

EngiNX 2018: The Digital Twin

Engineering for Next Generation

An Engineering Innovation contest from TCS - Engineering and Industrial Services & Internet of Things Business Units

Introduction

Powered by Industry 4.0, Business 4.0 is setting the agenda for most industries. With onset of latest digital technologies, most industry has started seeing the need to perceive its products as a service to close the value generation loop. To realize your product as a service, it is essential to have a digital representation of your product. This “Digital Twin” is going to enable visualizing more and more products as a service.

Per Gartner Inc. report published in 2017, Digital Twin is one amongst the top 10 strategic technology trends which represents the convergence of physical and virtual worlds by assigning every product a dynamic digital representation.

A digital twin, when conceived right from conceptual design phase through the deployment phase, will enable a complete digital foot print of the product. When you have a digital ready twin for your product, seamless enablement of Machine Learning and Artificial Intelligence becomes feasible. This will in turn unleash the potential of most products in the IOT era.

EngiNX 2018 gives you the opportunity for you to begin your journey on this exciting path. Are you ready to build your own Digital Twin?

The Contest

The objective of EngiNX 2018 is to build and demonstrate a “Digital Twin of a Closed loop IoT system”, which shall address a real world problem statement.

The contestant's shall

- Identify a real world problem with a reasonable level of complexity
- Represent the functionality of each entity of the system with a Twin
- Use Artificial Intelligence or Machine learning algorithms for Analytics and decision making, Simulate/Train the Twin with Historic data for improving accuracy of the system
- Connect to IoT for real world data feed live from the physical entity
- Build physical model which will be working in synergy with the Twin

Participation

The contest is open to students from the 2019 and 2020 batch from all the relevant institutes in India.

Disciplines

The contest is open to students from any discipline. Multidisciplinary teams, combining more than one of the following areas are expected to bring the best in breed solutions.

Electronics and related disciplines - Electronics and Telecommunication Engineering (EXTC), Electrical and Electronic Engineering (EEE), Electrical Communication Engineering (ECE), Embedded Technology, Digital Communications, Digital Electronics, Applied Electronics, Telecommunications etc.

Computer Science and related disciplines - Computer Science, Computer Science and Engineering etc.

Controls and related disciplines - Instrumentation and Controls, Controls, Industrial Automation etc.

Mechanical and related disciplines - Mechanical, Mechatronics, Robotics, Production, Industrial, Automotive, Aerospace etc.

Participation Guidelines

- Students should Register on TCS Campus Commune portal for taking part in the contest.
- Each team shall comprise of 4 members only from the same institute.
- Once contest registrations begin, all interested participants will be required to register for the contest on 'Campus Commune'.
- The team should choose a team name and the team leader.
- During registration, the team leader should 'Nominate' self as the Team leader and also 'Nominate' his/her Team Members. It is the responsibility of the Team Members to 'Accept' the nomination/ invitation.
- In case a Team Member rejects a Nomination, the Team Leader will be able to send a new request to another registered member from the institute.
- The team will be formed once all nominated members 'Accept' their nominations.
- The team leader of each legitimate team will be TCS' contact for any communication with respect to the contest, who in turn will be responsible for updating the respective team members.
- The team can be from the same discipline or may be inter-disciplinary. In line with the present business trends, we would encourage formation of multi-disciplinary teams and work as a cohesive unit to come up with innovative solutions.
- Teams have to be from the same college/ institute.
- Team composition to remain same throughout the contest. Movement within teams is not allowed and will lead to disqualification from the contest.
- The infrastructure expenses required for the development of the solution shall be borne by the respective teams or the institutions they represent. TCS will not be liable for any loss or possible damage to the infrastructure which may be caused by participants during the contest.
- Entries submitted after the round/contest end date will not be considered for evaluation.
- In the final stage of the contest, selected teams are expected to present an architecture of how data will come from the proposed system (with help of Mathematical Model) and then taken to cloud for analysis and decision taking and again sent back to the system for action.
- For top 5 finalist teams, TCS will reimburse the cost towards development of a working model up to **Rs.100,000/- (Rupees One Hundred Thousand only)** per team upon verification of the expense/s .

