

# Building Massively Scalable CAD Configurators for the Manufacturing Industry

**Nem Kumar**

Director, Consultancy | @NemKumar



## About the speaker

### Nem Kumar

He is director of consulting at CCTech and has been doing product development with companies from Manufacturing, Oil & Gas and AEC domain. He has vast experience in Desktop as well as Cloud software development involving CAD, CAM, complex visualization, mathematics and geometric algorithms. He has been actively working with Autodesk Vertical, Research and Fusion 360 teams. His current areas of interest are Generative Modeling and Machine Learning.

## co-speakers



SUBHRANSU MAJHI

Subhransu leads a research team at CCTech that develop AI-powered solutions. He has been working with CCTech for more than 7 years. He is a mechanical engineer and has worked with teams that have developed software for various domains like CFD, Computational Geometry, Genetic Algorithm, Artificial Intelligence, Augmented Reality.



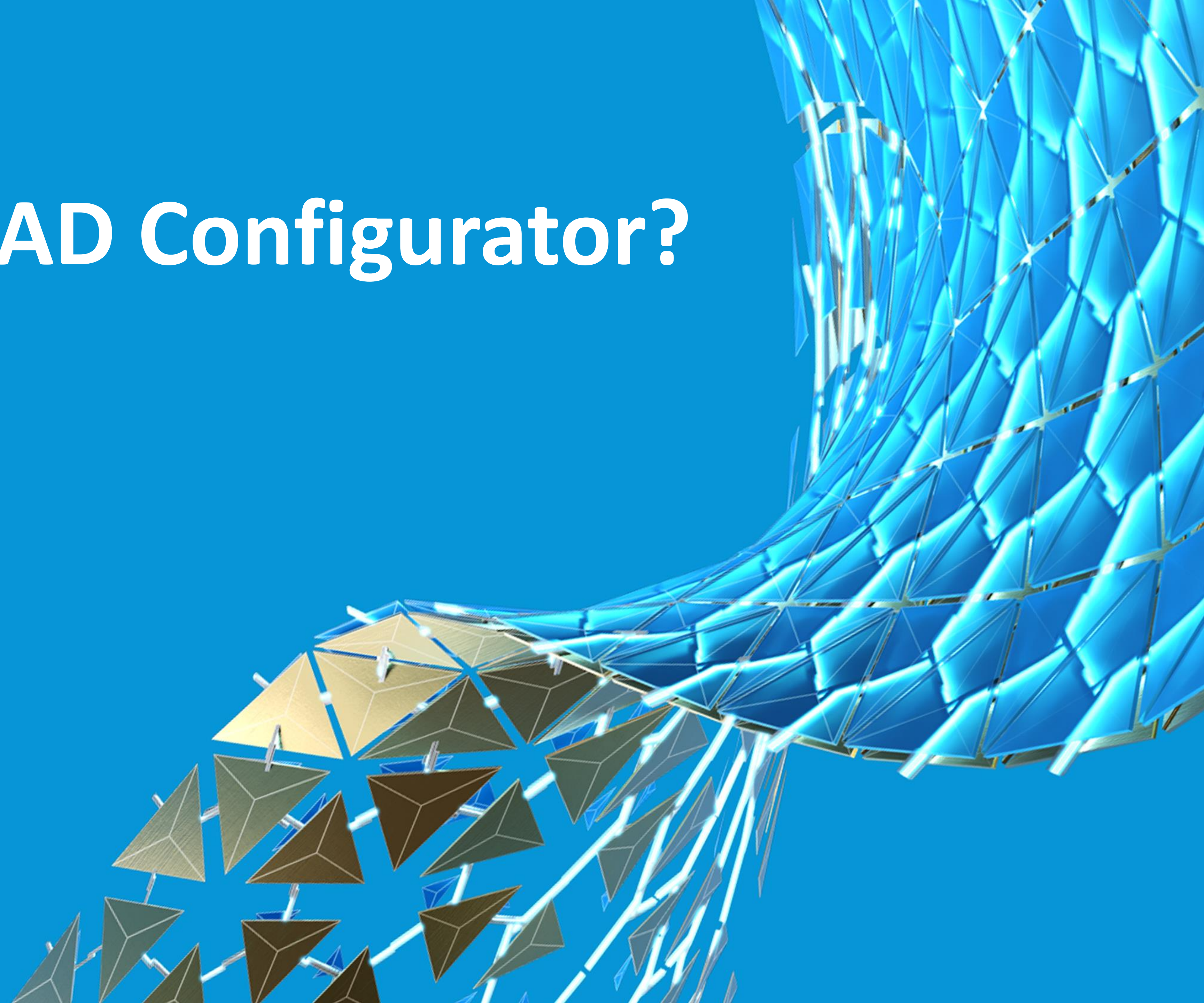
ASHISH SHETE

Ashish is a software development manager at CCTech. He has been working in the CAD development field for more than 12 years. Ashish has a master's degree in Automotive engineering. He has been part of teams that have developed CAD and PLM applications for maritime, oilfield, and manufacturing domains. Ashish's areas of interest are visualization, computational geometry, web-based 3D applications and automated testing.

# Outline

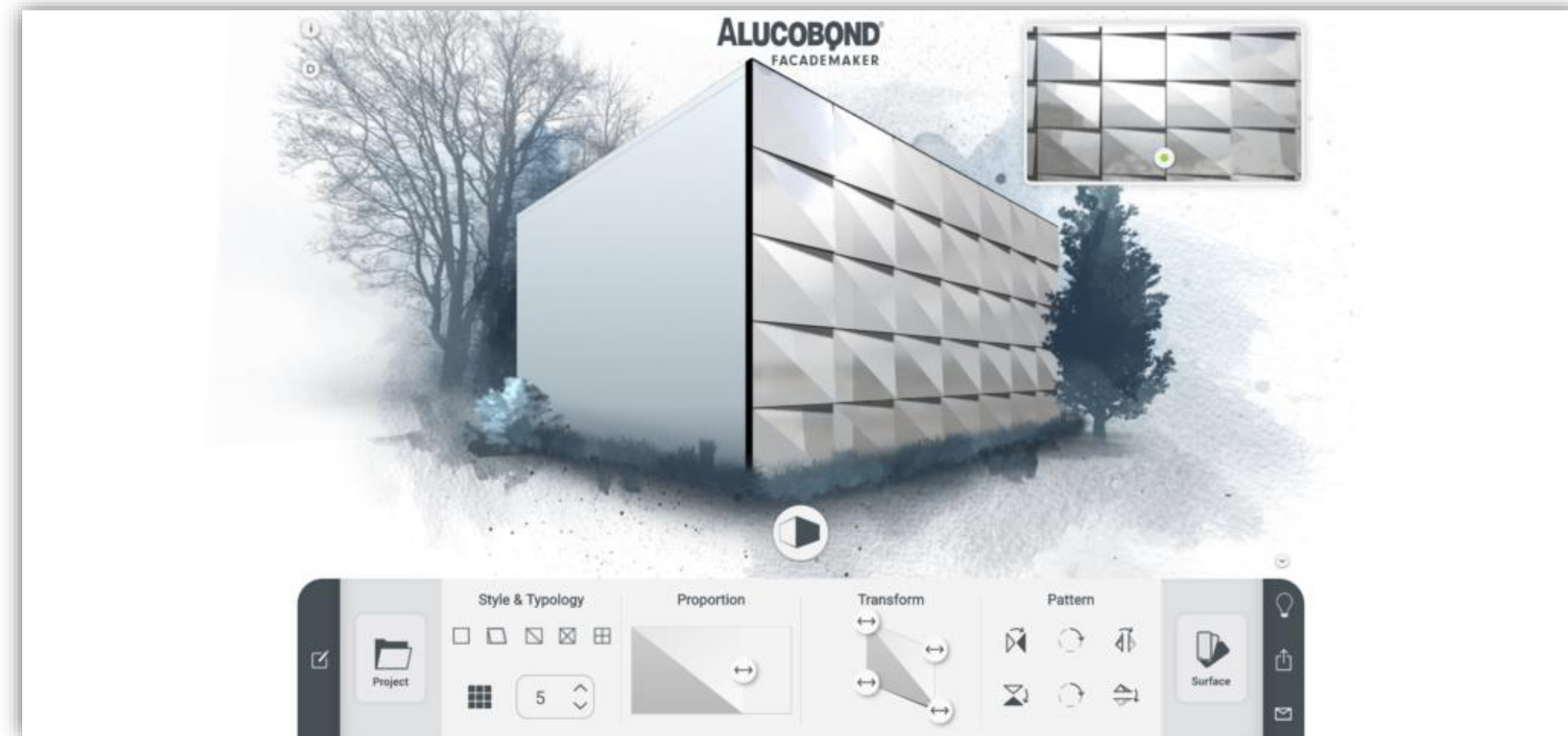
- **CAD Configurator?**
- **Need for a Configurator**
- **Fable of developing a configurator**
  - Stage 1 – Design automation on desktop
  - Stage 2 – Moving to Cloud
  - Stage 3 – Shift to Autodesk Forge Platform
  - Stage 4 – Massively scalable web based configurator
- **Case Study**

