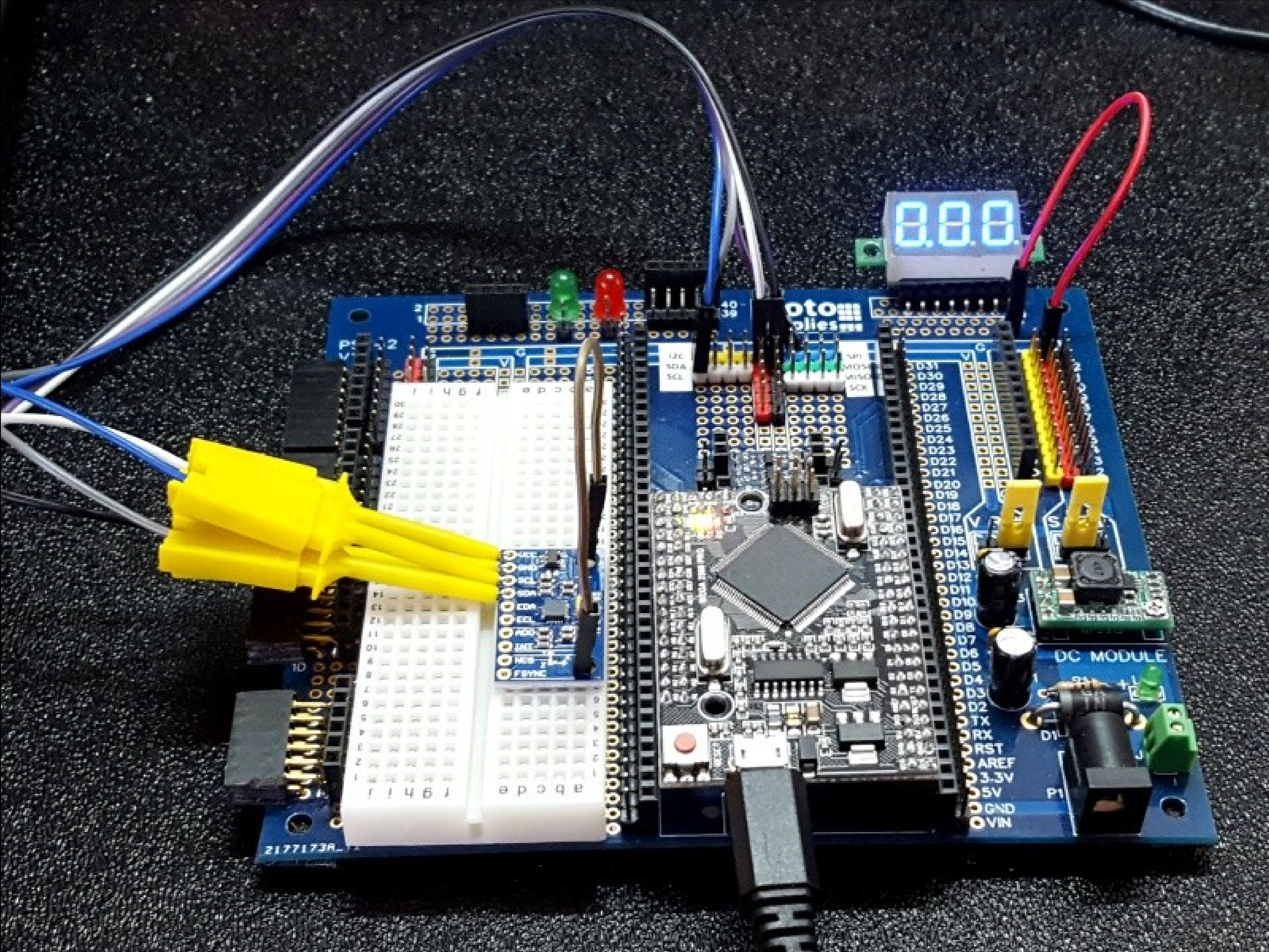
- Design for easy incremental prototyping
  - Module based prototyping
  - Use DFP tips for your SMT PCB protos
    - Refer to IEW2019 presentation :)
- Design for Testability (DFT)
  - Test points, injection points, JTAG etc

Prototyping Strategy

- 1. Module Based Prototyping
  - To partially validate the Concept / Design






I2C
SDA
SCL
SPI
MOSI
MISO
SCK
D31
D30
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D8
D7
D6
D5
D4
D3
D2
TX
RX
RST
AREF
3.3V
5V
GND
VIN
DC MODULE
D1
P1