- Each team will own the respective model developed by them and will be responsible for keeping the same in possession at all times throughout the duration of the contest. TCSL will not claim any ownership/ responsibility towards the models developed or any component/s of the same.
- Finalist teams will get a fully sponsored trip to Grand Finale venue.

Contest Structure

Our resolve to nurture creativity and innovation among the students to develop problem solving techniques has inspired us to come up with four rounds for this contest. This contest structure, we believe, will give ample time and scope for students to demonstrate their skills right from idea conception stage to successful implementation of the solution.

The following stages explain the structure of the contest in detail:

Registration Window: 20th March 2018 to 27th April 2018

Round 1: Qualification Round

Teams will be required to take an online 2 Level MCQ Quiz developed by the in-house teams of Tata Consultancy Services Limited.

- The first level will be Basic Technical Assessment with focus on Physics, Mathematics and Analytics ability.
- The second level will be opened for first level qualifiers only with MCQs of Mathematical modelling and IoT.

The top 200 teams across India from all the zones will move to Round 2.

Round 1 Quiz Date: 28th April 2018.

Round 2: Use Case Proposal Round

EngiNX Round 2 requires the teams to conceptualize a physical system, propose a digital twin along with complete architecture and algorithm that will enable artificial intelligence to provide a closed loop system, against one of related contest themes published by TCS post registration freeze.

Apart from the identified problem and solution, the proposal shall very clearly capture the solution architecture of

- Data transfer mechanism from the Physical entity to the Digital twin
- Model or Functional breakdown of the system, possible tools for the simulation
- Decision making Algorithms, Analytics that's carried out in the Cloud
- Feedback system for acting upon the decisions taken.

The use case shall also talk about how the proposed solution is able to monitor remotely and diagnose. In a nutshell, the use case document shall capture the solution architecture and algorithm of how the digital twin will act as a live replica of the physical system.

In a nutshell, Use Case Proposal Round shall have the listed below details captured clearly.

1. Problem statement
2. A high level architecture (+ Cloud connectivity diagram)
3. Functional flow of the model as diagram/flow chart (Description on how the model is conceived)
4. Tools/platforms that will be used
5. Simulated data generation method for testing the model (this should be in line with the actual data which comes from the physical system)
6. Cloud platform that will be used
7. Cloud connectivity/Handshake schemes to the physical system and the Twin
8. Algorithm (ML/AI) that will be used
9. Physical system architecture
10. Method to Interface Human Interaction
11. CAD/3D drawing linked to the Mathematical model (Optional)
12. User interface design (Optional)

Each team at this round will be allowed to submit only one use case with solution. In an event where any team submits more than one proposition, the second use case submitted will be considered null and void and will not be considered for evaluation.

Submissions will be in form of presentation.

The idea will be evaluated on the following factors:

- Innovation
- Impact
- Implementation

After evaluation of all the legitimate propositions, the Top 100 teams would move to Round 3.

Round 2 Closure Date: 20th May 2018.

Round 3: Digital Twin Round

The Digital twin round requires the teams to make 20 min video presentation along with simulated mathematical models of proposal submitted in Round2. The submission should include:

Objective

Brief description of the proposed solution

Demonstration of Mathematically modelled Digital Twin of the proposed system

(Please Note: The Mathematical Model should accurately portray the functions of a physical system. Also, it represents each and every function of the system, with precise physics based Mathematical model. In the foreground, A Physical representation (CAD like drawing) can also be added (if required) to provide clarity for the users as a CAD Drawing **alone** would not suffice, It needs the functionality to be modeled\simulated with Field data.)