# What is a CAD Configurator?

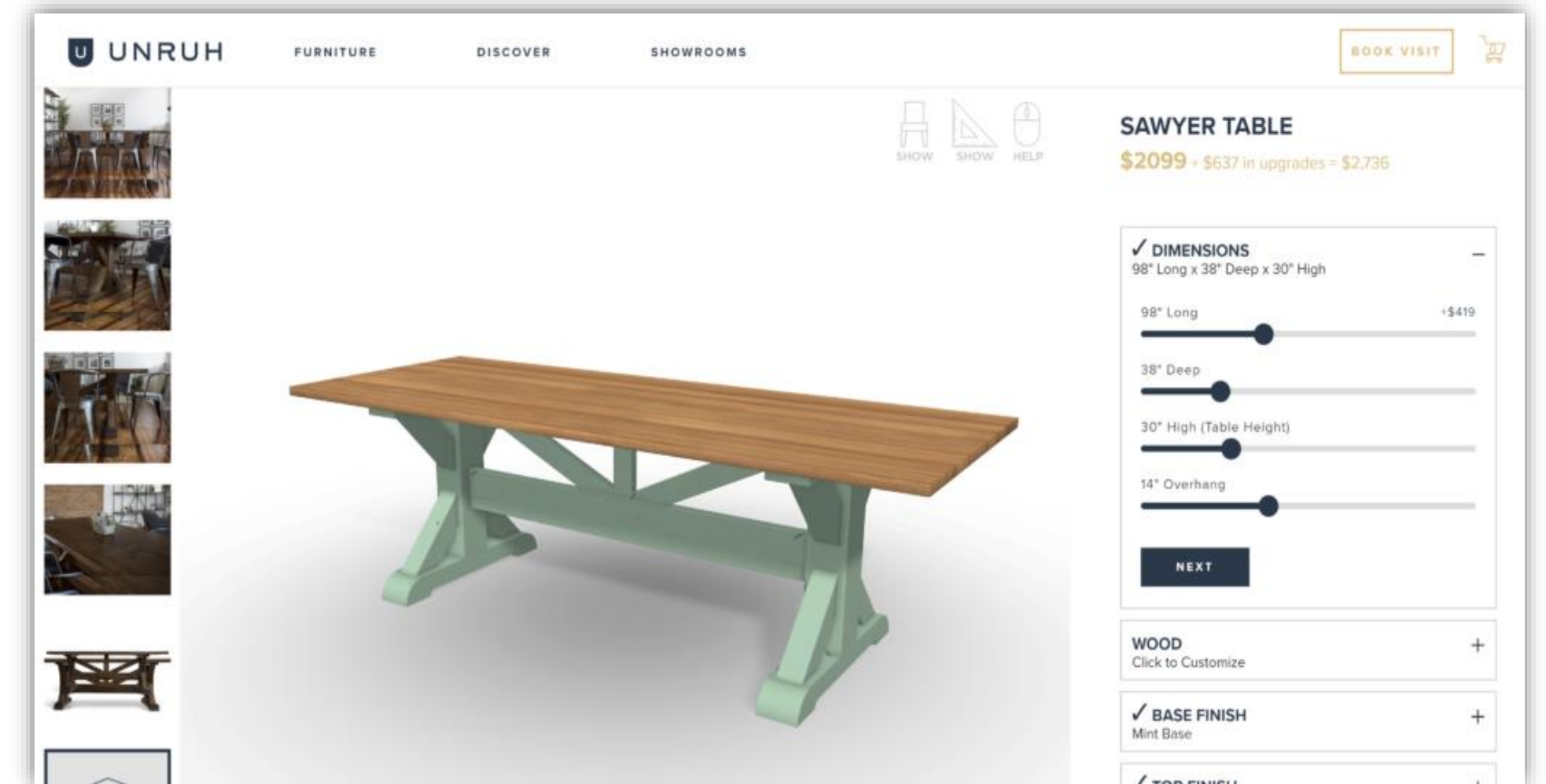


# What are product configurators?

MARKETING



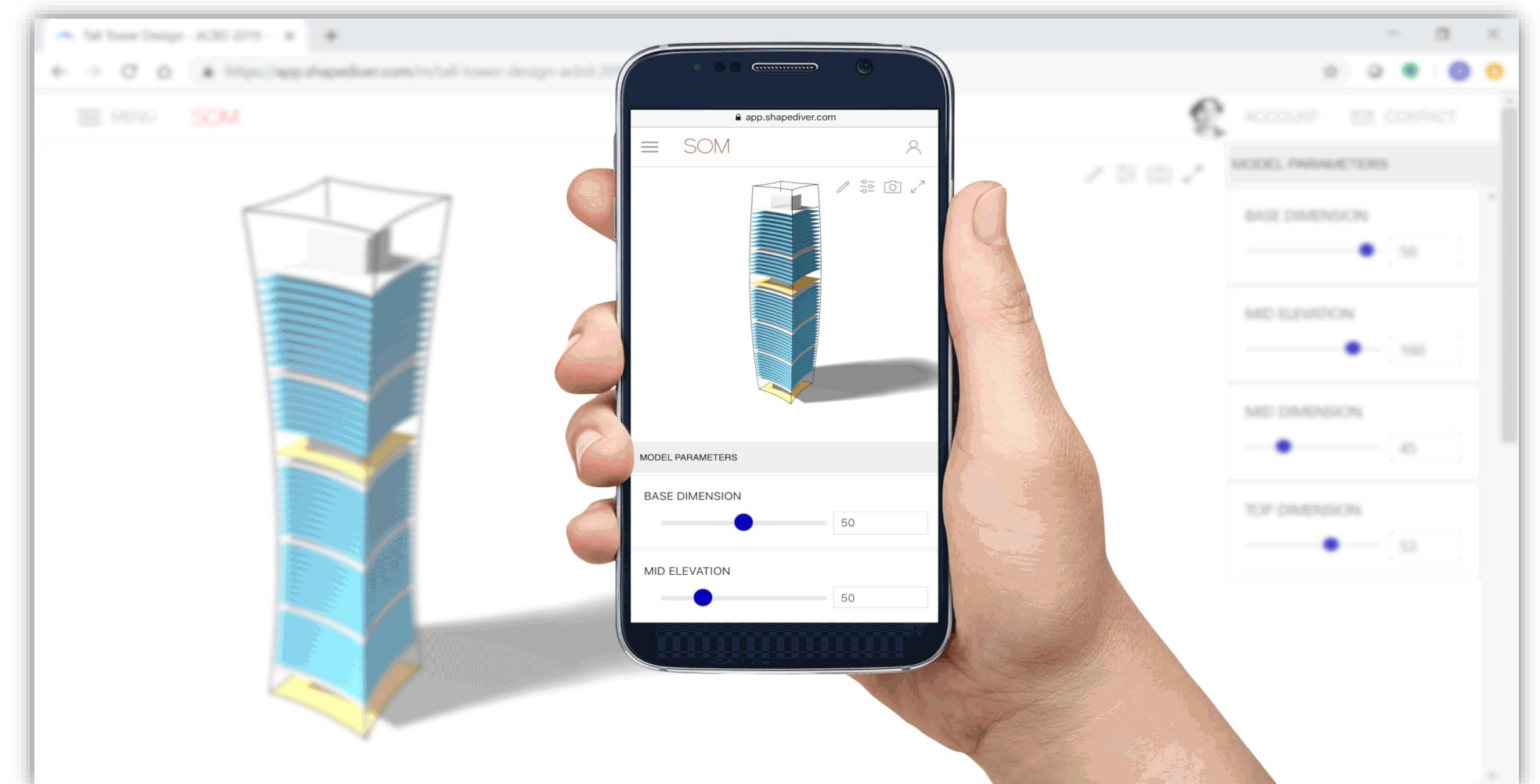
COMMERCIAL



TECHNICAL

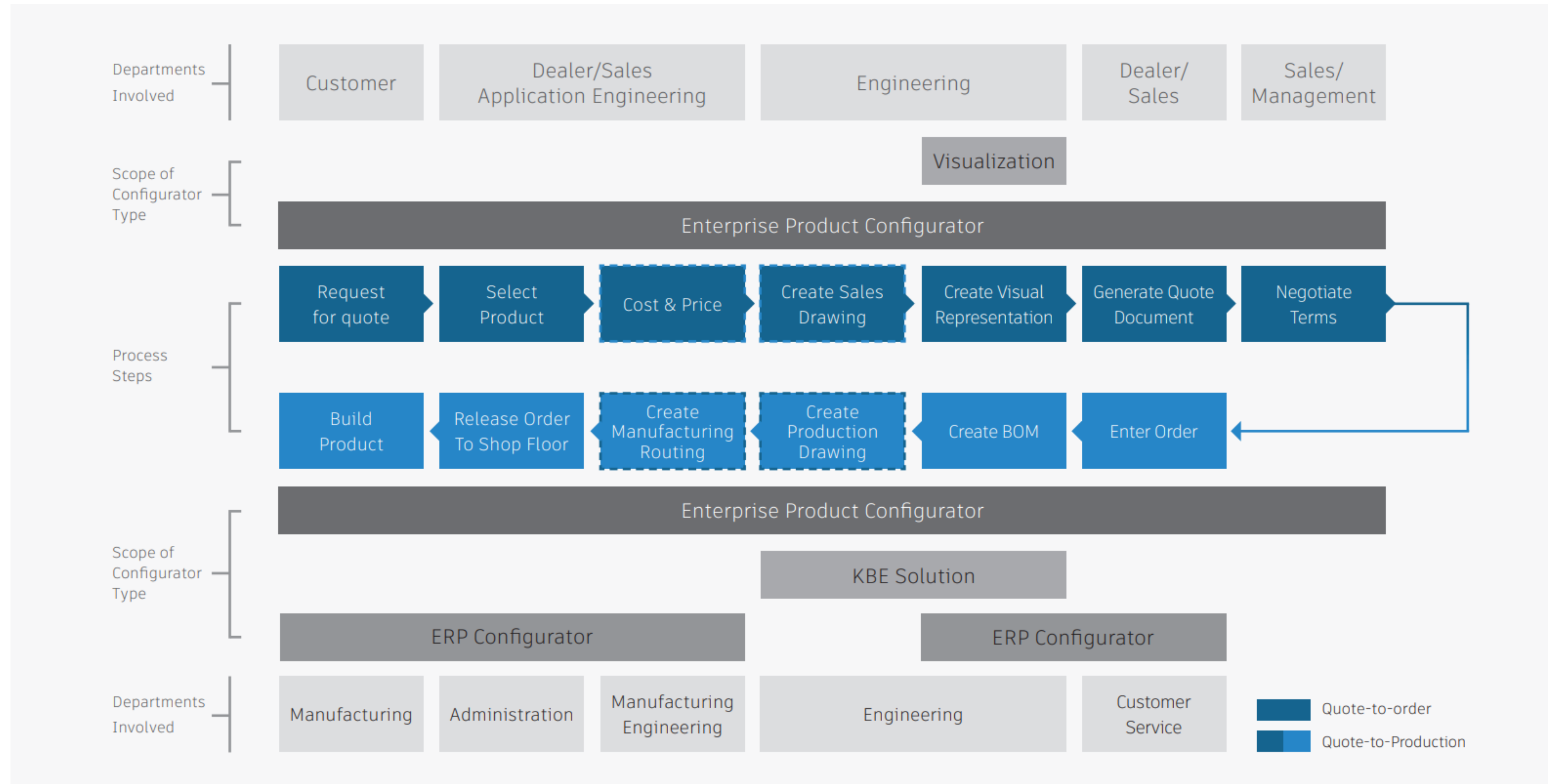


INTERNAL



# Types of configurators

- Knowledge based Engineering solutions
- ERP configurator modules
- Product visualization solutions
- Enterprise product configurators



