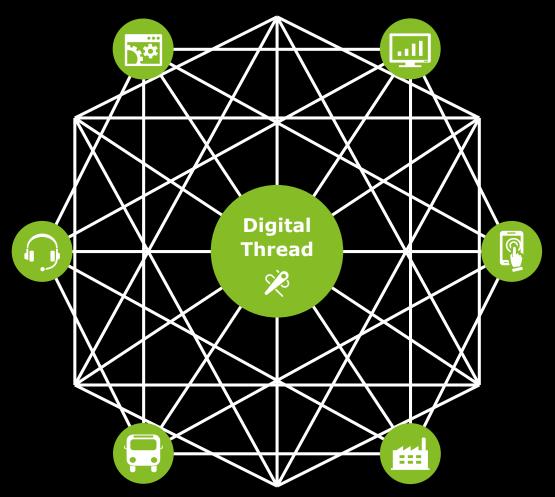
Deloitte.



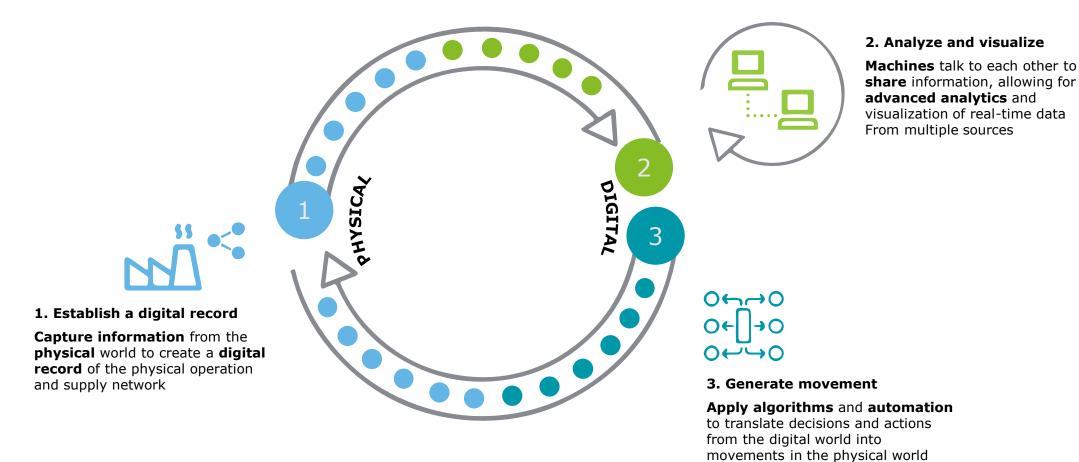
Digital Thread in Additive Manufacturing