Functioning of the Twin along with decision making algorithm

Effectiveness of the proposed solution in making the system intelligent and optimal

In addition to details submitted in round 2, the teams should include the listed below details in 3rd Round

1. Functional Model of the physical system/process (Preferable Tools: Matlab / Simulink / Stateflow, LabVIEW)

2. Simulated data set to be fed in to see the working model
3. The working model which can be simulated using the Simulation data generated

After evaluation of all the presentations the Top 25 teams would have an interactive evaluation where TCS panelists will connect with the teams either in person (preferred) or over video conferencing.

The expectation is that the schema and mathematical model shall synthesize data from various sources including physical data, manufacturing data, operational data and insights from analytics software to create a digital twin of the proposed physical system. In this round simulated data is acceptable in absence of real data.

The discussion shall range from 60 to 90 minutes and shall cover the areas listed below.

- I. How data will come from the system with help of Mathematical Model
- II. How it's taken to cloud for analysis and decision making
- III. How decision making happens
- IV. How its fed back to the system for actuation

Project plan for building the working model

Q & A on the Idea Presentation

After evaluation of all the presentations the Top 5 teams would move to Round 5 (The Grand Finale).

Round 3 Closure Date : 1st July 2018

Round 4 : Development of Working Model and Presentation (Grand Finale)

Each team at this level will be reimbursed up to an amount of Rs.100,000/- (Rupees Hundred Thousand only) which is to be utilized towards developing the working model of the proposition submitted. TCSL would encourage development of a working model which is compact and portable.

Along with the demonstration of the model the teams will be required to submit an executive summary of the proposition along with final presentation video to TCS. A power point presentation (adequate for 20 min. presentation time) in the same line would also be required to be submitted.

A pre-evaluation and guidance session may be arranged at this stage by the designated TCS team at respective college.

Subsequently all the teams will be called in a TCS Location (date and venue to be announced) where each team will be required to demonstrate the proposition along with the physical demonstration of the model(s) created to a selected audience.

In addition to previous two rounds, the final round should have the listed below covered in the final prototype.

- Functional model of the entire system
- Connectivity interfaces from/to the physical world
- Algorithm Implementation (ML/AI) for finding the solution/analytics
- Connectivity to the cloud / IoT system.
- User interface panel to simulate the model

Demonstration of the solution: 15 minutes

- ✓ -Teams shall bring all required supporting models, illustrations etc.,
- ✓ -Teams will be required to bring their own devices for the demonstration
- ✓ -The solution should not deviate from the idea submitted in Round 2. Any

- ✓ -Team found to have deviated from the original idea submitted, will be disqualified
- ✓ -Business presentation of the solution: 20 minutes (by power point)
- ✓ -The teams will be required to present their solution to the jury and selected audience
- ✓ -Teams may use relevant videos and audios for the presentation.

Q&A on business presentation: 10 minutes

The evaluations will be based on:

- ✓ Originality
- ✓ Technology Leverage
- ✓ Impact
- ✓ Practicality
- ✓ Generalisability
- ✓ Safety
- ✓ Cost-effectiveness
- ✓ Timeline Feasibility
- ✓ Use of Funds
- ✓ Acceptance

Pasted below is the representation of expected outcome round wise for an easy understanding.

Expected Outcome	Round 2	Round 3	Round 4
Problem statement			
A high level architecture (+ Cloud connectivity diagram)			
Functional flow of the model as diagram/flow chart (Description on how the model is conceived)			
Tools/platforms that will be used			
Simulated data generation method for testing the model (this should be in line with the actual data which comes from the physical system)			
Cloud platform that will be used			
Cloud connectivity/Handshake schemes to the physical system and the Twin			
Algorithm (ML/AI) that will be used			
Physical system architecture			
Method to Interface Human Interaction			
CAD/3D drawing linked to the Mathematical model (Optional)			
User interface design (Optional)			
Functional Model of the physical system/process (Preferable Tools: Matlab / Simulink / Stateflow, LabVIEW)			
Simulated data set to be fed in to see the working model			
The working model which can be simulated using the Simulation data generated			
Functional model of the entire system			
Connectivity interfaces from/to the physical world			
Algorithm Implementation (ML/AI) for finding the solution/analytics			
Connectivity to the cloud / IoT system.			
User interface panel to simulate the model			

Grand Finale: 24th August

Winner Declaration

The top three teams (Winner, 1 & 2nd Runners Up) will receive exciting prizes.