# Why do we need configurators?



Reduce quotation  
lead times



Reduce order  
lead times



Reduce costs

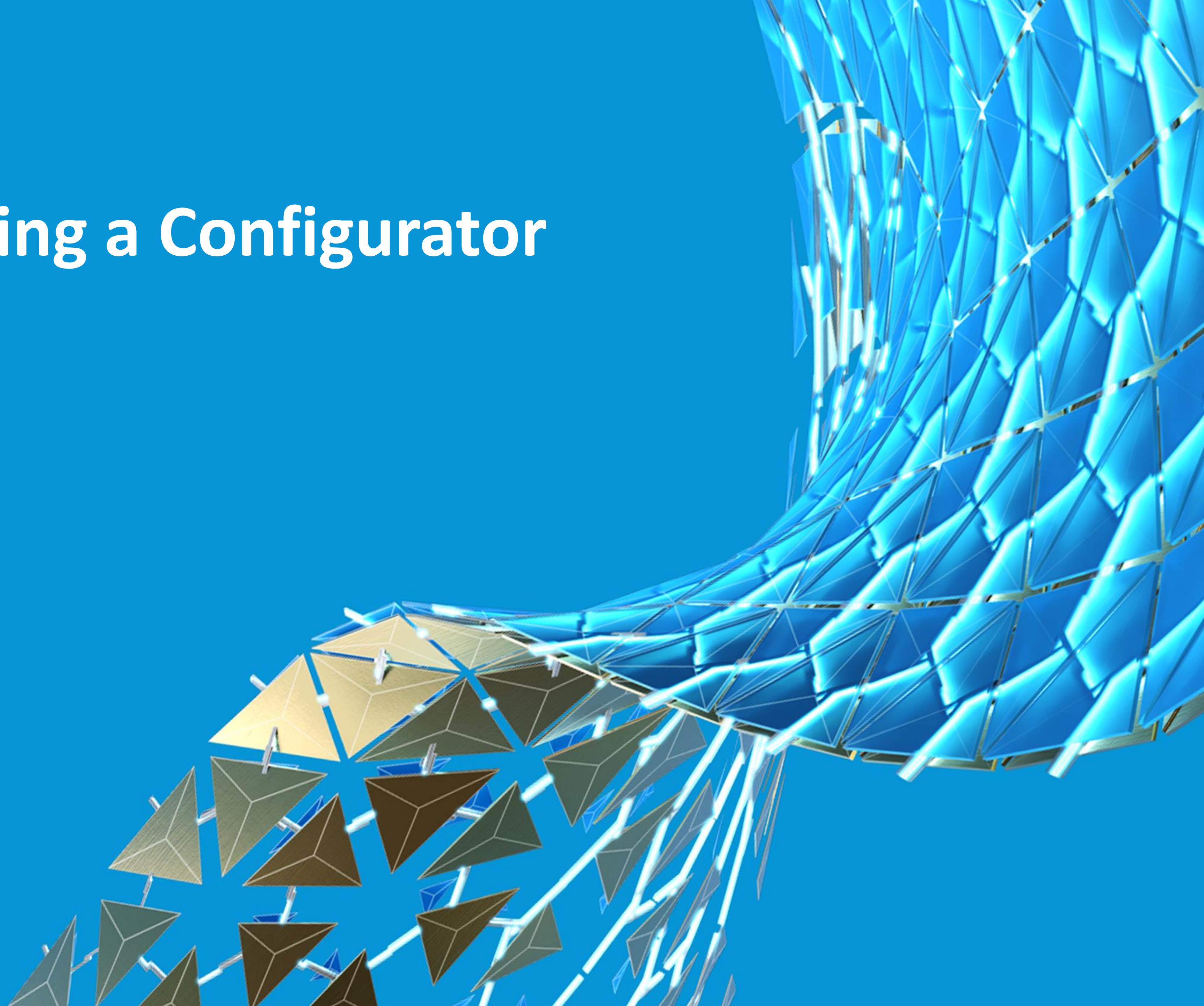


Grow market  
size



Eliminate errors  
and rework

# Fable of developing a Configurator



# Resurrection of town of Haiti



**Haiti town needs a portable power plant. Town council asks companies to provide quick proposal.**

# Call for proposals



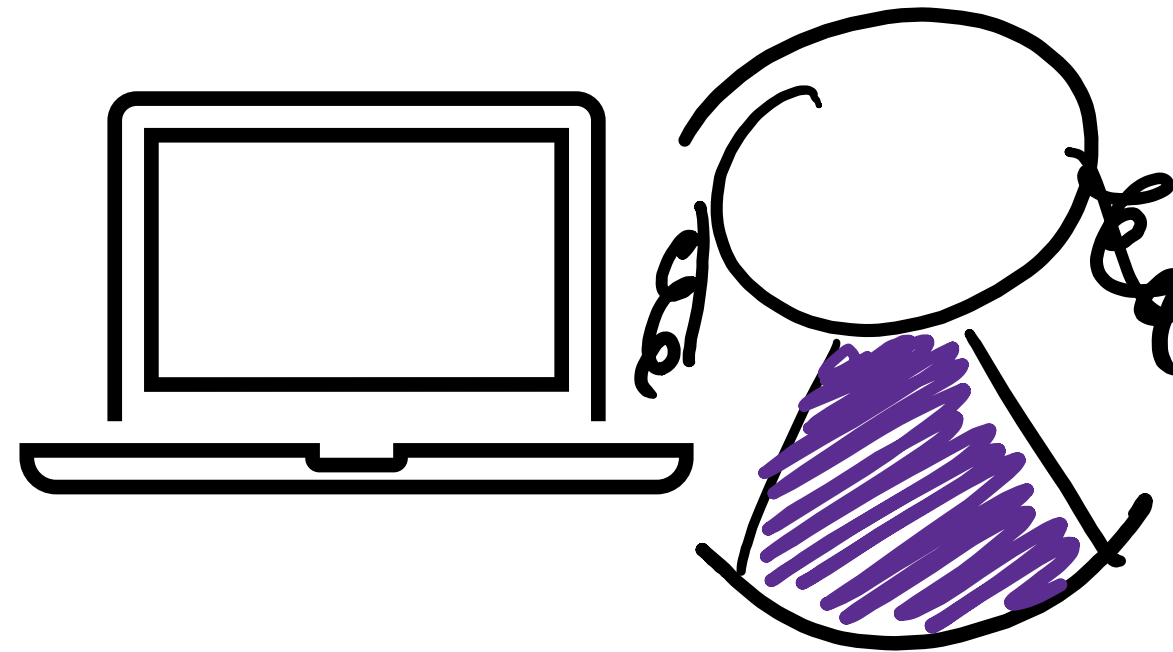
Joe at PAT Dynamics visits Haiti and submits a proposal, but before submission, some errors happen due to which rework is needed.

# Deal lost



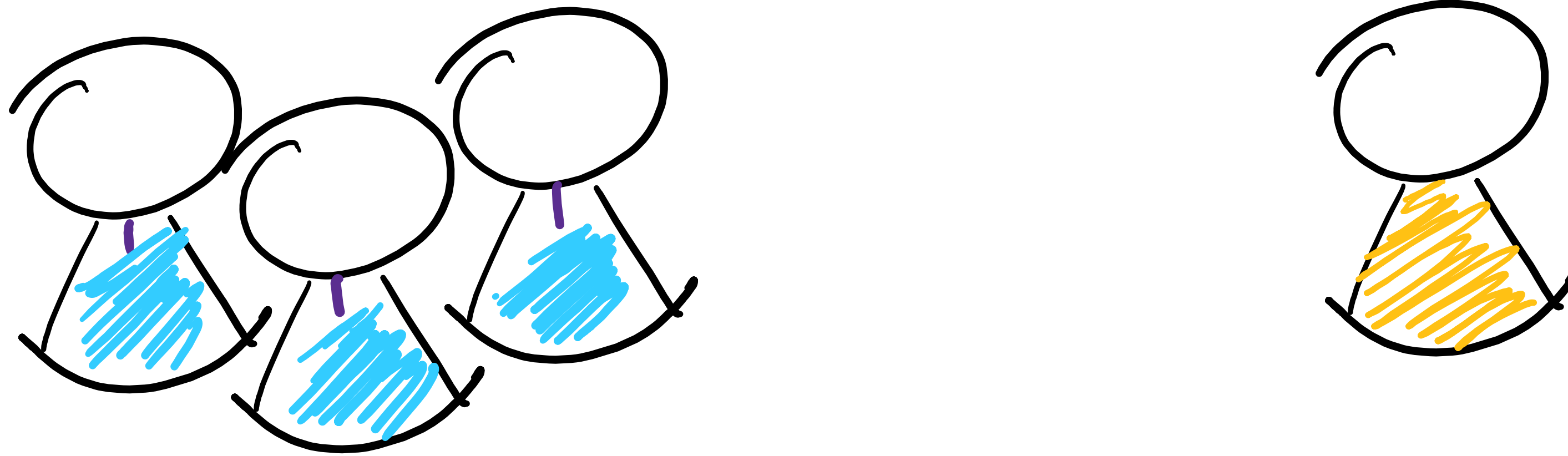
**Rework does not happen in time and Joe loses the deal.**

