

# Trinity College Dublin: Science and Technology in Advanced Manufacturing (STAM)



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TCD  **stam**<sup>TM</sup>

Presenters: Dr. Jeff Morgan & Dr. Garret O Donnell #1



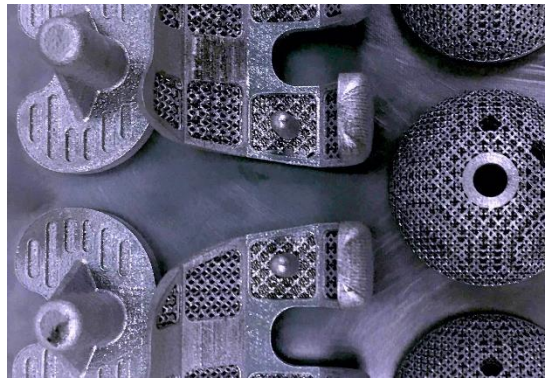
# Trinity College Dublin: Science and Technology in Advanced Manufacturing (STAM)

## Active Research Projects at STAM:

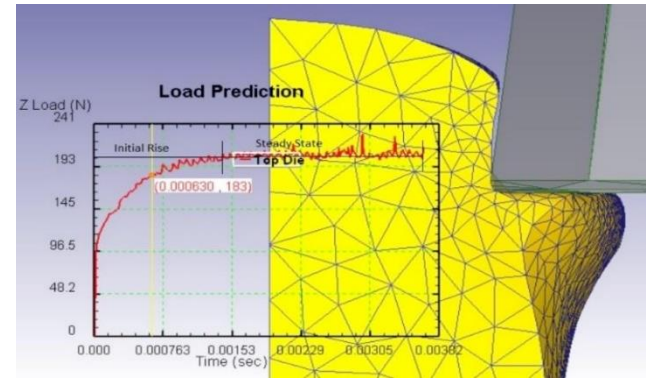
[www.tcd.ie/mecheng/research/stam/](http://www.tcd.ie/mecheng/research/stam/)



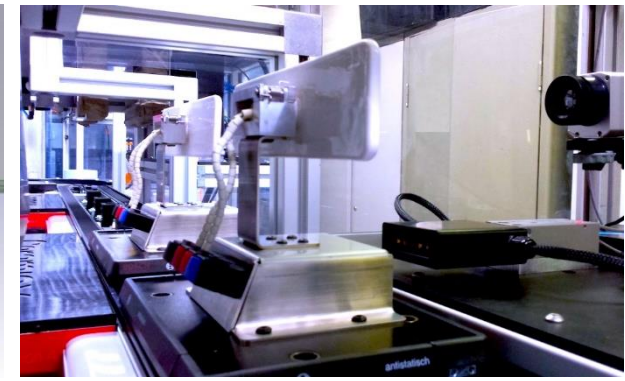
Surface Acoustic Wave (SAW) - Sensors



Metal - Additive Manufacturing



Machining – Characterisation & Modelling



Automated test – Industry 4





# Paving the Way for Industry 4.0 with Smart, Reconfigurable Manufacturing Machines

 Project CIRCLE

SR-TEX (Smart Reconfigurable – Test EXecution)



## Technology Paradigms

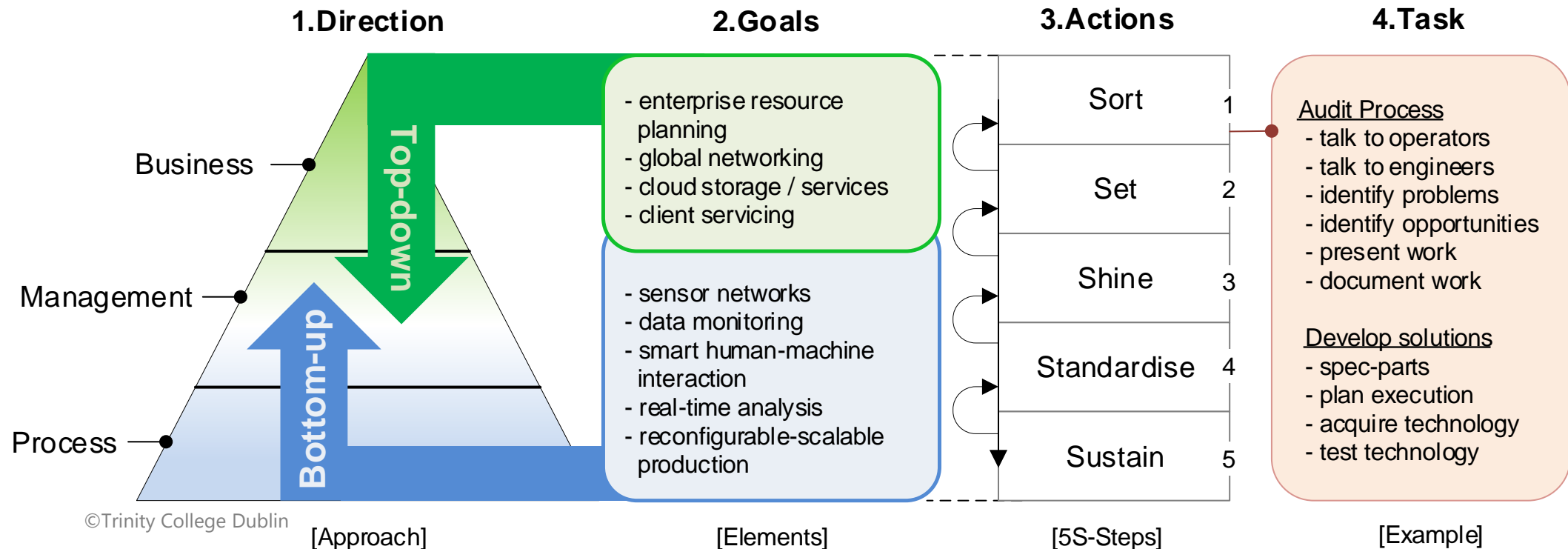
- **Internet of Things (IoT)**  
plant-wide data acquisition
- **Cyber Physical Systems**  
seamless integration of cyber space with physical processes
- **Smart Factory**  
adaptive, flexible, autonomy, autonomous learning & risk management
- **Industrial Internet**  
new products and services
- **Enterprise interoperability**  
Hierarchical data collaboration

## What is Industry 4?



## Implementation Model

## What is Industry 4?





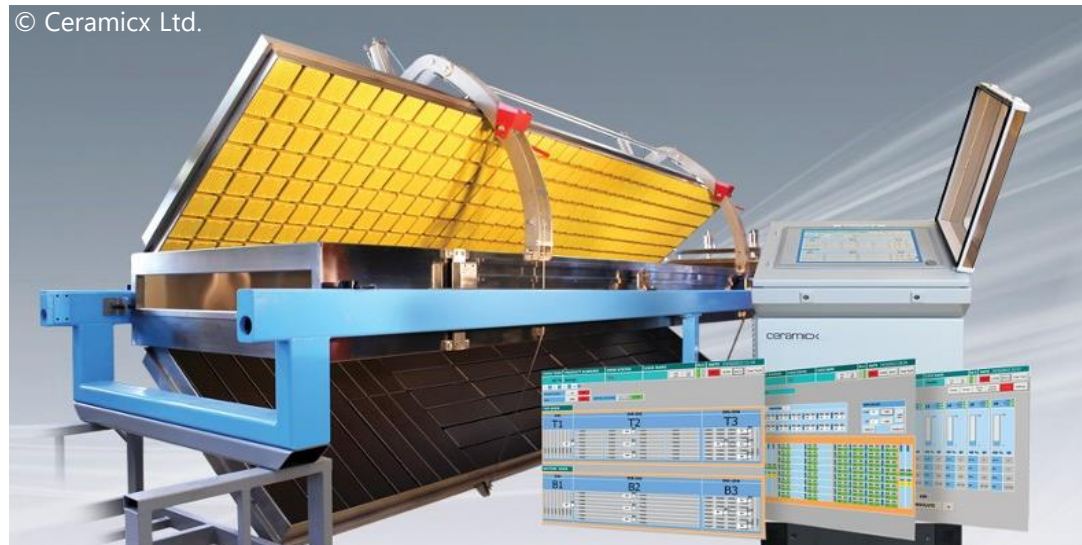
# Paving the Way for Industry 4.0 with Smart, Reconfigurable Manufacturing Machines