Special prizes may also be awarded for exceptional talents and each member of the participating teams at the Grand Finale will have an opportunity of having an internship with the TCS Engineering and Industrial Services (EIS) team, subject to fulfilling the applicable terms and conditions that govern the process. Direct Interview/Job offers may also be made to select participants as a special gesture based on fulfilling the applicable criteria. This will be based on management decision at the Grand Finale event.

Terms and Conditions

By entering the contest, each team and its members thereof confirms and agrees to the following terms and conditions:

- The team and its members thereof acknowledges that the idea/solution submitted will be an original work created solely by the team, and that the idea/application does not infringe on copyrights, trademarks, moral rights, rights of privacy/publicity or intellectual property rights of any person or entity, and that no other party has any right, title, claim, or interest in the idea/solution.
- The solution must not contain content where any person/s would be required to undertake actions that is inappropriate, indecent, obscene, violent, hateful, tortuous, defamatory, slanderous; that promotes racism or hatred against any group or individual or that promotes discrimination based on race, sex, religion, nationality, disability, sexual orientation or age; or that is unlawful, in violation of or contrary to the laws or regulations in the state or province where the solution is developed.
- The team and its members thereof is the sole author of the idea/solution and that it is the team's original work.
- The team and its members thereof have not licensed or disposed of any rights in the idea/solution that would conflict with any of TCSL use (if any).
- The contest entrants who have submitted their idea/solution are either the copyright owners of the component parts of that work or are posting the work under license from a copyright owner or otherwise as permitted by law. TCS does not claim ownership rights in your works or other materials used by you.
- For the sole purpose of enabling TCSL to make the idea/solution available through its' portal you grant TCSL a non-exclusive, royalty-free license to reproduce, distribute, re-format, store, prepare derivative works based on, and publicly display your content. You agree not to distribute any part of the portal other than the developed content in any medium other than as permitted in these Terms and Conditions.
- Display or publication of any entry on a TCSL website does not indicate the entrant will be selected as a winner. TCSL will not be required to pay any additional consideration or seek any additional approval in connection with such non commercial use.
- By entering this Contest, all entrants agree to release, discharge, and hold harmless TCSL from any claims, losses, and damages arising out of their participation in this Contest or any Contest-related activities. TCSL assumes no responsibility for any error, omission, interruption, deletion, defect, or delay in operation or transmission; communications line failure; theft or destruction of or unauthorized access to Contest entries or entry forms; or alteration of entries or entry forms. TCSL is not responsible for any problems with or technical malfunction of any telephone network or lines, computer online systems, servers or providers, computer equipment, software, failure of any email entry to be received on account of technical problems or traffic congestion on the Internet or at any website, human errors of any kind, or any combination thereof, including any injury or damage to entrants' or any other persons' computers related to or resulting from participation, uploading or downloading of any materials related to in this Contest.

- TCSL reserves the right, at its sole discretion, to cancel or terminate the Contest, at any time it deems fit and proper. No claims or representations shall be entertained in this regard.
- TCSL reserves the right to relax any of these restrictions if permitted by law before the start of the Qualifying Round. A cash prize of equivalent value may be given where required by law, or at TCSL's discretion.
- All contestants must have access to the Internet, a valid postal address, and a valid email address in order to enter the contest.
- TCSL reserves the right to verify eligibility and to adjudicate on any dispute at any time. TCSL will be the sole authority to decide the winners of the contest and decision of TCS will be final and binding on all the contestants.

Indemnifications

You fully indemnify and hold us (Tata Consultancy Services Limited) harmless for and against all damages, losses, and costs that might be caused by:

- Your failure to comply with the terms of the above agreement
- Third party claim(s) of their rights and IPR being violated/effectuated by your article(s) submitted to us.