Tying it all together

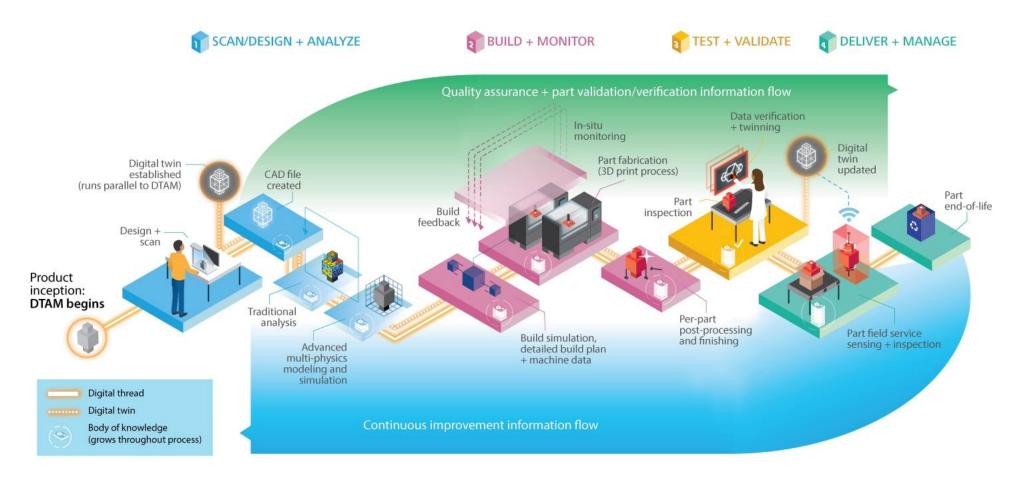
Geir Arne Veglo Stavanger, 10.03.2020

The physical-digital-physical loop

Industry 4.0 integrates digital information from many different sources to drive the physical act of doing business



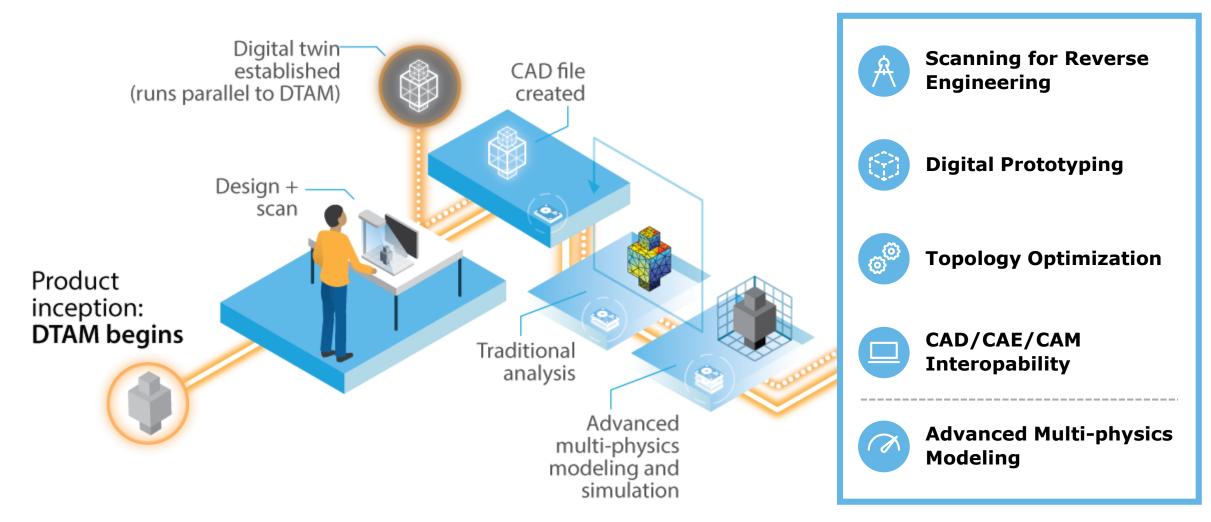
Digital Thread for Additive Manufacturing (DTAM) Connecting the entire product lifecycle



Digital Thread – "A single, seamless strand of data that stretches from the initial design concept to the part end-of-life"