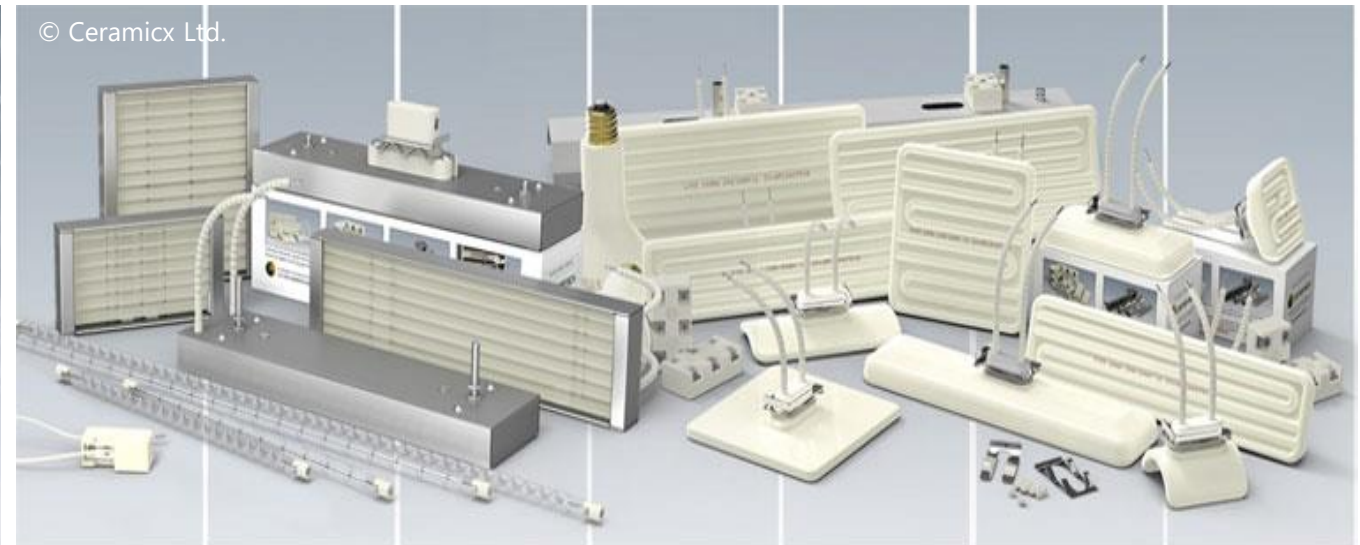
Global provider of infrared heating technologies and services

Gortnagrough, Ballydehob, Co. Cork, Ireland  
[www.ceramicx.com](http://www.ceramicx.com)

Industrial Partner  
(smart test machine)



Industrial ovens & thermoforming



Ceramics & Quartz heating elements



# Paving the Way for Industry 4.0 with Smart, Reconfigurable Manufacturing Machines



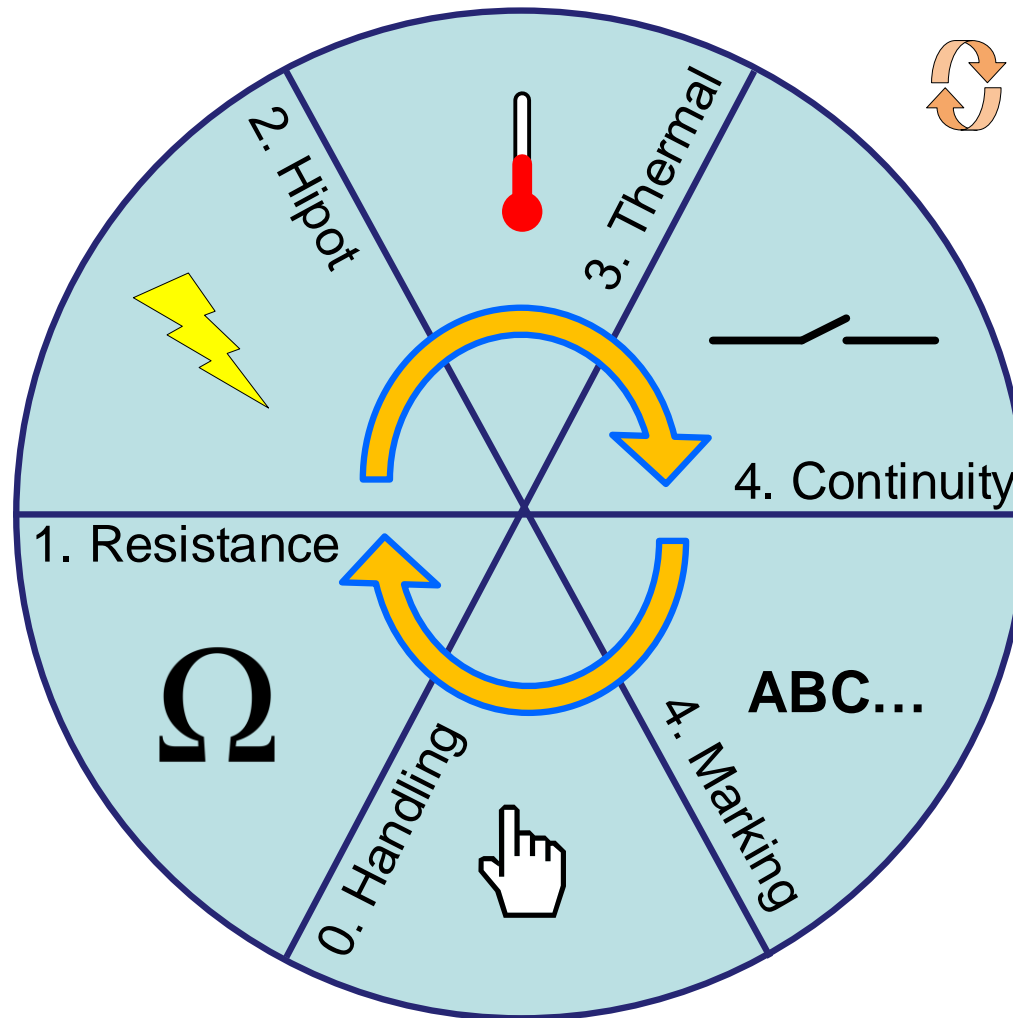
## Project CIRCLE

(smart test machine)

Contributors:



Trinity College Dublin  
Coláiste na Tríonóide, Baile Átha Cliath  
The University of Dublin



Baseline Measurement Circle:

Investors:



**ENTERPRISE  
IRELAND**



Ireland's European Structural and  
Investment Funds Programmes  
2014-2020

Co-funded by the Irish Government  
and the European Union



**EUROPEAN UNION**  
Investing in your future  
European Social Fund





## Operation requirements:

- Production: automate testing and validation of heating elements
- Laboratory: measurement and characterisation of new elements
- Data: storage and analysis of production data
- Design: extensible for future requirements (future proof)

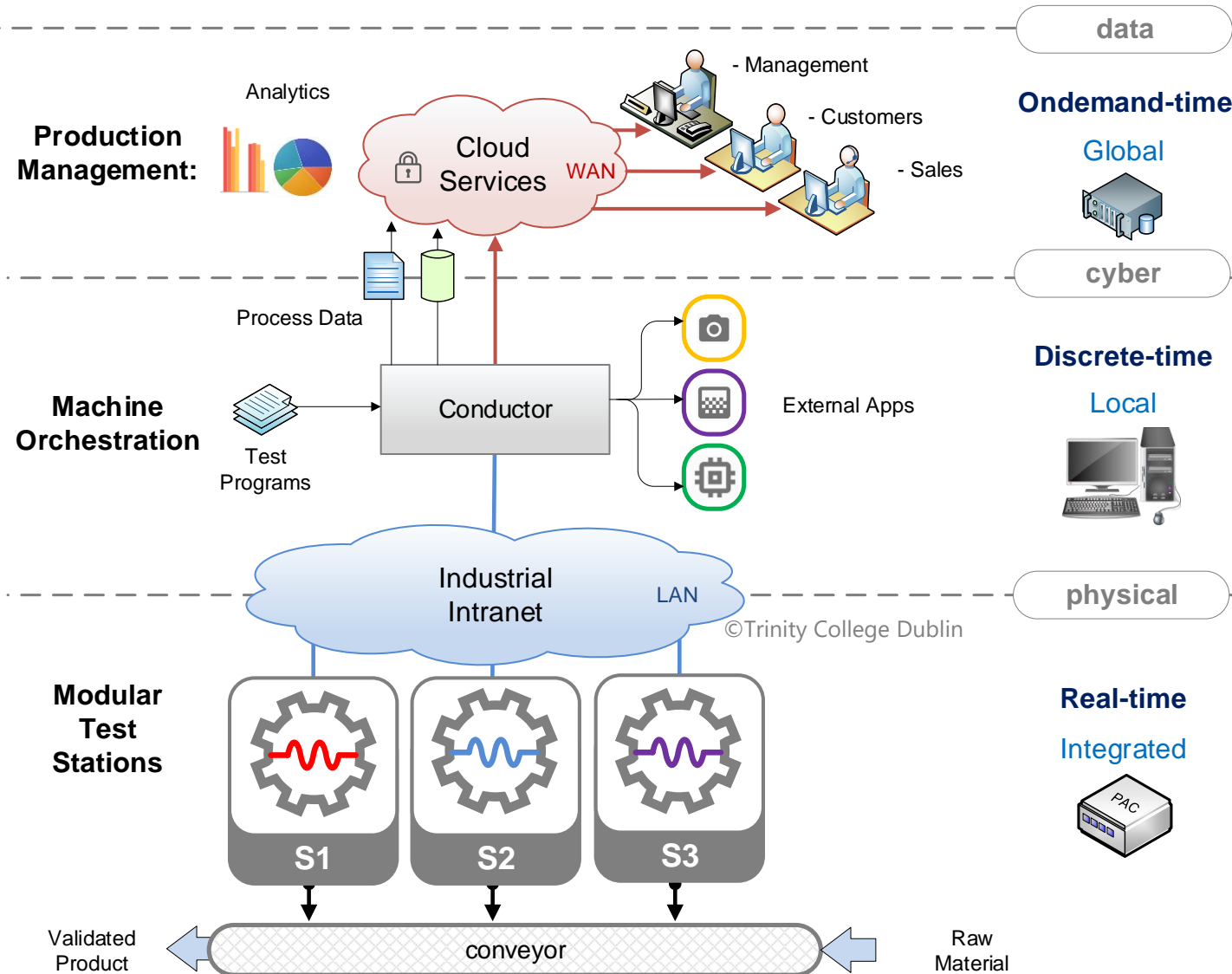




## Design requirements:

- High speed automated testing (>140 parts per hour, <25sec test time)
- Variable testing processes (Electro, Thermo, Marking) x
- Adaptable testing actuations (150+ part types) x
- Reconfigurable test parameters (Low turnover time)
- Open hardware/software (Production control / laboratory control) x
- Data extraction/storage (Database)
- Extensible functionality (Future testing requirements) x
- Extensible throughput (Future volume requirements) x
- Robust safety (High power / high temperature)
- User friendly control (Minimise complexity)
- User friendly configuration (No coding experience) x

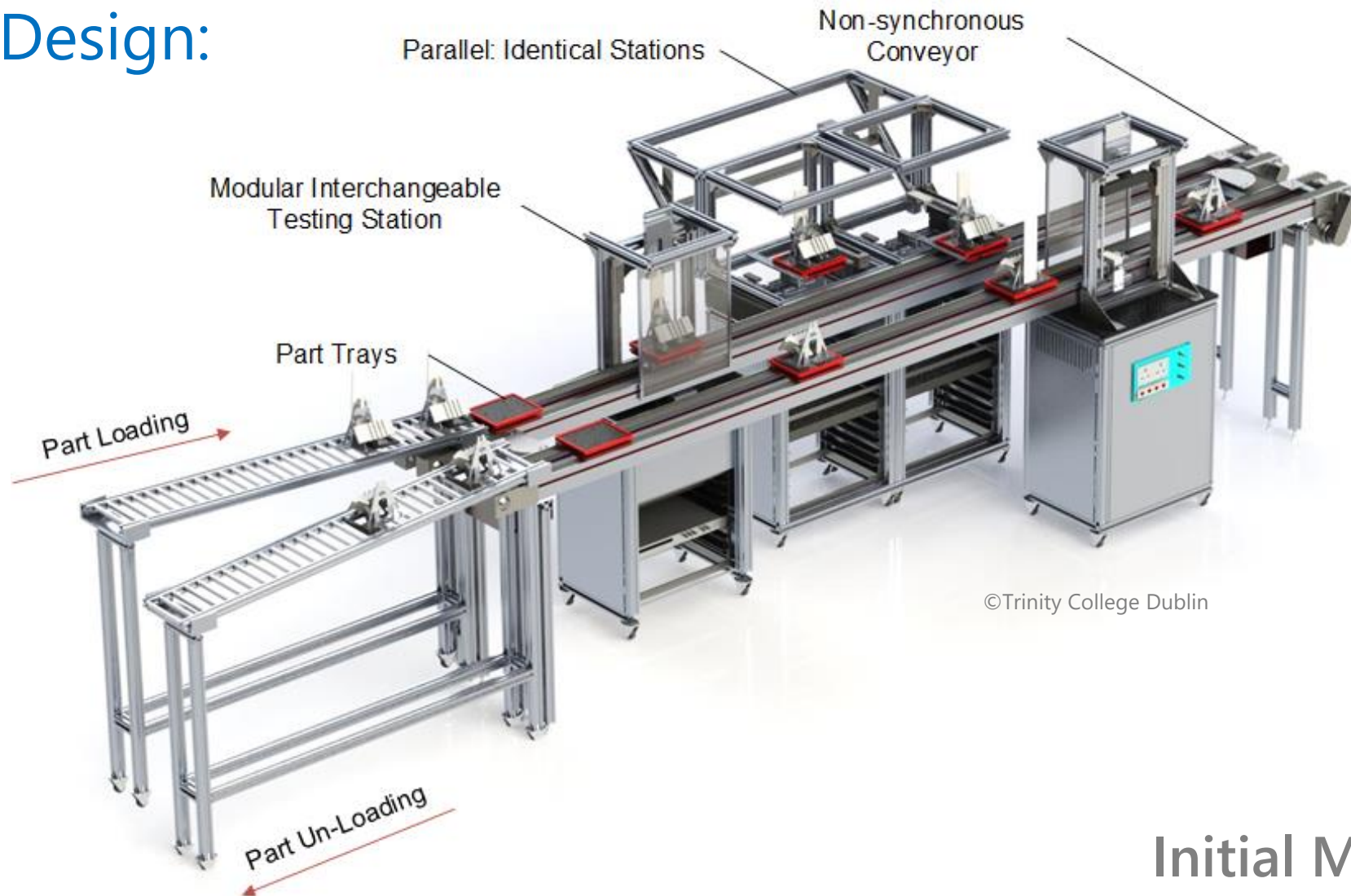
# Concept:





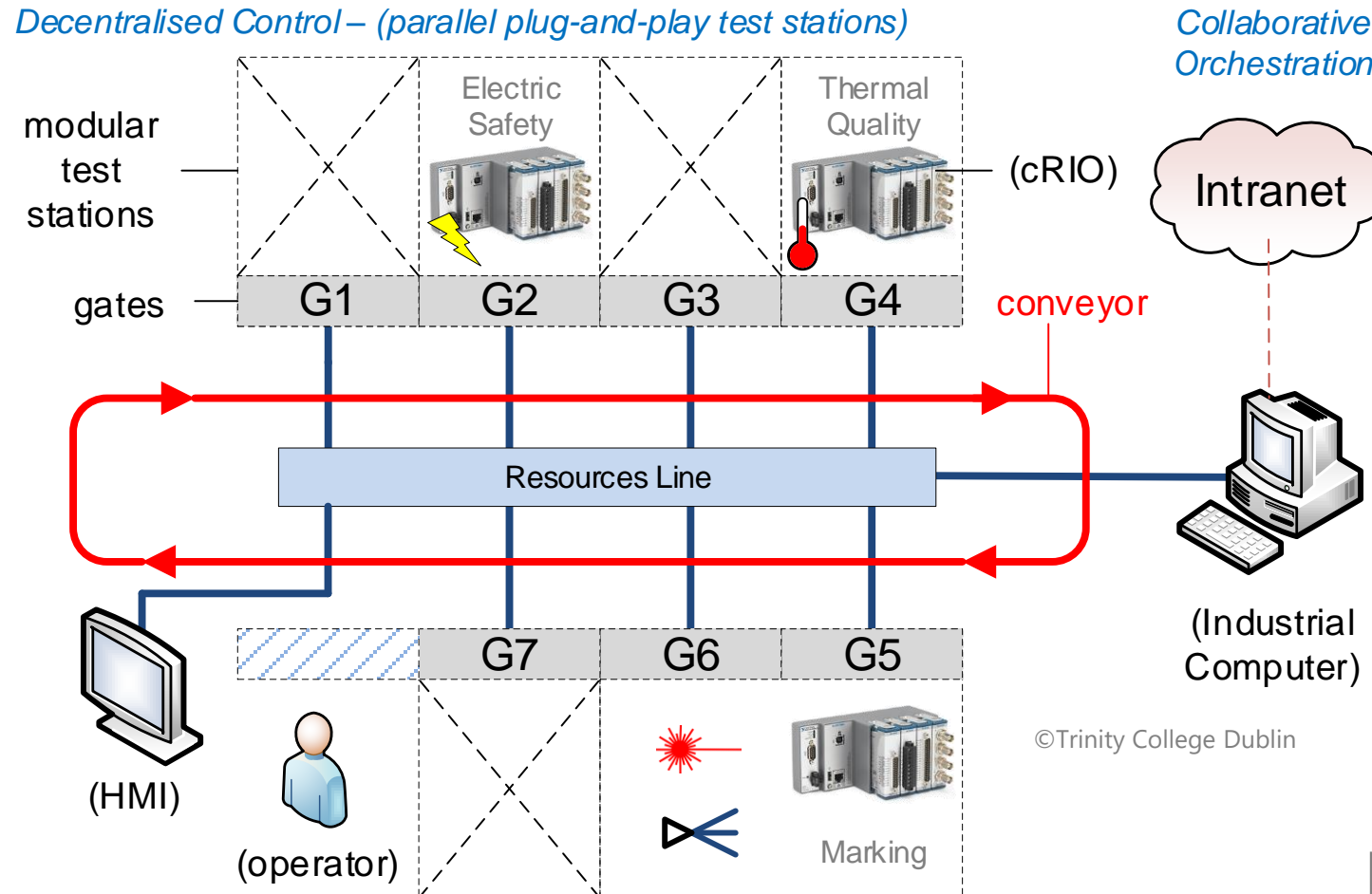


## Physical Design:



Initial Model

## Physical Design:



Layout

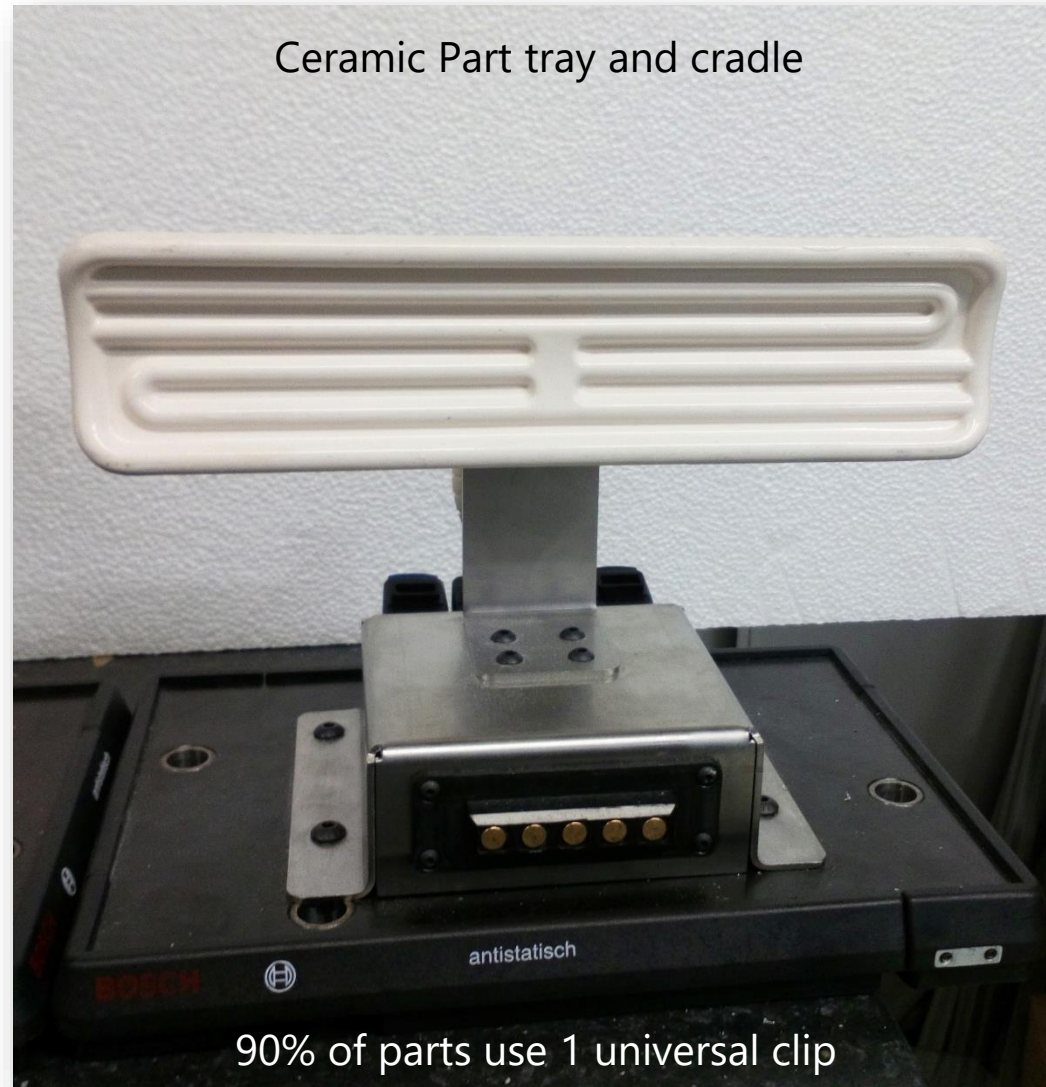


## Physical Design: Part Handling

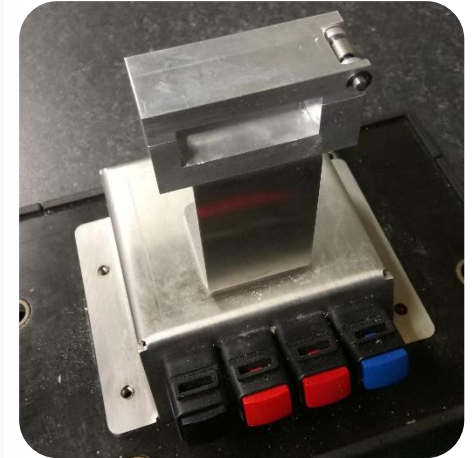