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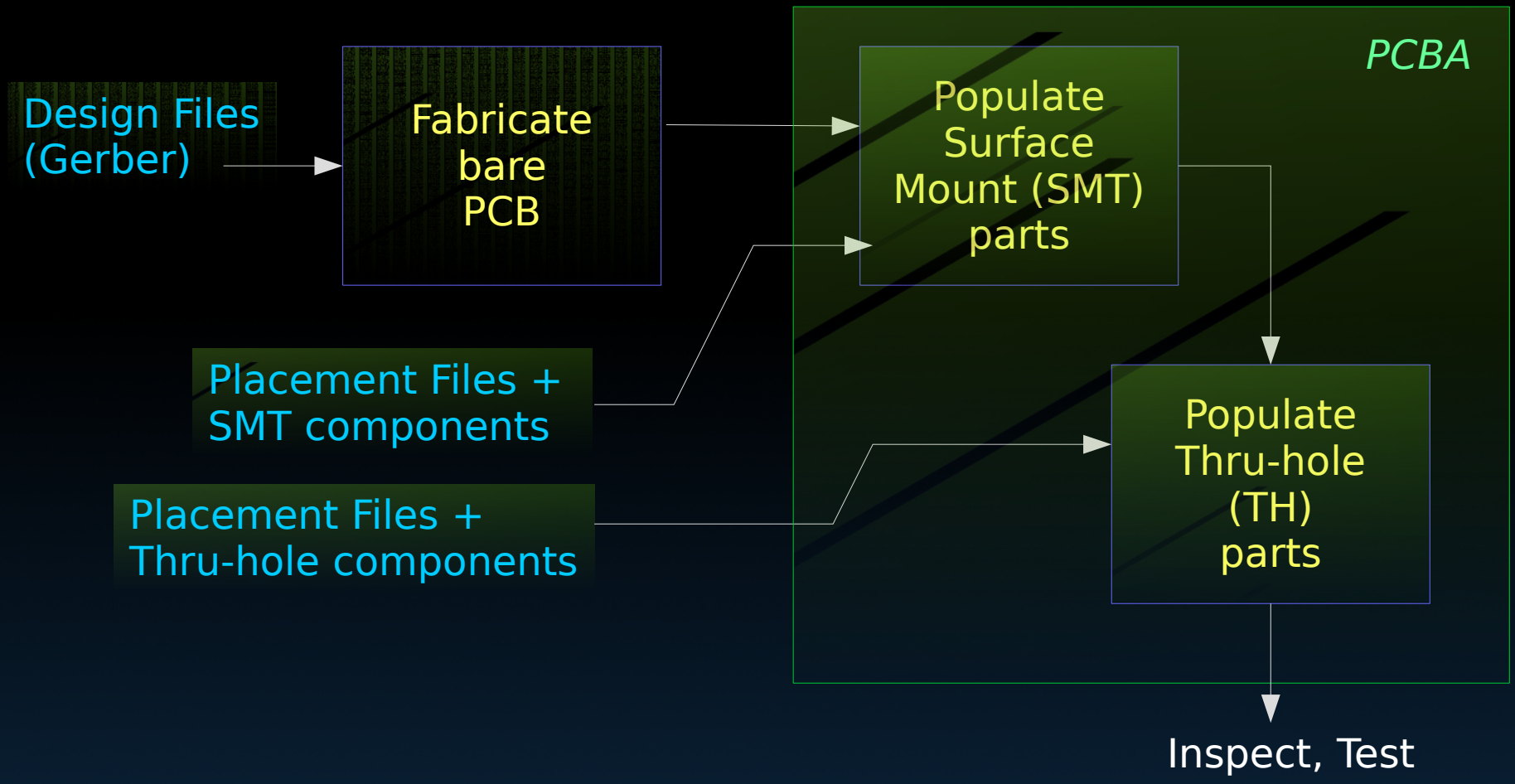
Prototyping Strategy

- 2. Product-intent Prototyping
  - To validate outputs of Detailed Engg.
  - Allow incremental (subsytem-wise) P & T
  - To allow software design to start (h/w-s/w codesign)
  - Run Tests & Measurements
  - To (eventually) prepare for Certifications & Manufacturing
  - Under “nearly-there” product conditions