# Who wins the deal?



**Samantha of Future corporation wins the deal as she had a product configurator on her laptop**

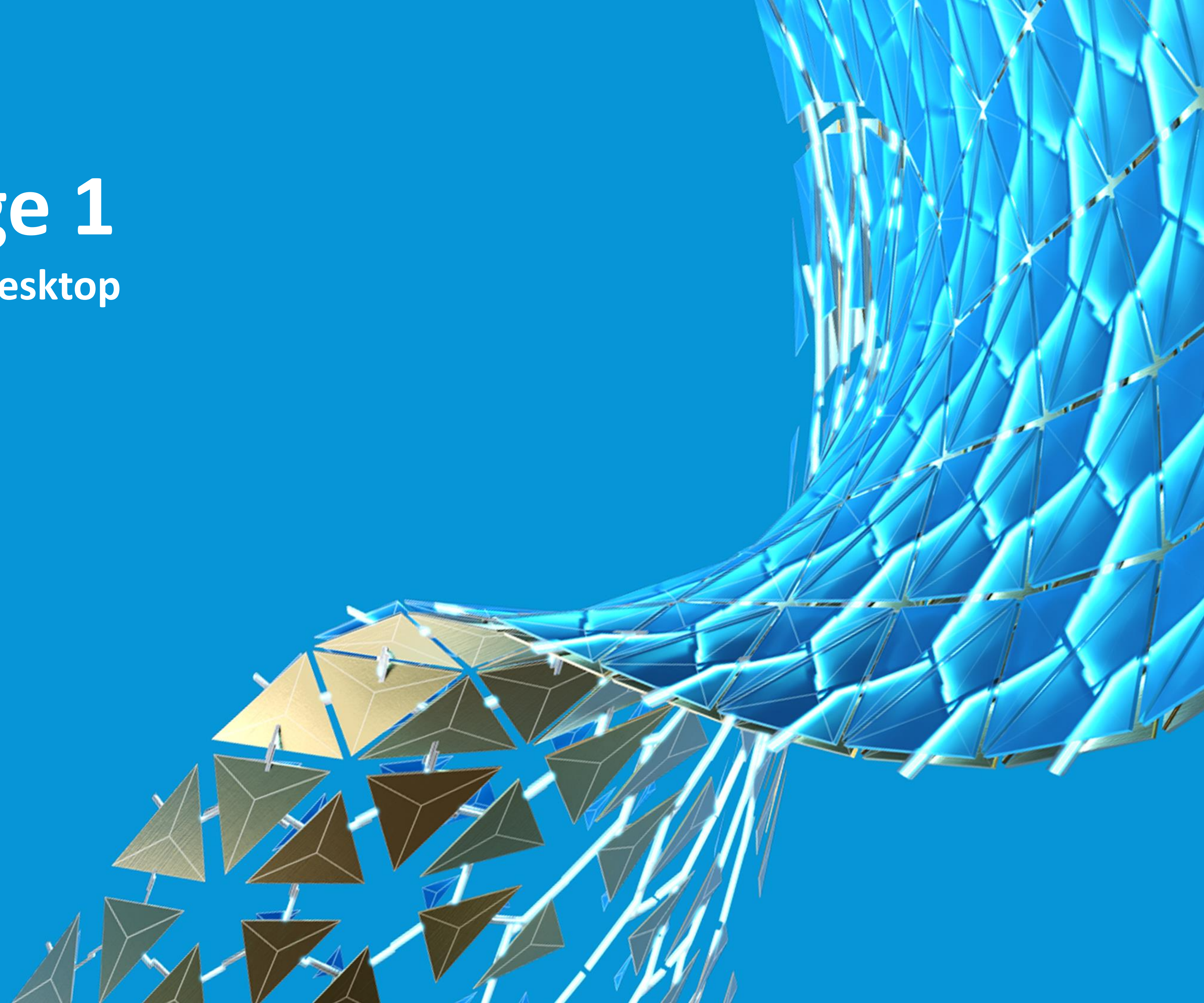
# How to win future deals?

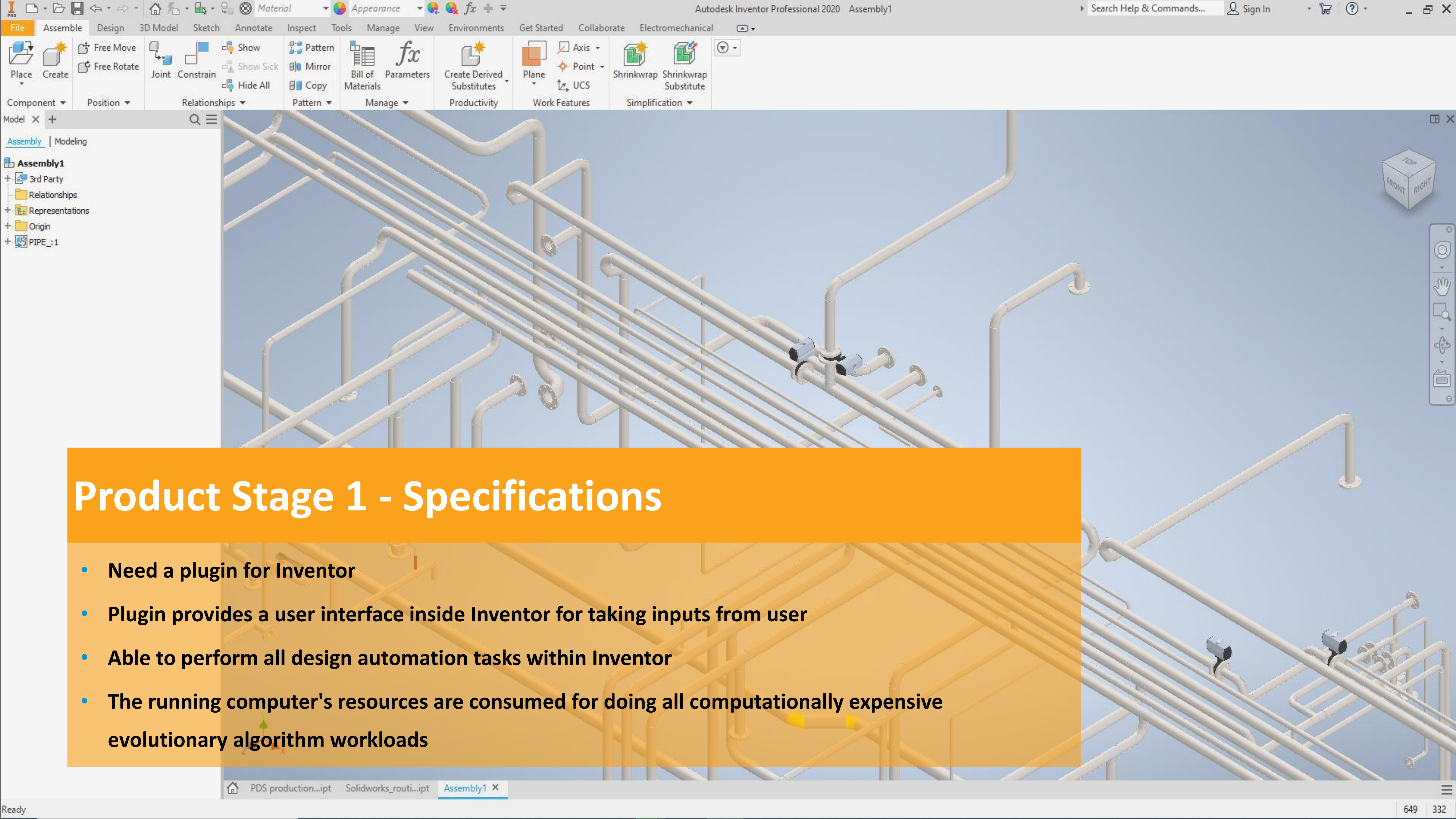


Joe discusses with his higher management to invest in creating a configurator, so that they can send quick and error free proposals in future