Station Contact Pin Actuator



Ceramic Part tray and cradle

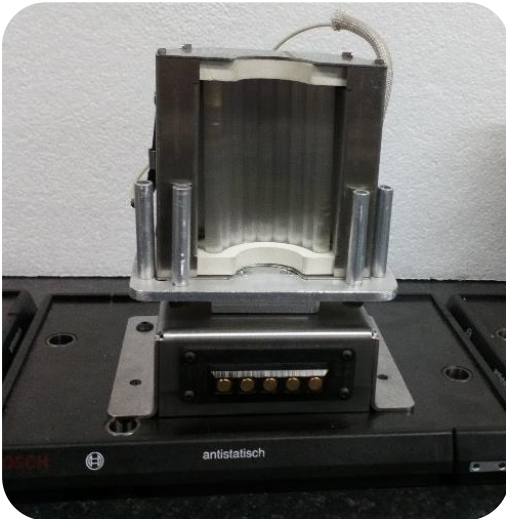


Push clip wire connectors

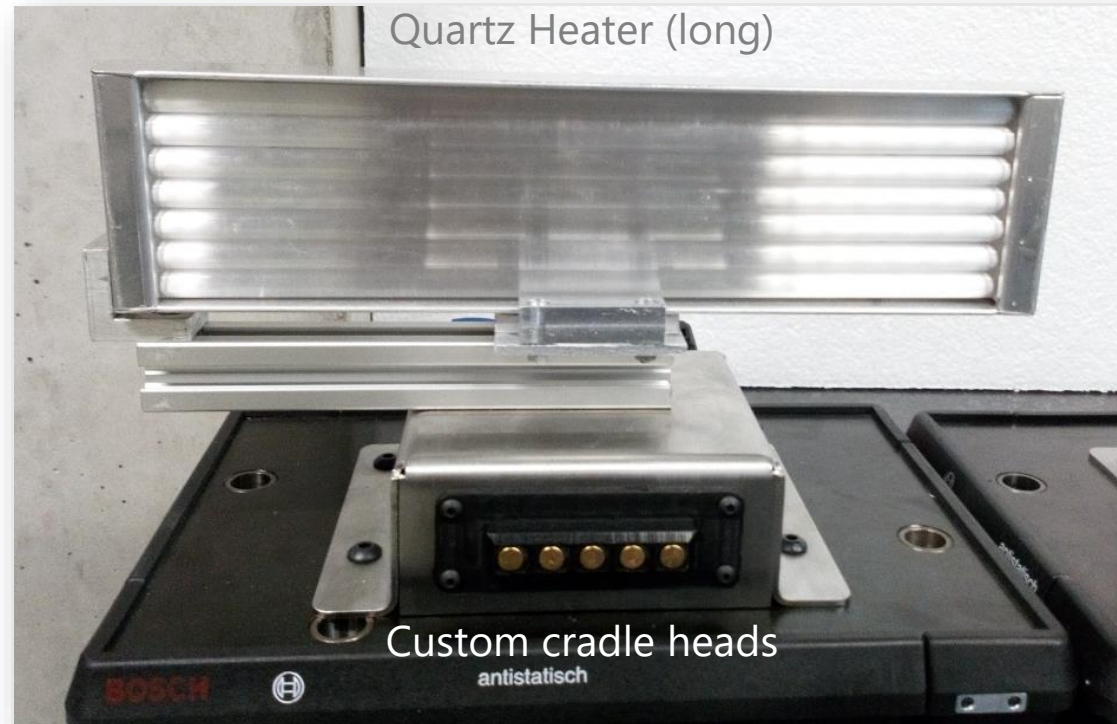


## Physical Design: Part Handling

Quartz Heater (curved)



Quartz Heater (long)