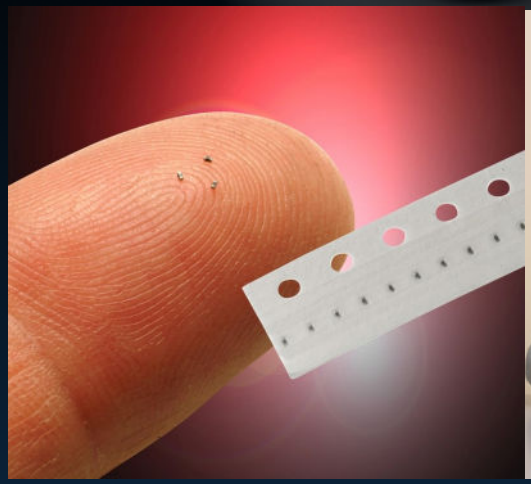
DFP Tips Overview

- Insert Test points
- Use 0-R’s to isolate ckts, subsystems
- Use easy-to-proto parts / footprints
- Use 0-R’s for trial configurations/options
- Accessibility for rework
- …etc [Refer to IEW2019 talk]

PCB based Prototyping



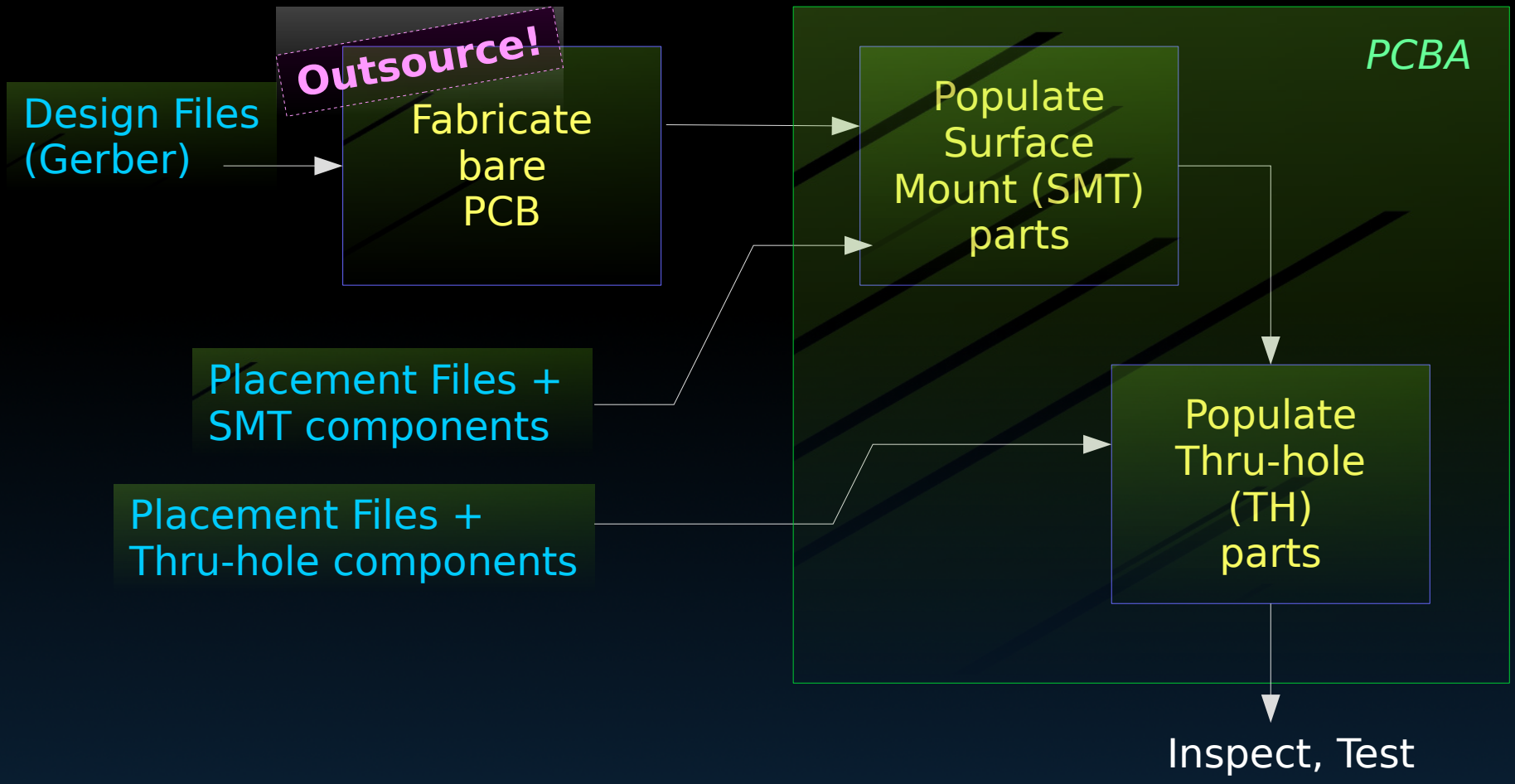
Challenges in Product-Intent Prototyping