# Product Stage 1

Design Automation on Desktop





# Product Stage 1 - Specifications

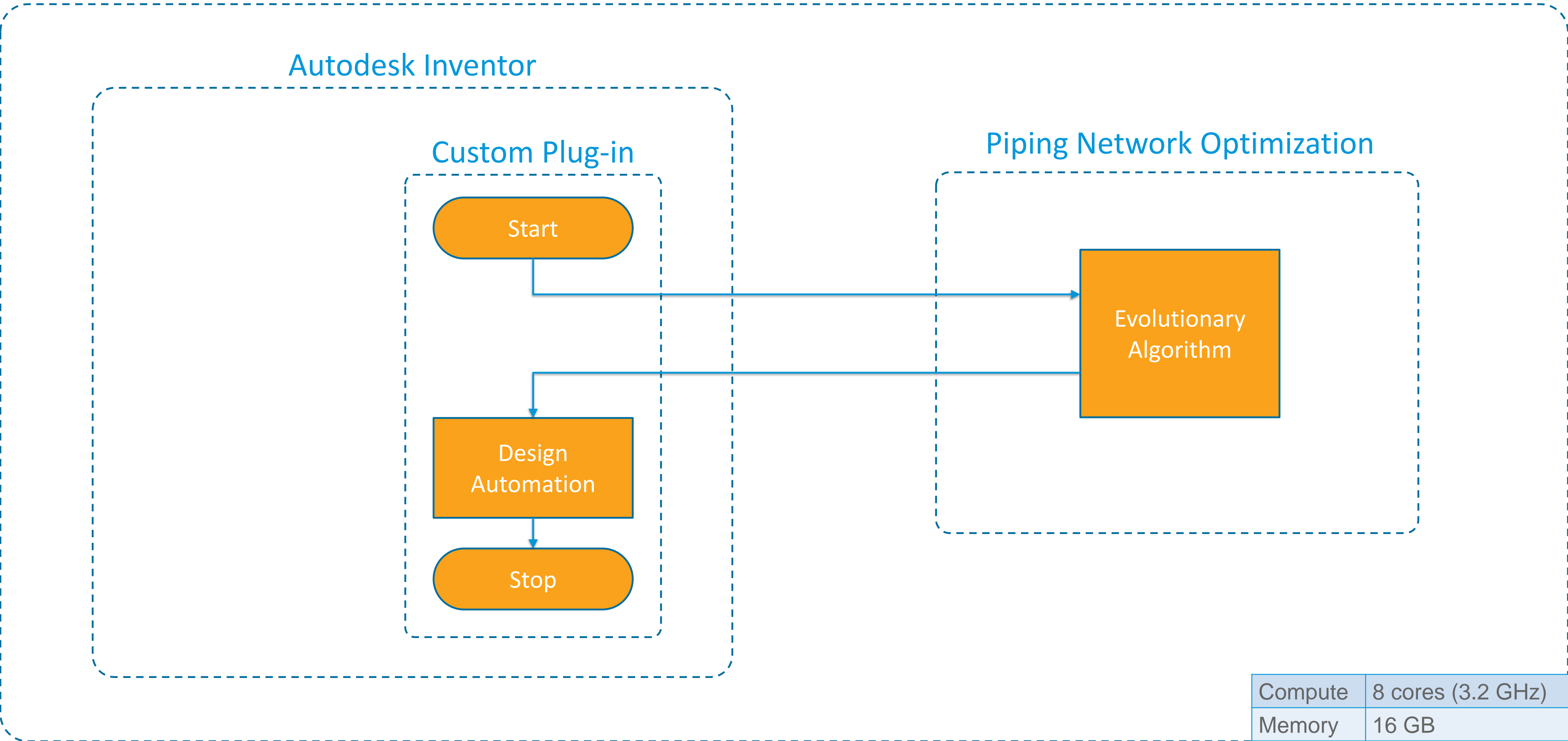
- **Need a plugin for Inventor**
- **Plugin provides a user interface inside Inventor for taking inputs from user**
- **Able to perform all design automation tasks within Inventor**
- **The running computer's resources are consumed for doing all computationally expensive evolutionary algorithm workloads**

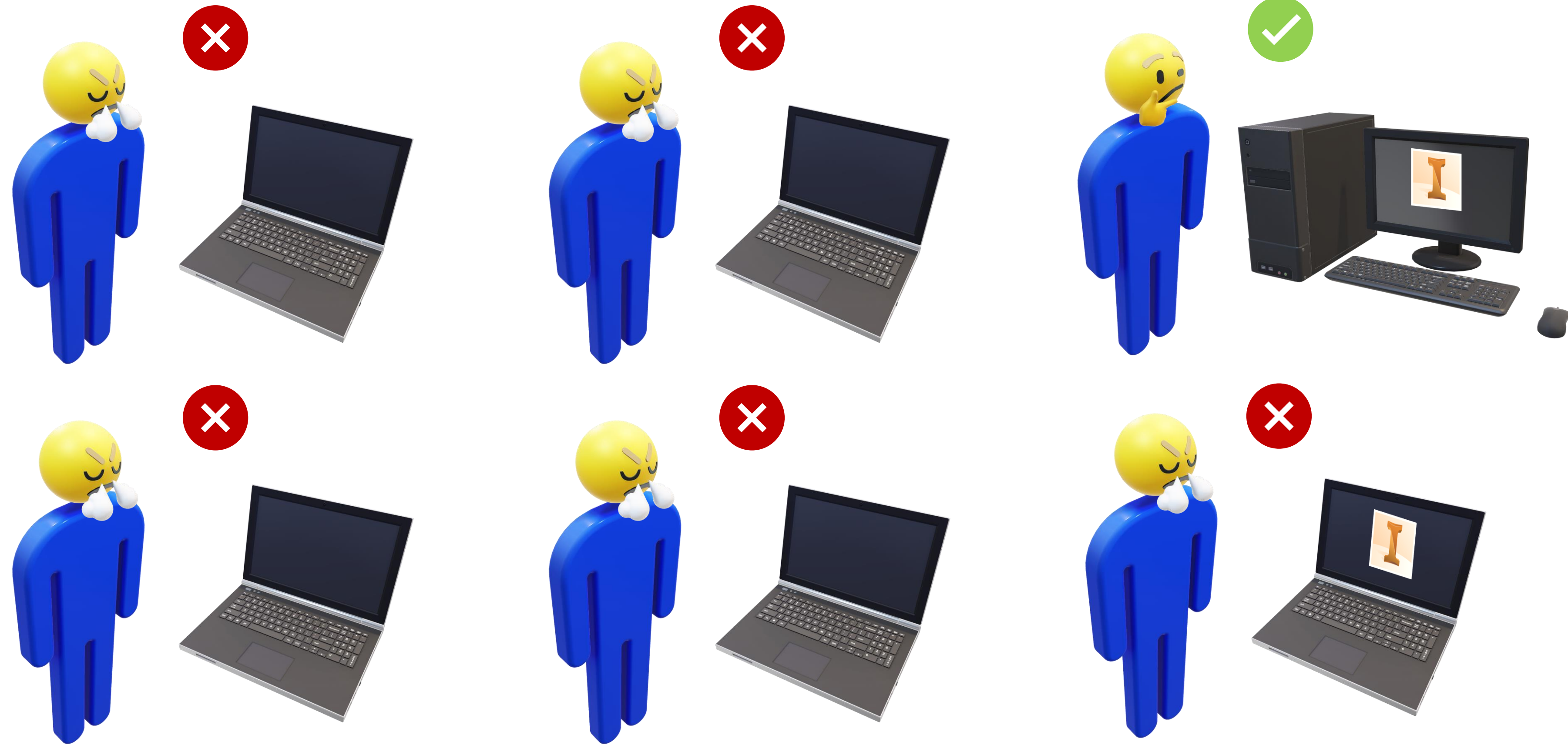
# Product Stage 1 - Benefits

- It would save a lot of time for all engineers involved in the process
- It would lead to reduction in errors as the whole process gets automated
- It would need very less knowledge to use the plugin compared to a CAD software

# Product Stage 1 – Board diagram

Design Engineer's Desktop PC





## Product Stage 1 – Still there are limitations

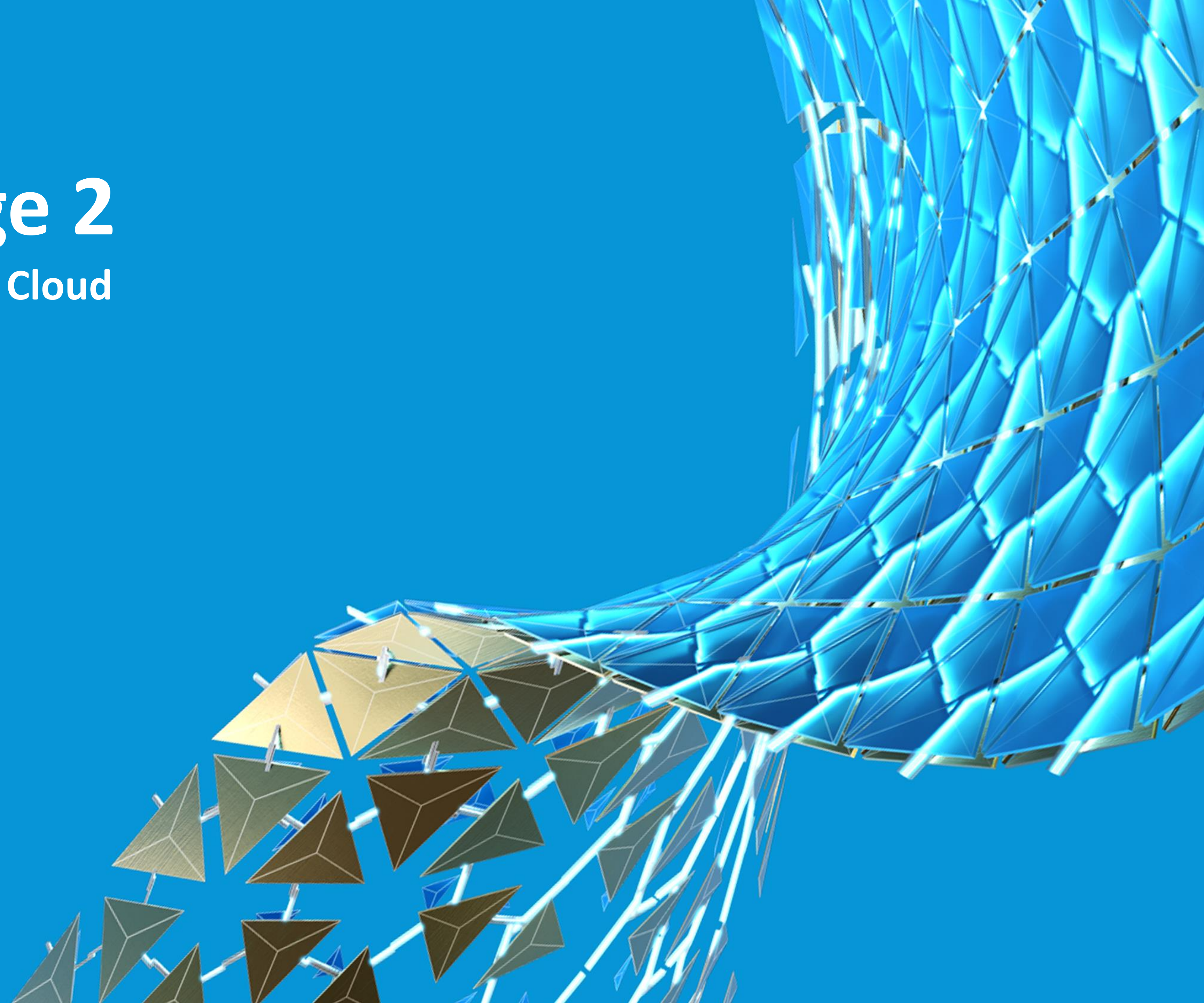
- The computer on which the plugin will be used has to be upgraded as that it can run the non-CAD computationally expensive optimization workloads
- Optimization jobs take somewhere around 6-24 hours