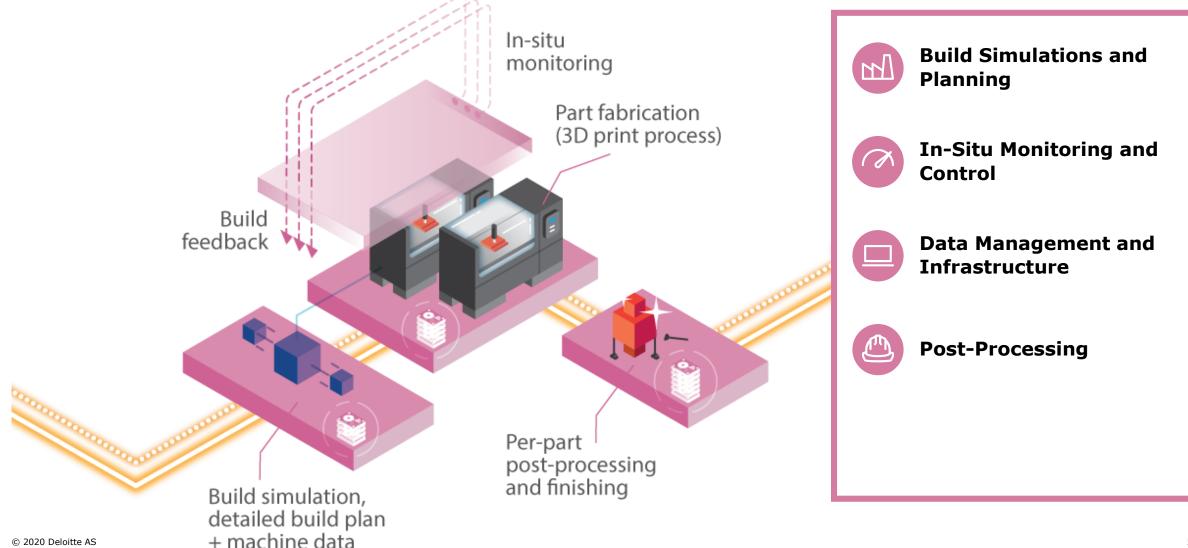
1. Scan/Design + Analyze

The physical part or part concept is converted into a 3D computer model, analyzed and refined



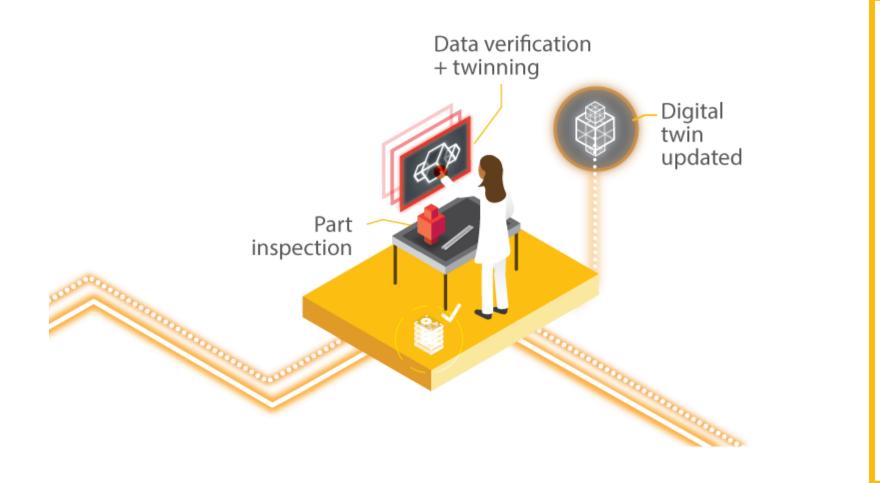
2. Build + Monitor

The build is planned and simulated using the 3D model, then executed using senor data to monitor or control the process



3. Test + Validate

Testing and validation builds on previous process data, enriched with topographic and NDT data





Non-Destructive Evaluation



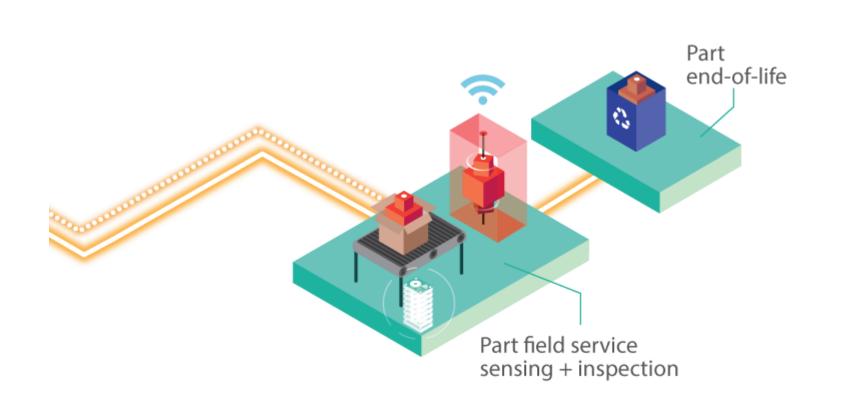
Coordinate Measurement Machines



Data Verification and Twinning

4. Deliver + Manage

Once the products are released for delivery, the products sensor data updates the digital twin and thread with the operational and sustain history