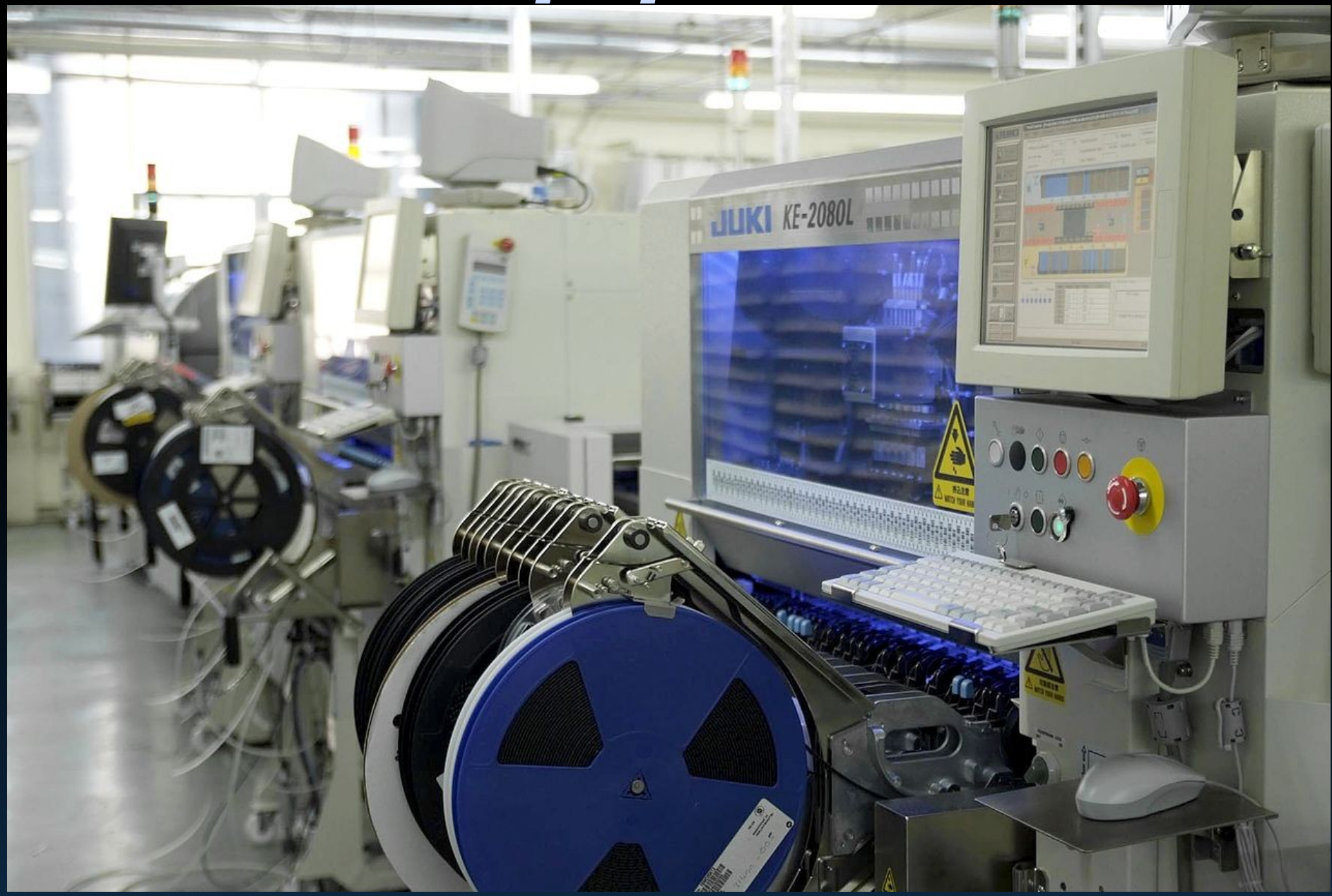
Outsourcing ?