Ceramic Bulb





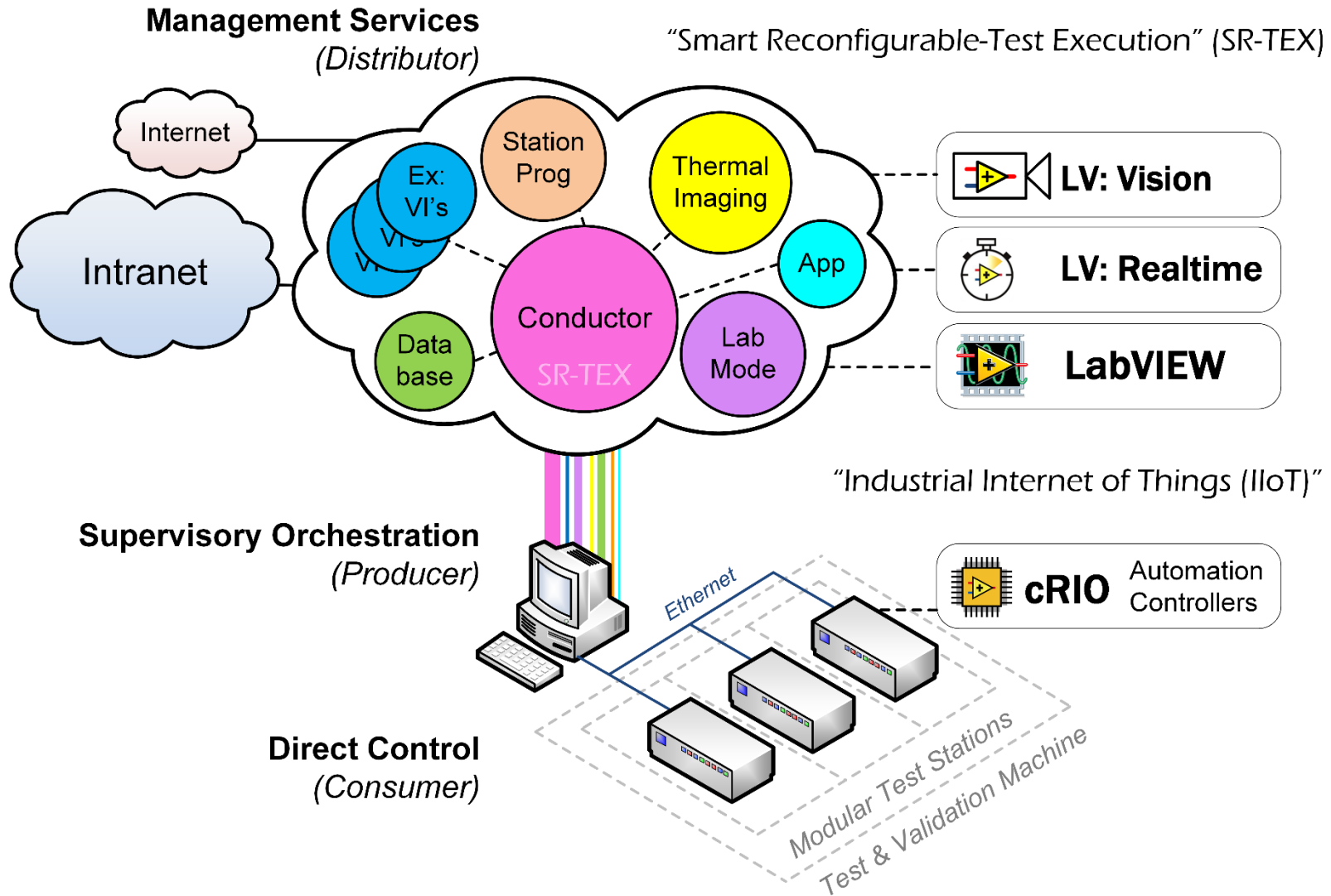
# Physical Design:

## Overview

- Bosch TS2 plus: modular conveyor
- Bosch strut station frames
- SMC Pneumatics
- Dell computer
- NI cRIO station controllers
- Custom sheet metal panels and fixtures
- Integrated test devices
  - HIPOT
  - IRcam
  - Multimeter
- All programmed with LabVIEW