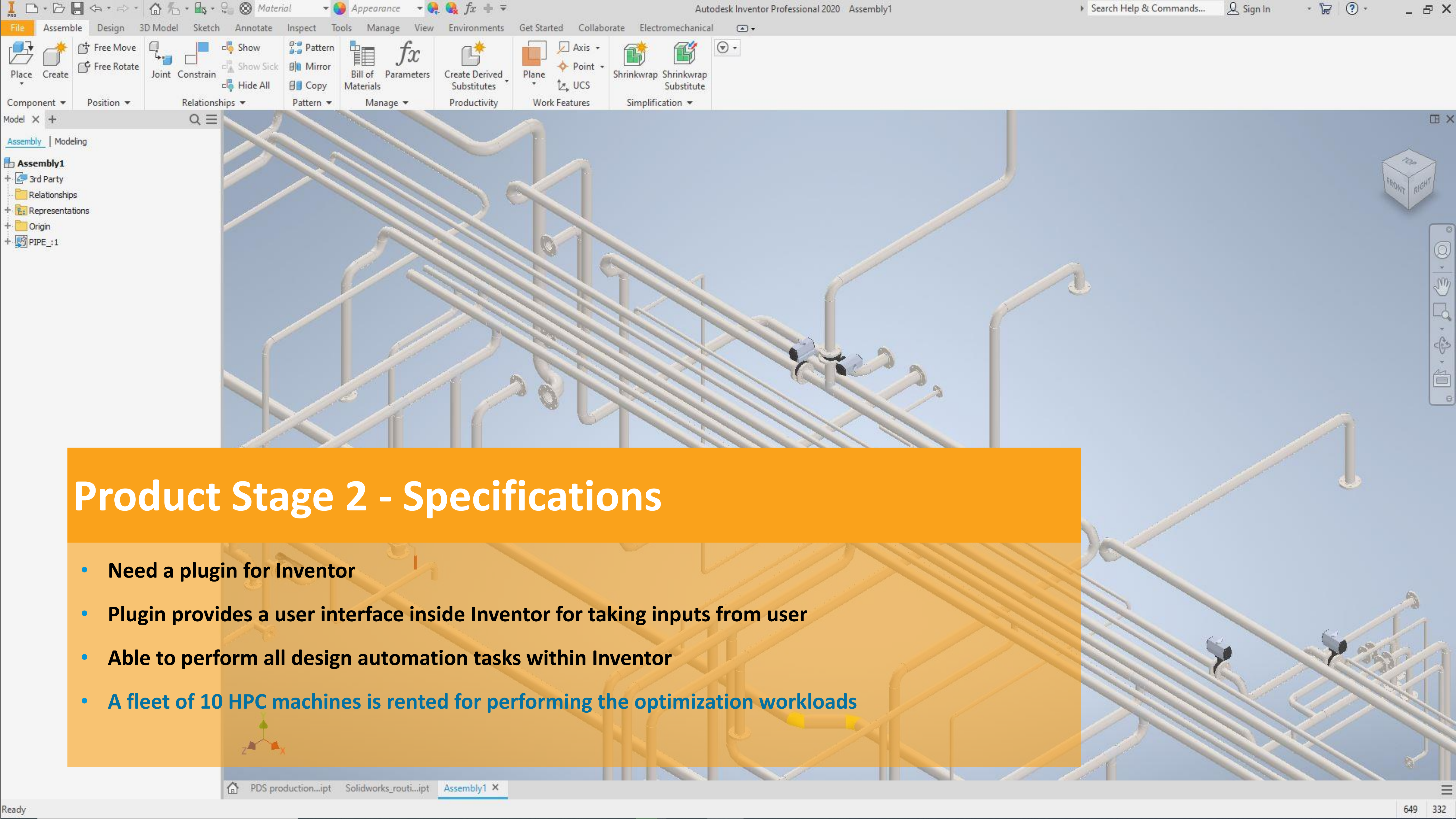
# Product Stage 1 - What to do next

**There is a need to run the optimization workloads on HPC machines to reduce the time consumption**

# Product Stage 2

Partial movement to the Cloud





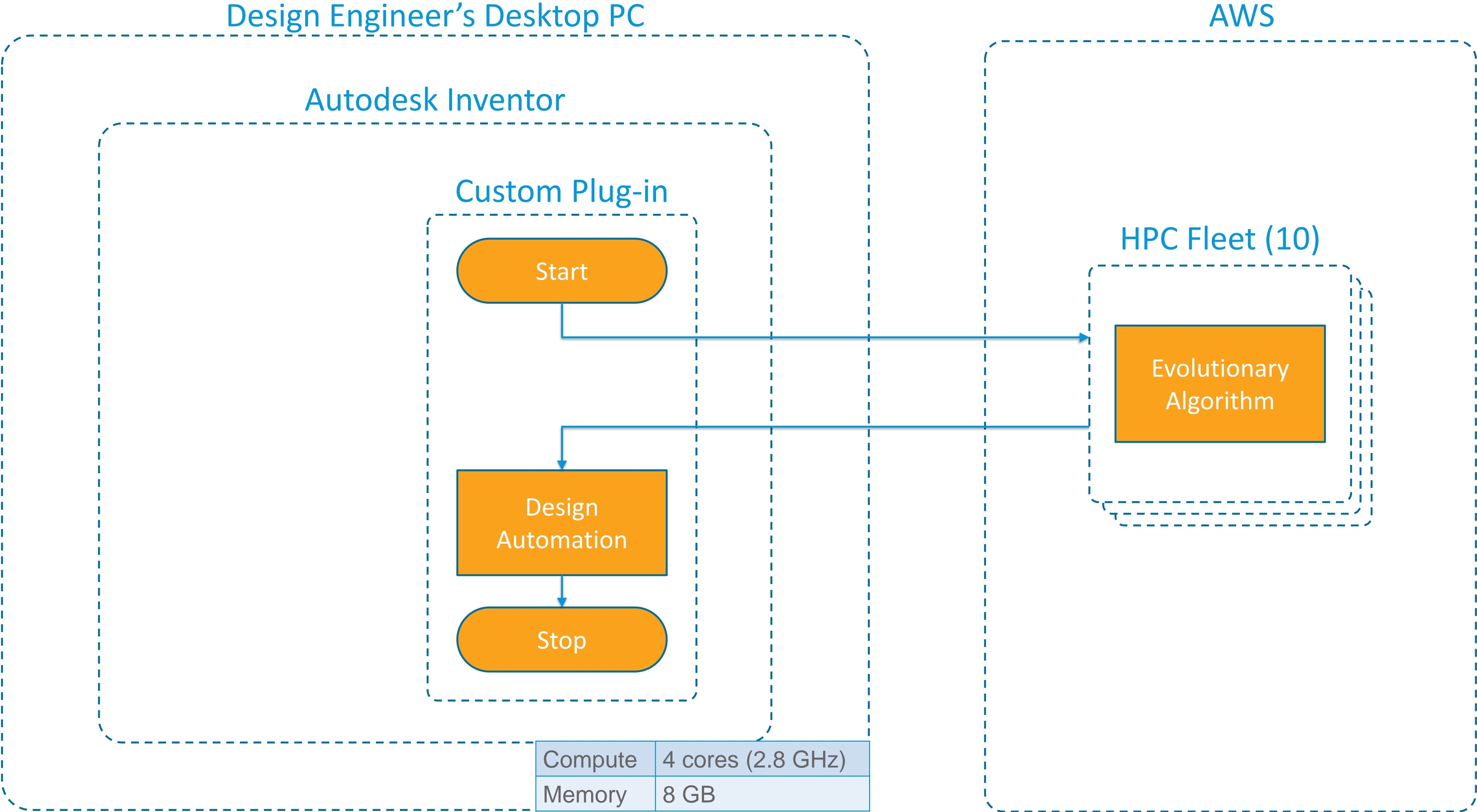
## Product Stage 2 - Specifications

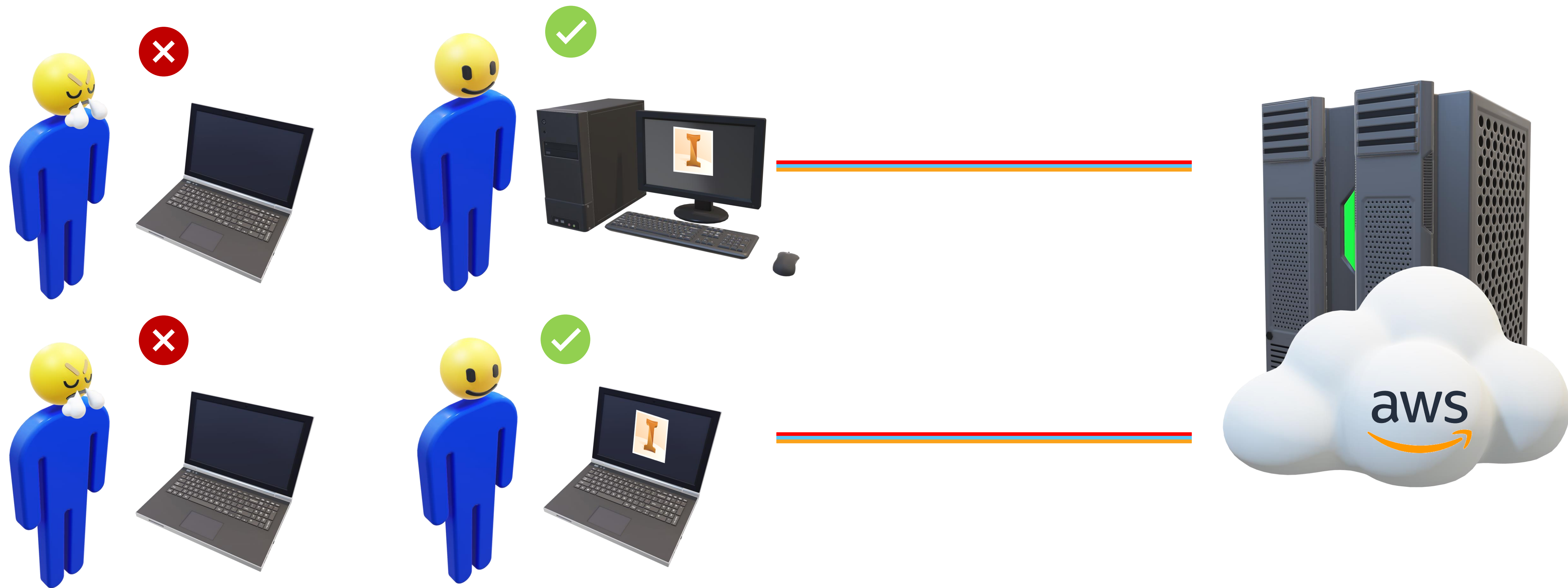
- Need a plugin for Inventor
- Plugin provides a user interface inside Inventor for taking inputs from user
- Able to perform all design automation tasks within Inventor
- A fleet of 10 HPC machines is rented for performing the optimization workloads

# Product Stage 2 - Benefits

- It would save a lot of time for all engineers involved in the process