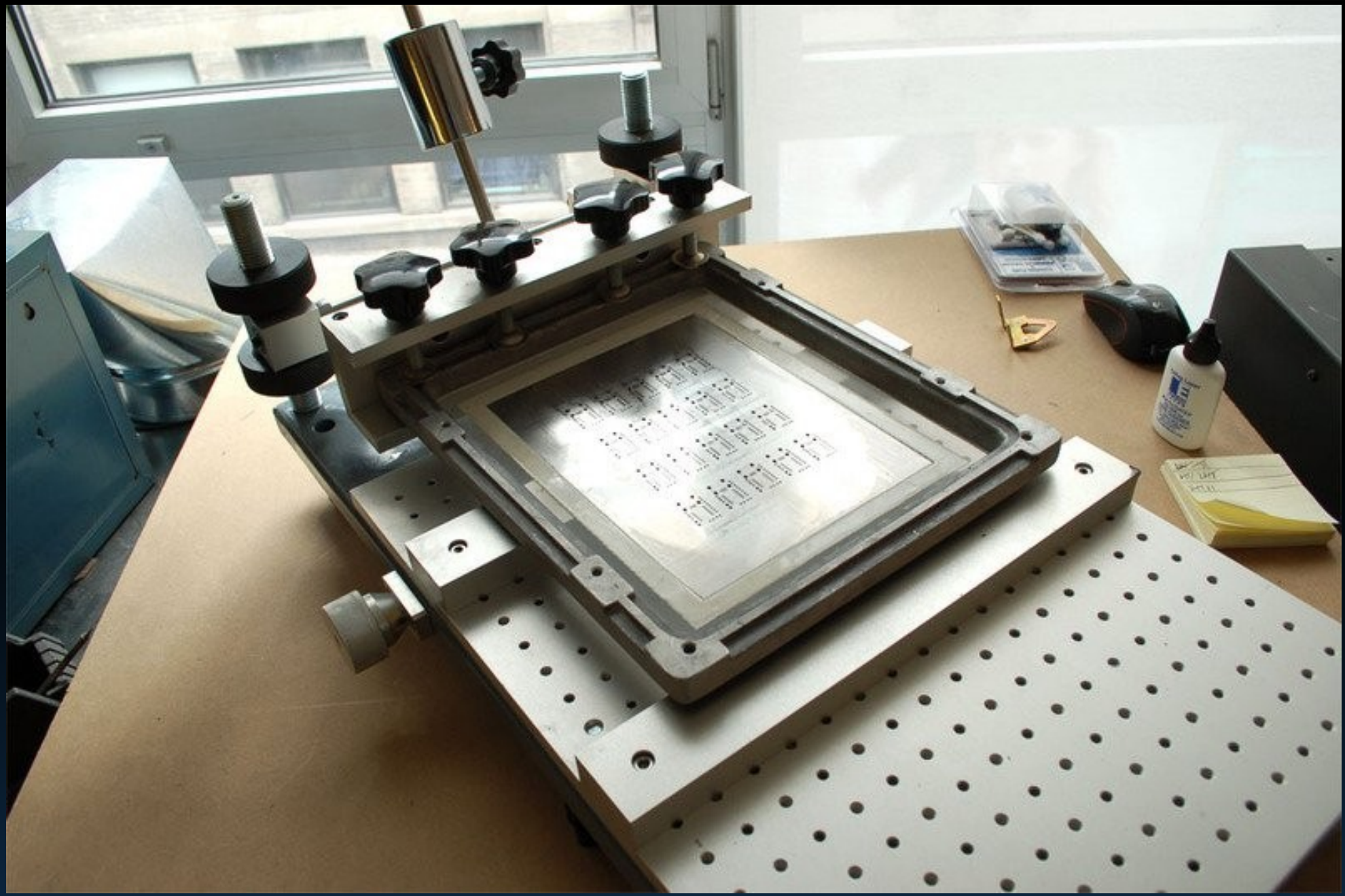
- Negatives of Outsourced Prototyping
  - Increased cycle time, loss of control
  - Puts Time-to-Market under risk
  - Potential Intellectual Property risks
  - Parts overages/wastage
  - Kills incremental prototyping strategy
  - Impedes h/w – s/w codesign strategy

PCB based Prototyping



PCBA Equipment





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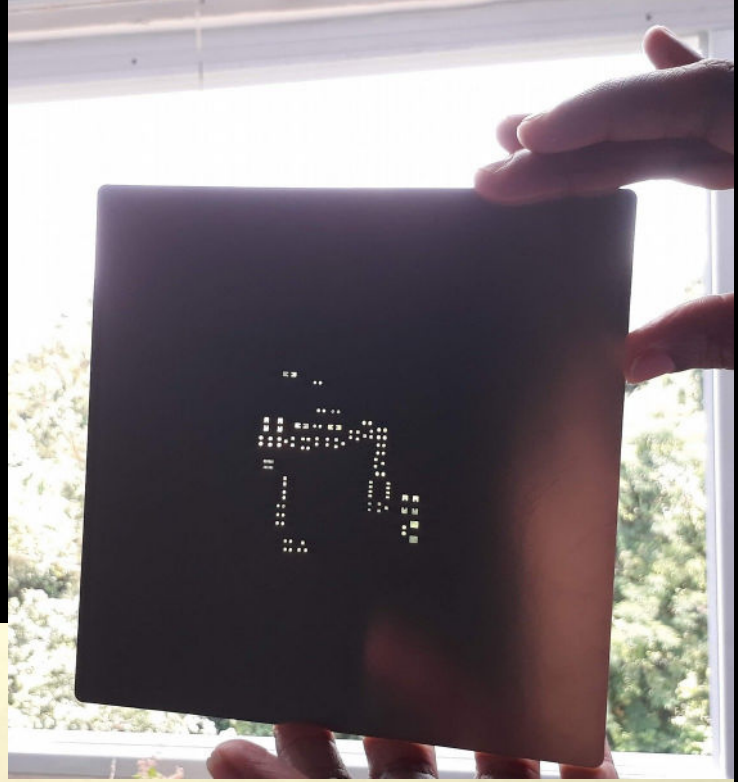
Prototyping on your Desktop is no longer a dream.