Analytics and Lifecycle Modeling

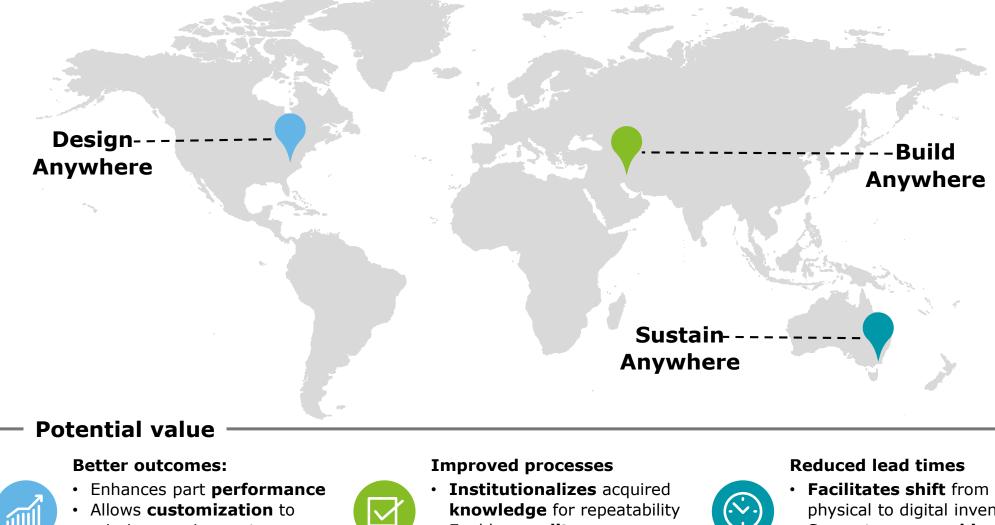


Digital Feedback to the Design Process



Connected Sensors in Field Service

Digital thread value proposition Unlocking value across the product lifecycle



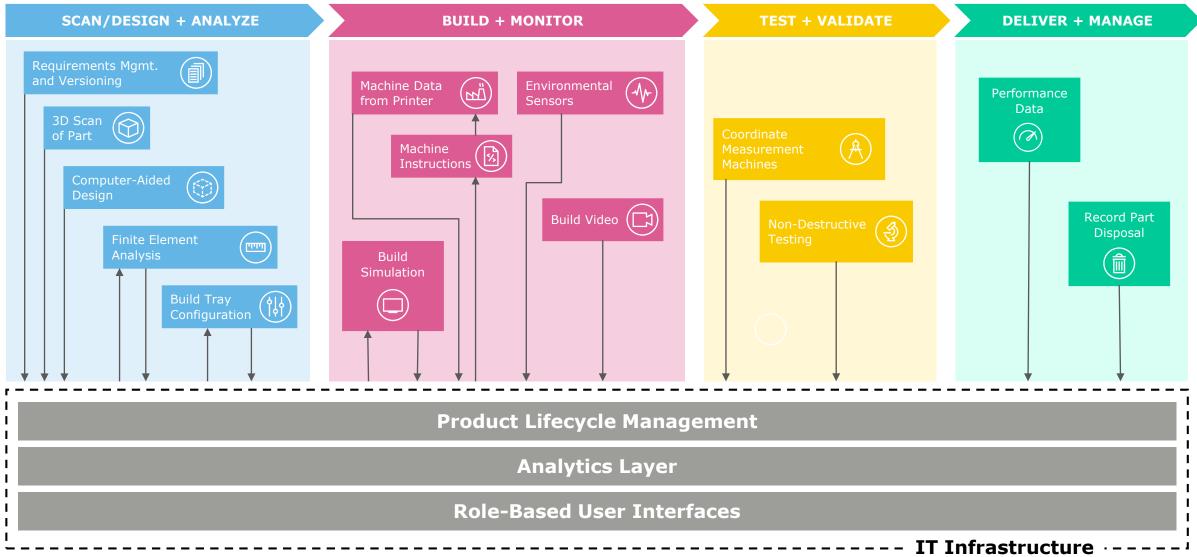
mission requirements Improves part reliability knowledge for repeatability