- It would lead to reduction in errors as the whole process gets automated
- It would need very less knowledge to use the plugin compared to a CAD software
- **It would now take between 30 mins to 2 hours for the optimization jobs to complete**
- **Now the users can run this application from medium configuration laptops as well**

# Product Stage 2 – Board diagram





## Product Stage 2 – Still there are limitations

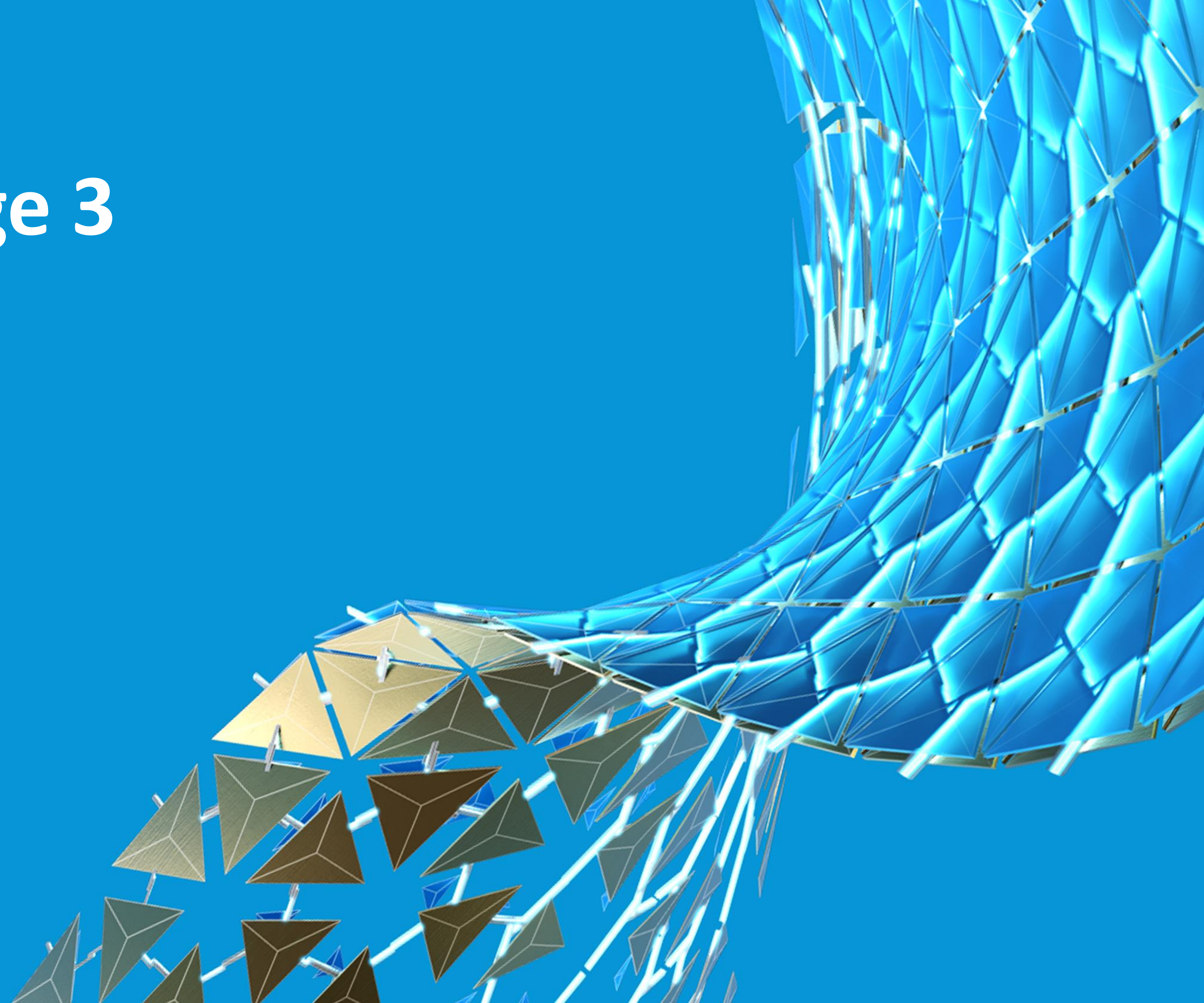
- Due to limited licenses of CAD software, only a few employees from the design department would be able to use the customized application
- Due to lack of database, data management is purely a manual process

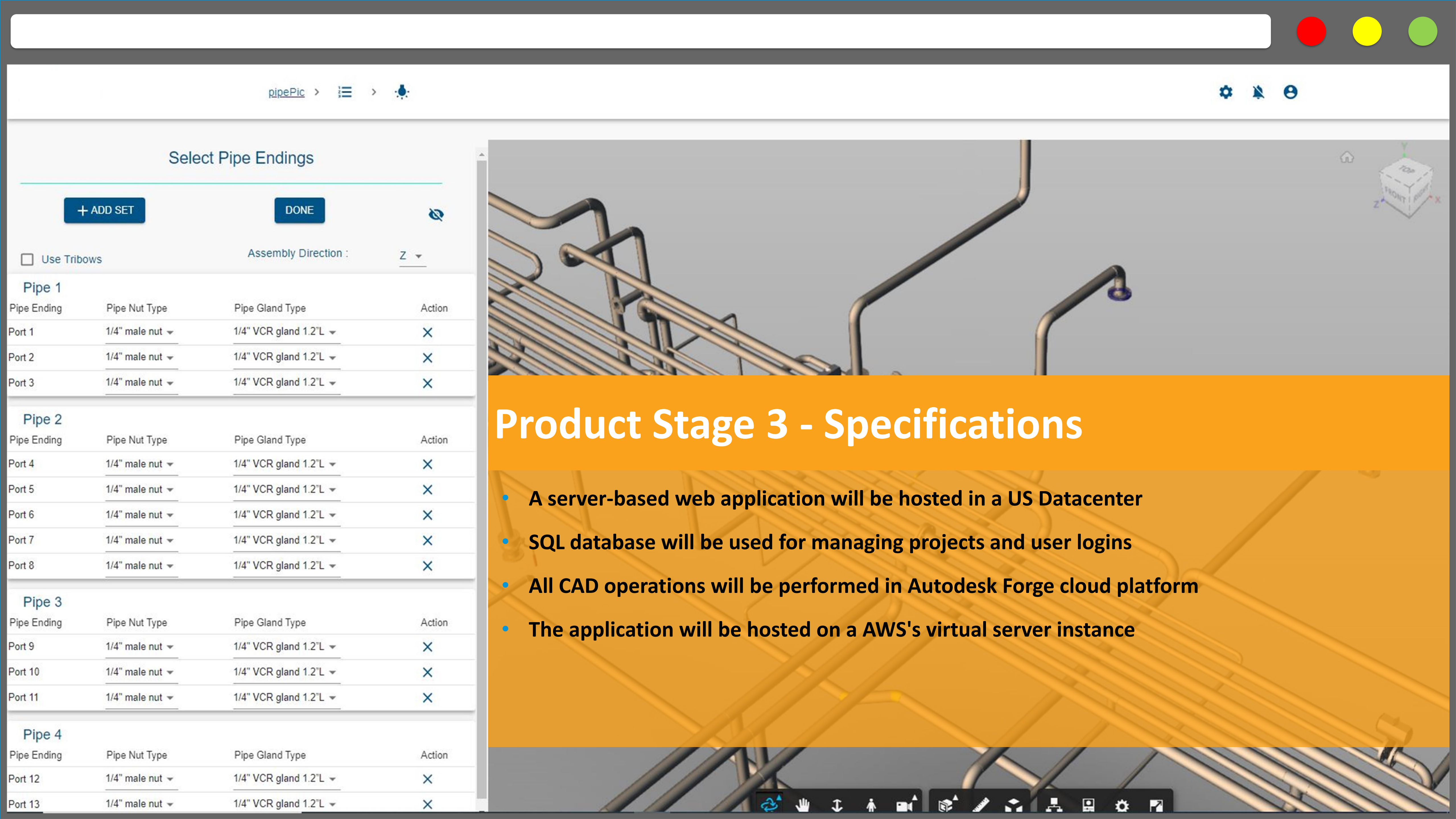
# Product Stage 2 – What to do next!