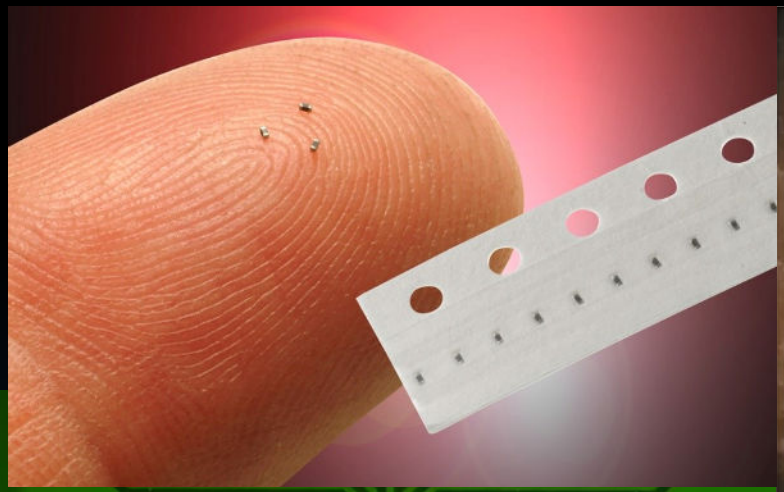
Cut Stencil →

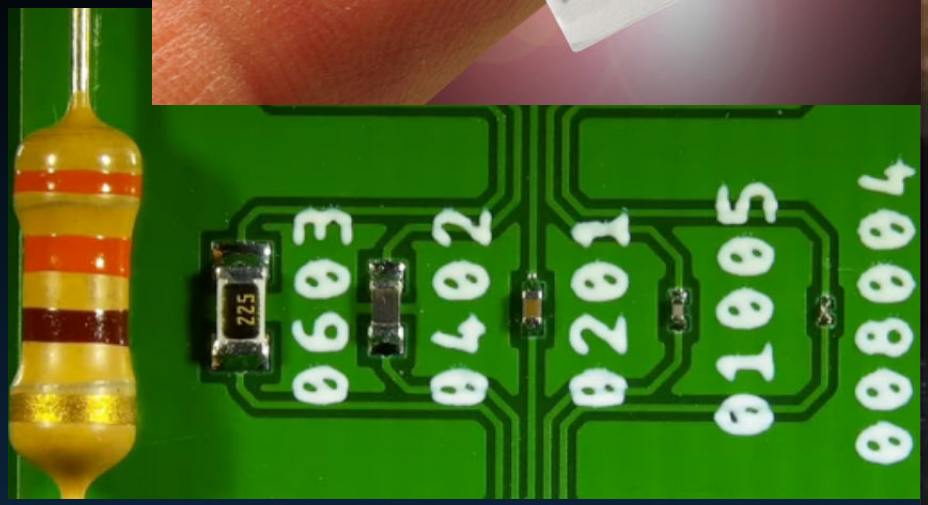


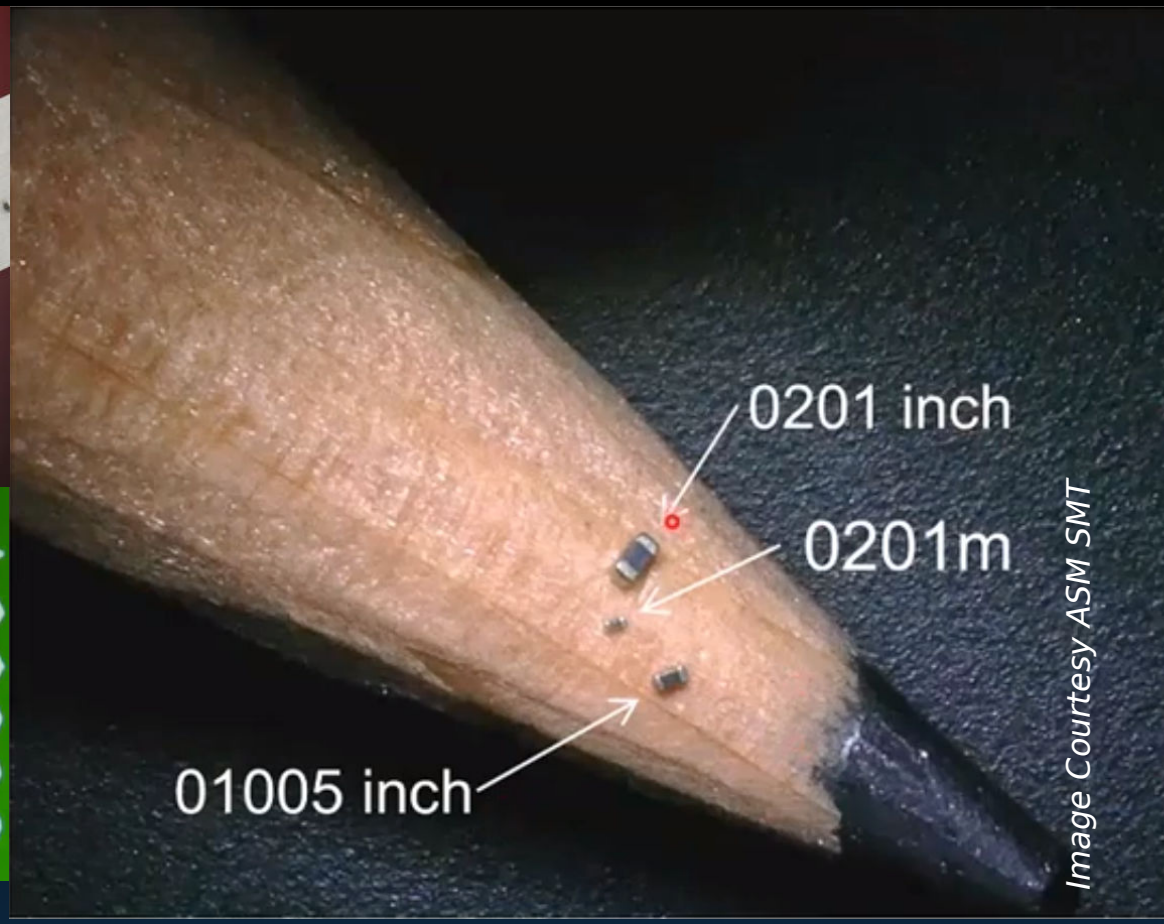
PlacerBot™

More DFP / DFM tips

- 1. Don’t “Live Dangerously!”