Enables quality assurance



- physical to digital inventory
- Supports geographically distributed activities

An architecture for today's digital thread for additive manufacturing Many of the required capabilities already exist and can be integrated



Digital thread data institutionalizes acquired knowledge

Capturing and managing data to be leveraged enterprise-wide



- 3D Model
- Product and manufacturing information (PMI)
- Simulation results
 - Load data
 - Finite element analysis (FEA)
- Build plan
 - Build tray configuration
 - Machine instructions

BUILD + MONITOR

- Manufacturing electronic work instructions (EWI)
- In-situ monitoring data
 - Video/Photo
 - Thermal Sensors
- Build anomalies
- Post-processing attributes



- Testing EWI
- Non-destructive evaluation results
 - As-designed vs. as-manufactured comparison
- Destructive evaluation
 process

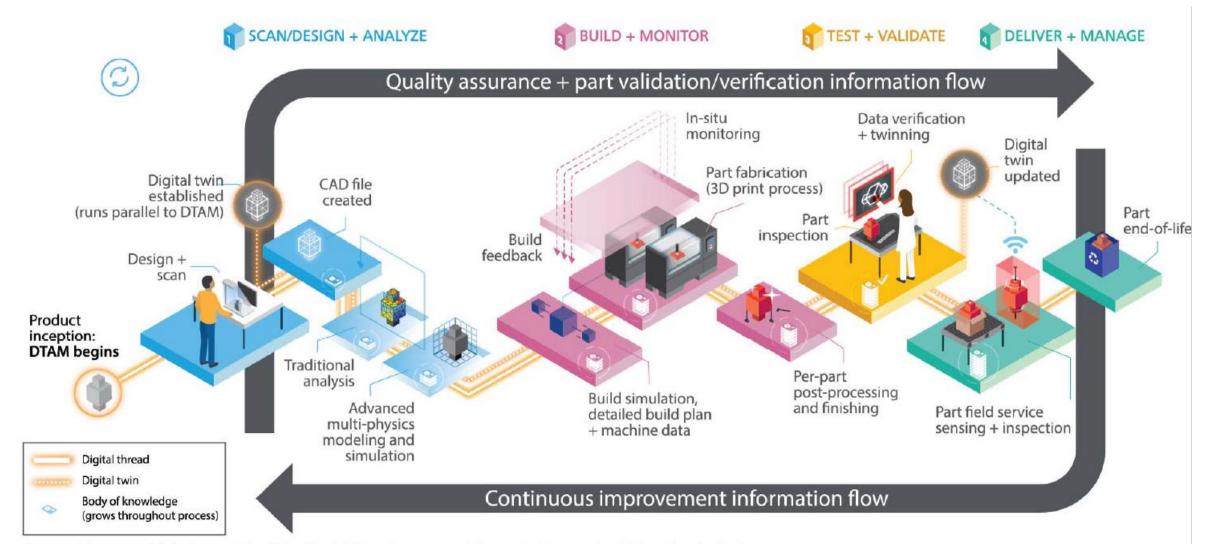
DELIVER + MANAGE

- Installation EWI
- Sustainment work
 instructions
- Usage data
- Maintenance logs
- Quality incidents

Data from each phase can define the plan or highlight the need for improvement for subsequent prints

Develop institutional knowledge and create blueprint for next print(s)

DTAM – improving products life cycle and knowledge/leanifying processes



Deloitte.



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