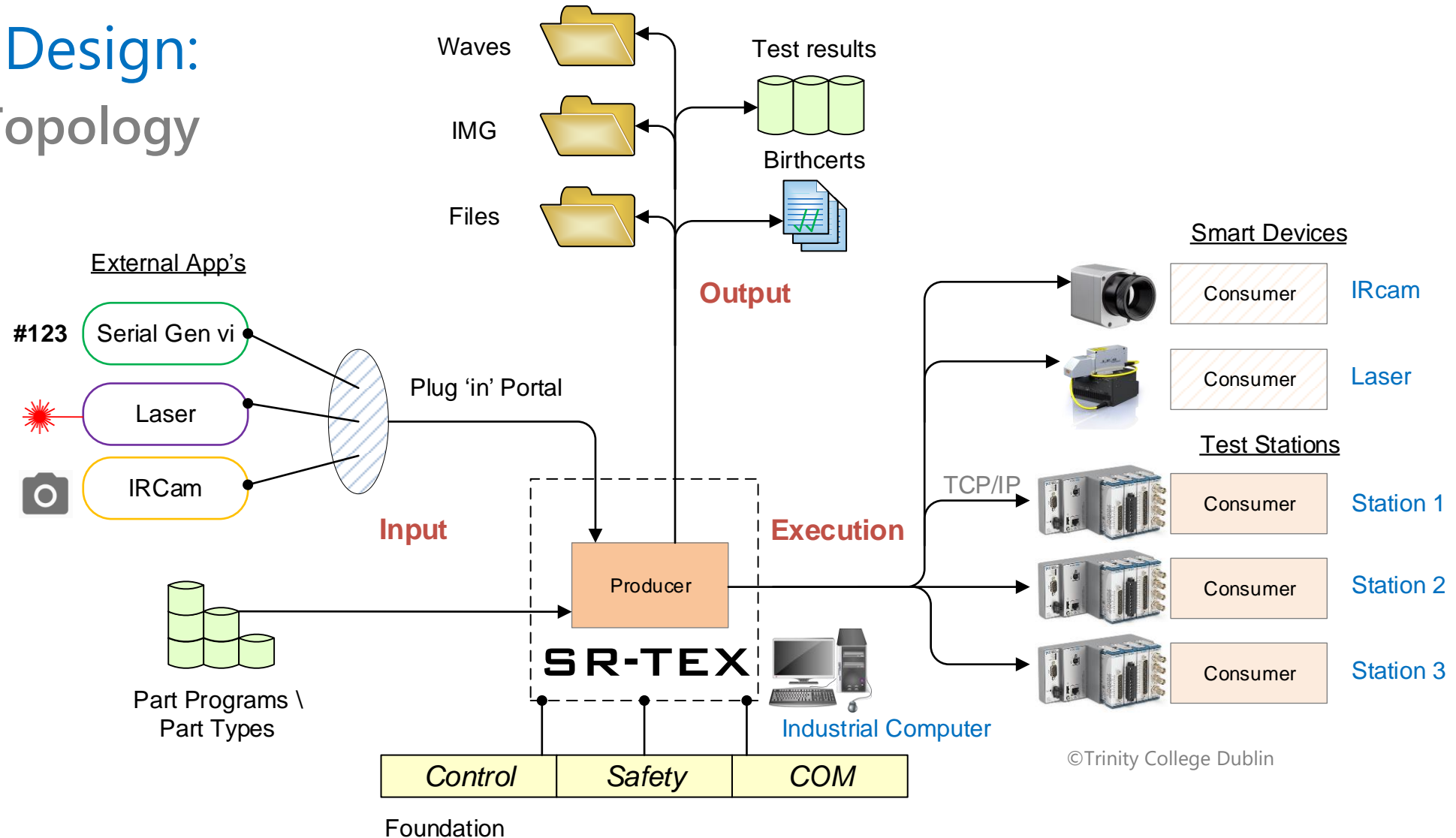


# Cyber Design: NI Graphic





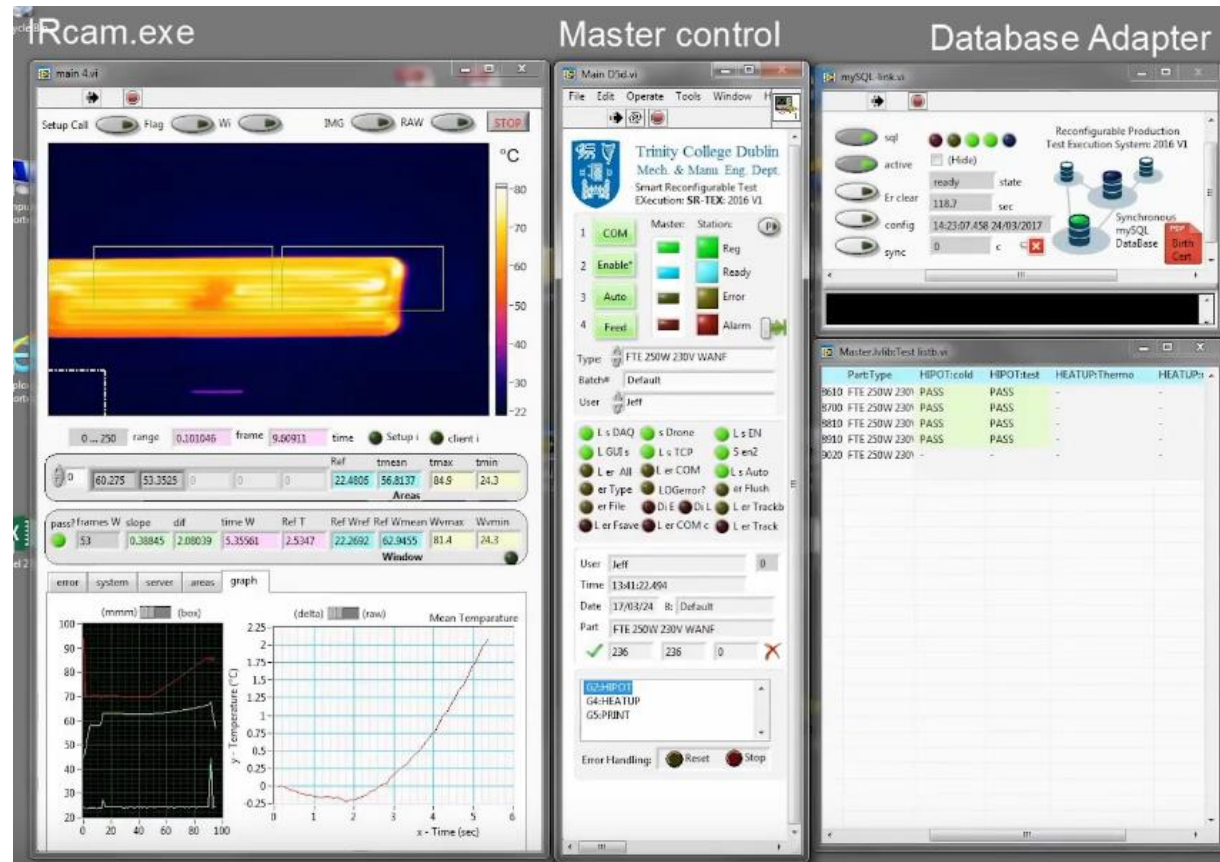
# Cyber Design: Basic Topology



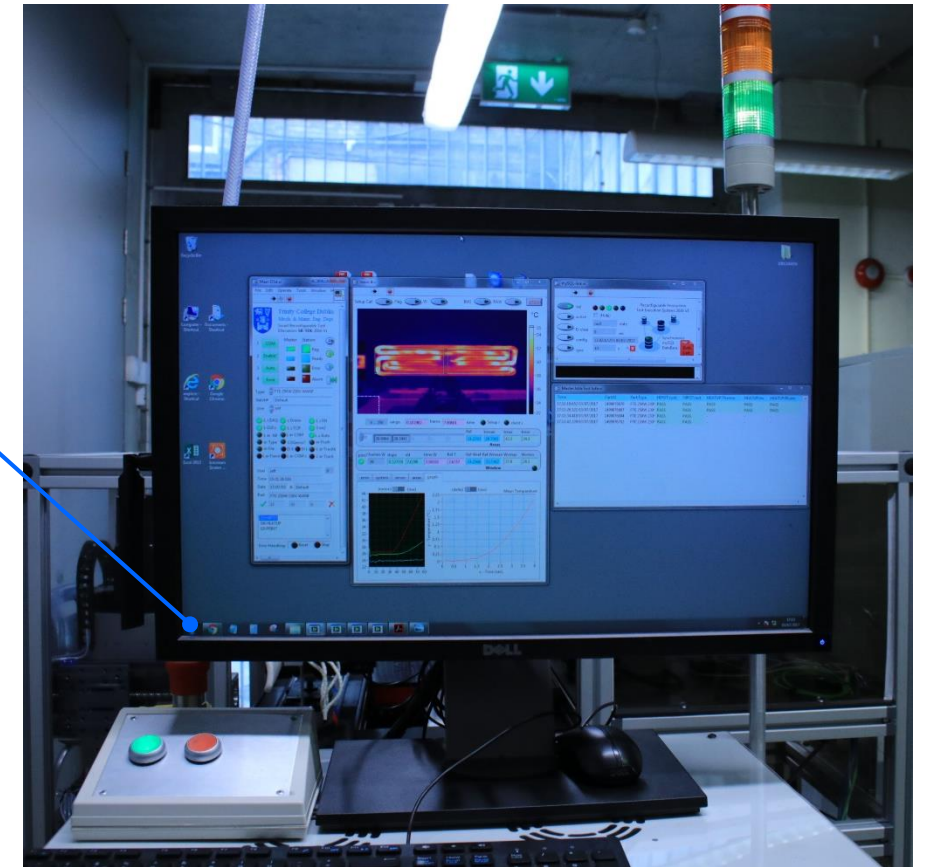
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# Cyber Design:

# Software Community



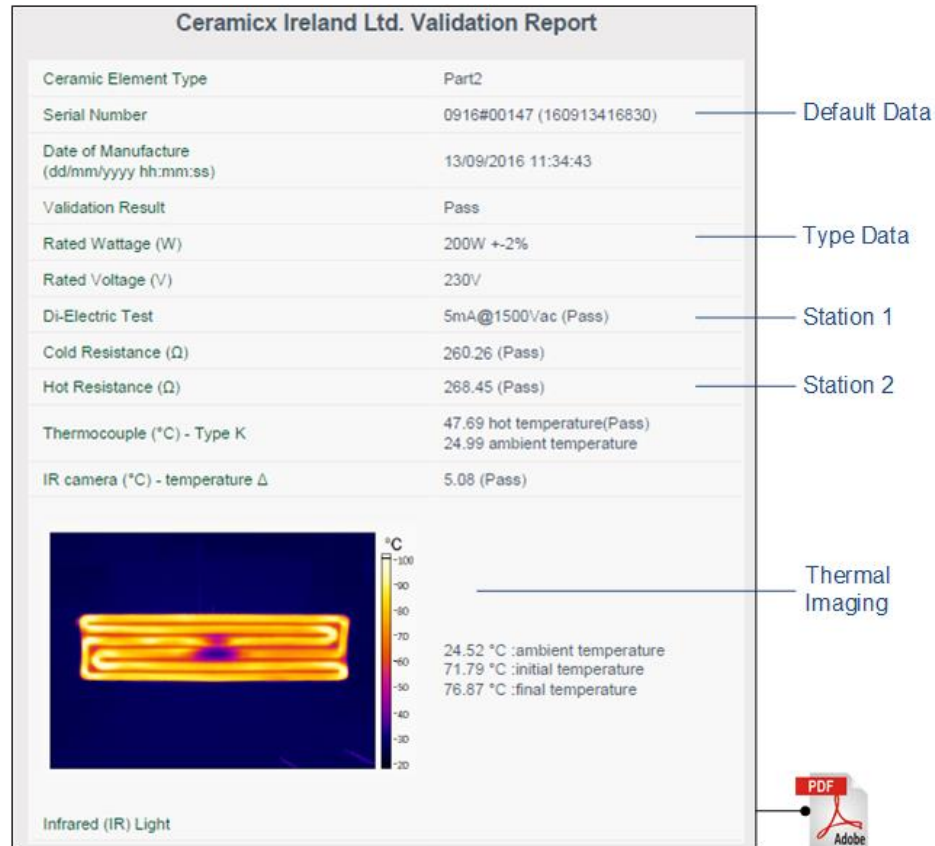
Dashboard



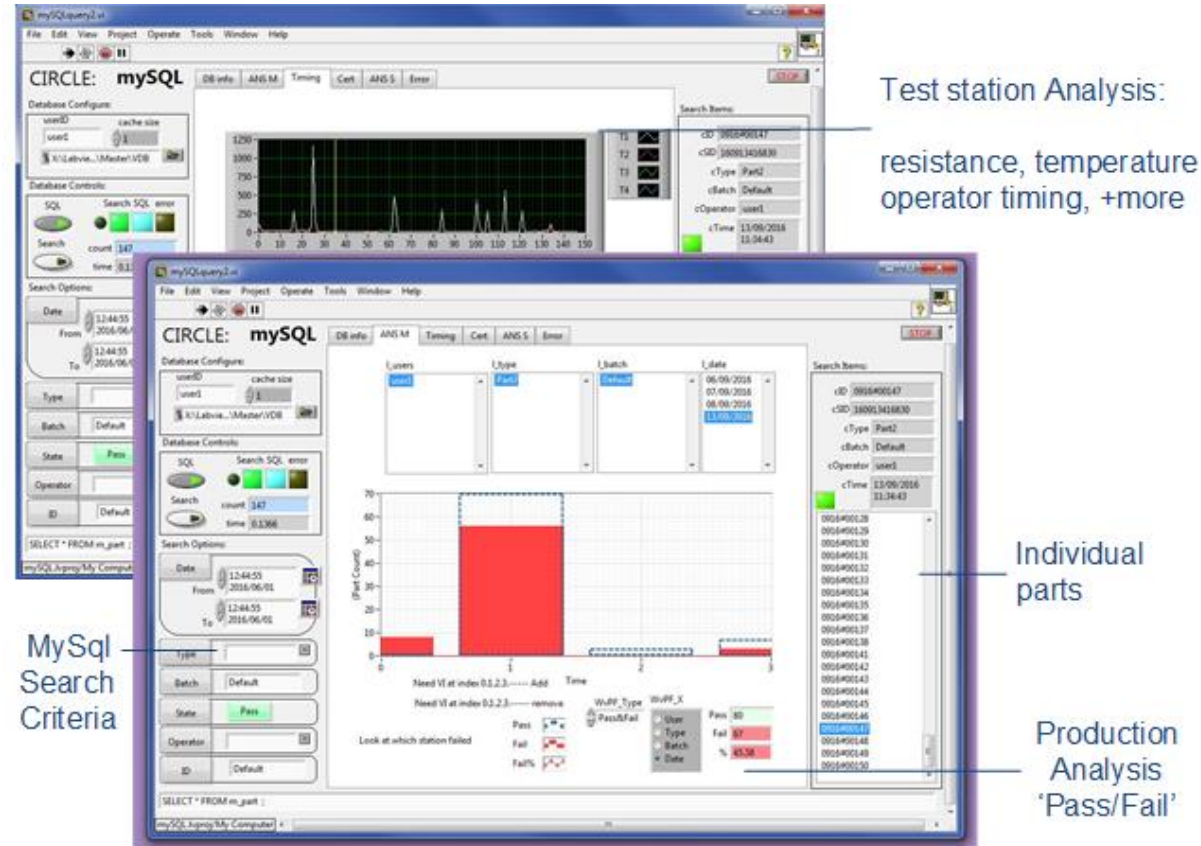
Master Control Station

# Digital Services:

## Product Birthcerts:



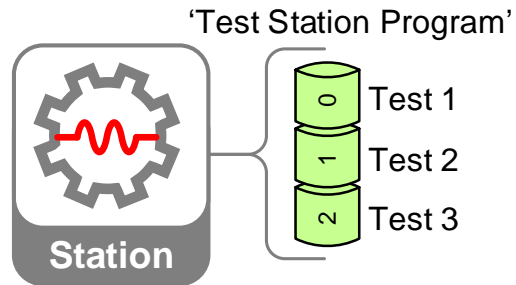
## Production analytics:



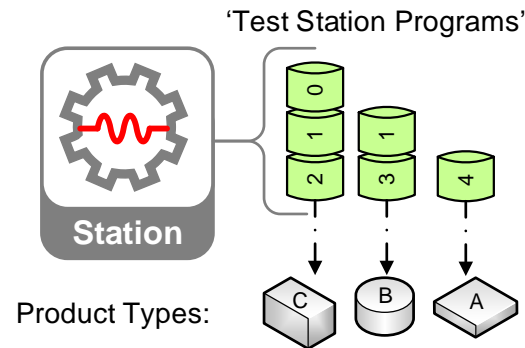




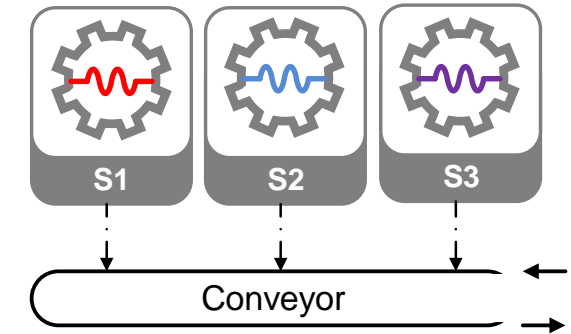
## Reconfigurable Test Features:



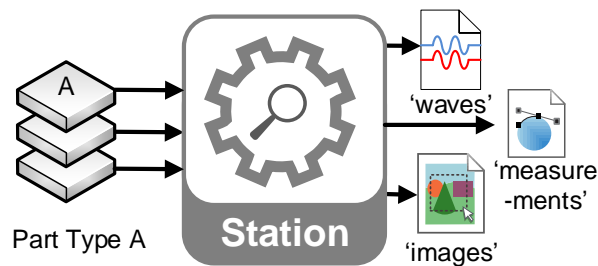
1. Dynamic Tests



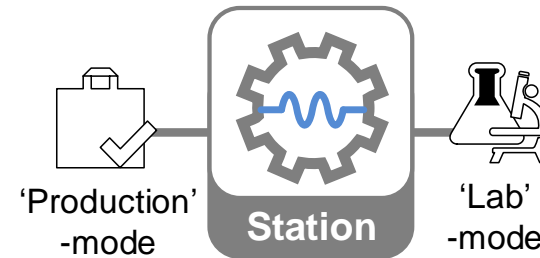
2. Scalable test parameters



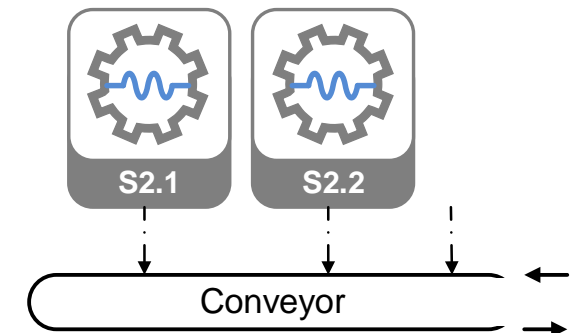
3. Parallel testing



4. Multi-metric-media



5. Measurement service



6. Expansion ready

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*Thank you*



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