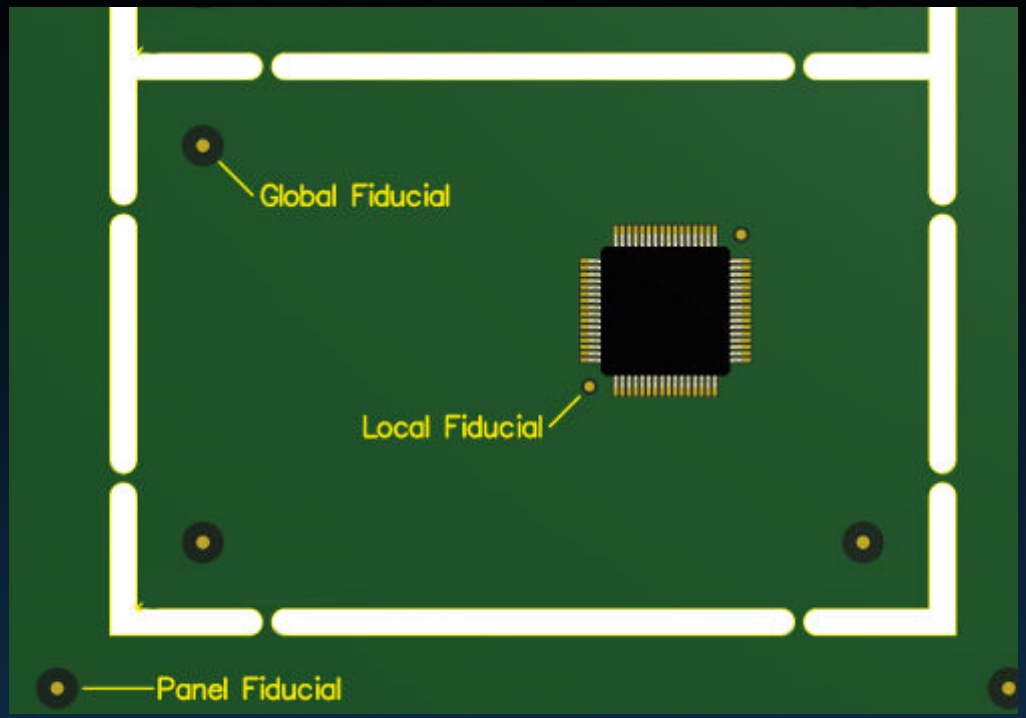






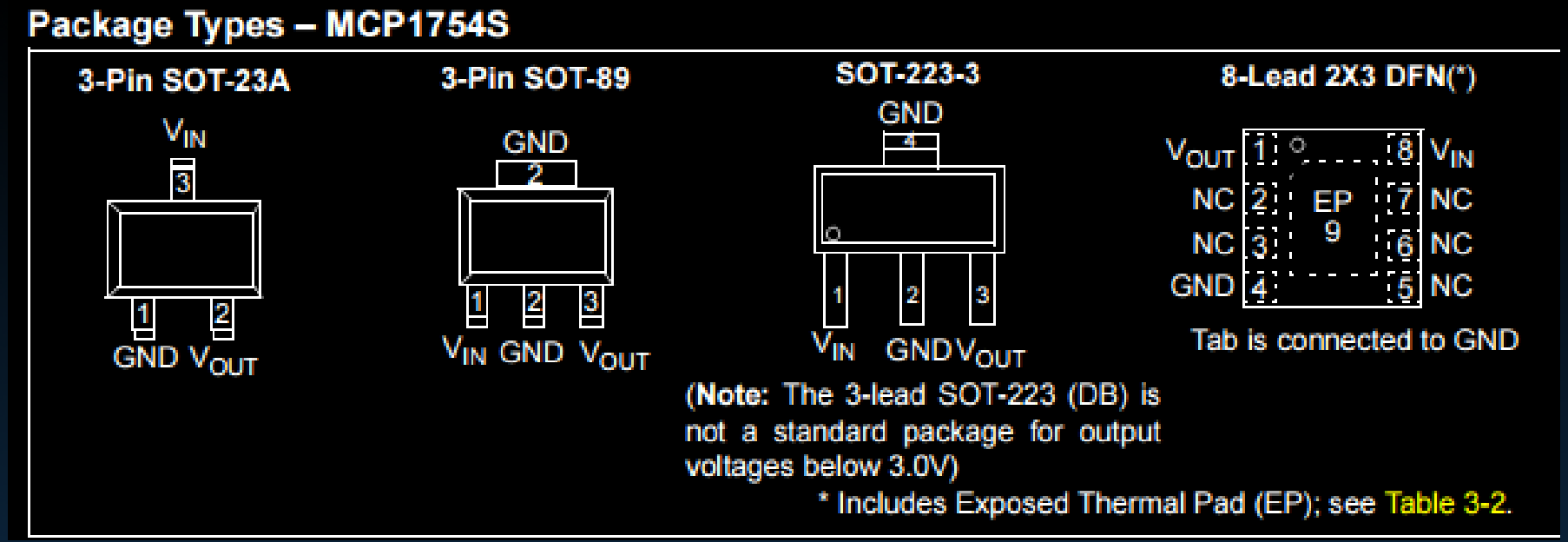
More DFP / DFM tips

- 2. Use Fiducials
  - Global Fiducials (nice to have 3)
  - Local Fids near large fine pitch ICs
  - Export Fids also to Placement File.



More DFP / DFM tips

- 3. Ensure “standard” Pin 1 positions
  - use footprints with “standard” rotation angles



More DFP / DFM tips

- 4. Use Part Numbers (and/or other unique ID like HPN – House P/N or equivt.)
- 5. Take Component Management seriously!

Equipment / Process Capability for Proto

- Should work with multi-layer PCBs
- -do- with cut stencils & T3/T4 paste (long life paste saves you grief)
- Passives min size 0402, 0201 desirable
- Fine pitch ICs
- Accept flexible feed volumes (cut tape, IC trays; not big reels!)
- Visual Feedback, friendly GUI, batch & ad-hoc modes
- Modest PCB sizes, reasonable speed
- Assistance in component management

Proto & Test is key

- To tame overall dev cycle time
- To be able to implement the optimum hardware-software codesign strategy
- Thereby Time to Market
- ... and IoT success

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Summary

- Many IoT projects fail; Fail-Fast is good
- Proper strategy and execution are important
- Proto & Test is key in IoT h/w dev
  - Control over P&T is crucial
  - Deploy the Right Equipment, Process and Methods that support your strategy