- There is a need to run the optimization workloads on HPC machines to reduce the time consumption
- Every employee of the organization should have access to CAD configurators
- The app needs to be free from CAD licensing limits

# Product Stage 3

Shift to Forge Platform





Select Pipe Endings

+ ADD SET      DONE     

☐ Use Tribows      Assembly Direction :      Z ▼

Pipe 1

Pipe Ending	Pipe Nut Type	Pipe Gland Type	Action
Port 1	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 2	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 3	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕

Pipe 2

Pipe Ending	Pipe Nut Type	Pipe Gland Type	Action
Port 4	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 5	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 6	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 7	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 8	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕

Pipe 3

Pipe Ending	Pipe Nut Type	Pipe Gland Type	Action
Port 9	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 10	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 11	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕

Pipe 4

Pipe Ending	Pipe Nut Type	Pipe Gland Type	Action
Port 12	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
Port 13	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕

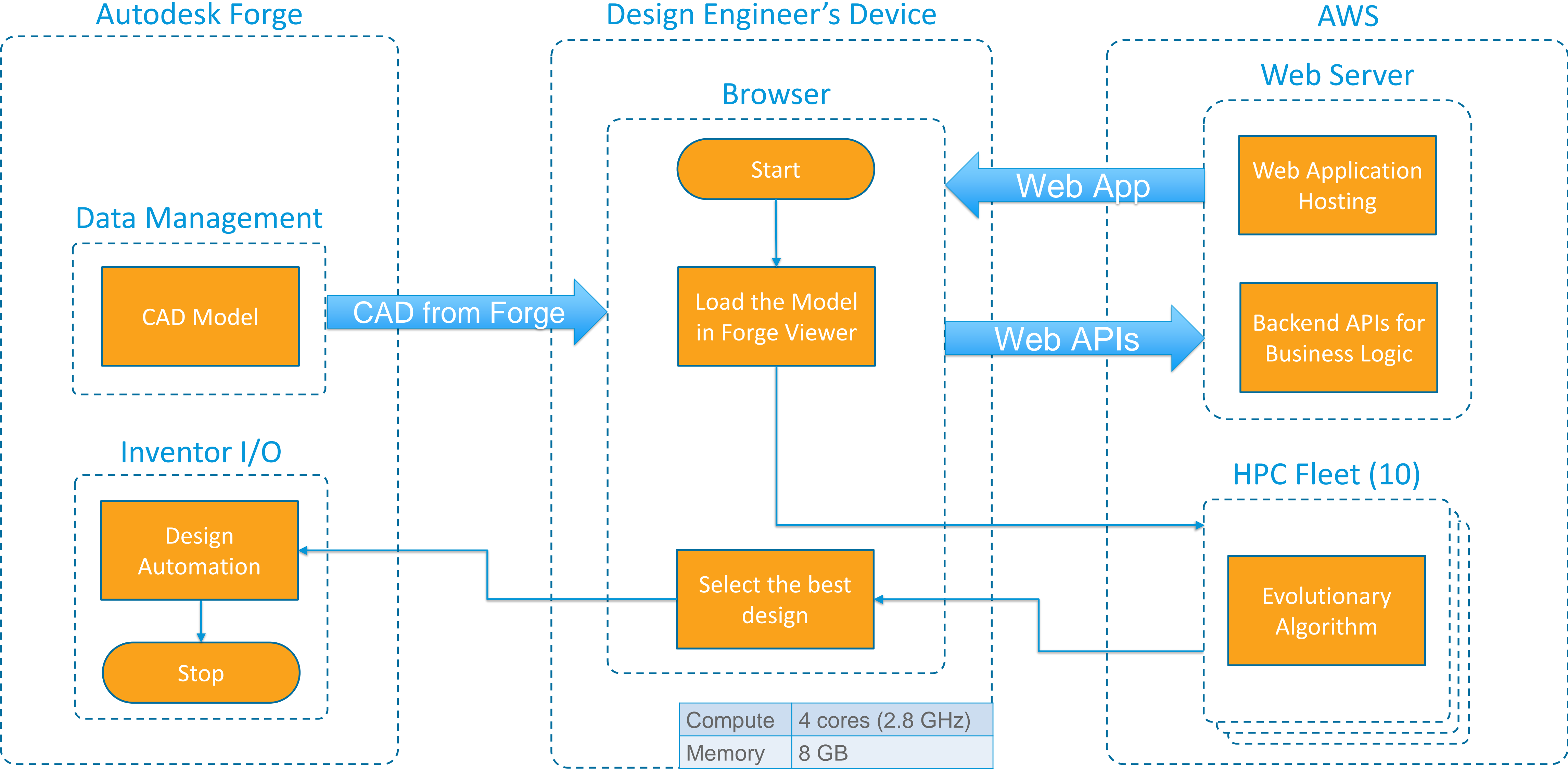
# Product Stage 3 - Specifications

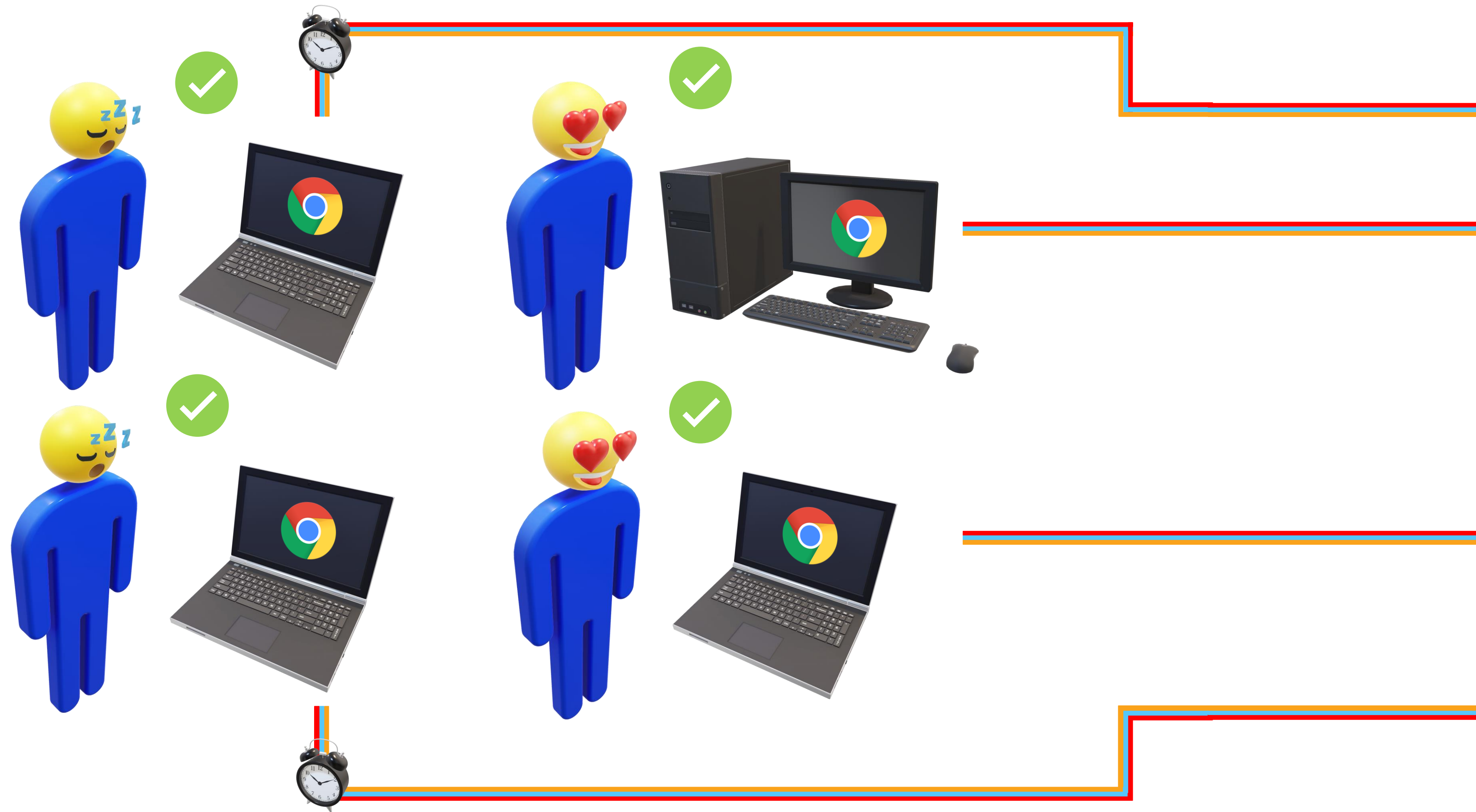
- A server-based web application will be hosted in a US Datacenter
- SQL database will be used for managing projects and user logins
- All CAD operations will be performed in Autodesk Forge cloud platform
- The application will be hosted on a AWS's virtual server instance

# Product Stage 3 - Benefits

- It would save a lot of time for all engineers involved in the process
- It would lead to reduction in errors as the whole process gets automated
- It would need very less knowledge to use the plugin compared to a CAD software
- It would take between 30 mins to 2 hours for the optimization jobs to complete
- Now the users can run this application from Tablets and Phones as well
- All employees of the organization can access the application

# Product Stage 3 – Board diagram





## Product Stage 3 – Still there are limitations

- Since Autodesk Forge allows as much as CAD operations to be done simultaneously and the web application is now accessible to a larger audience, the optimization jobs now get queued up on the 10 cloud HPC instances

# Product Stage 3 – Still there are limitations

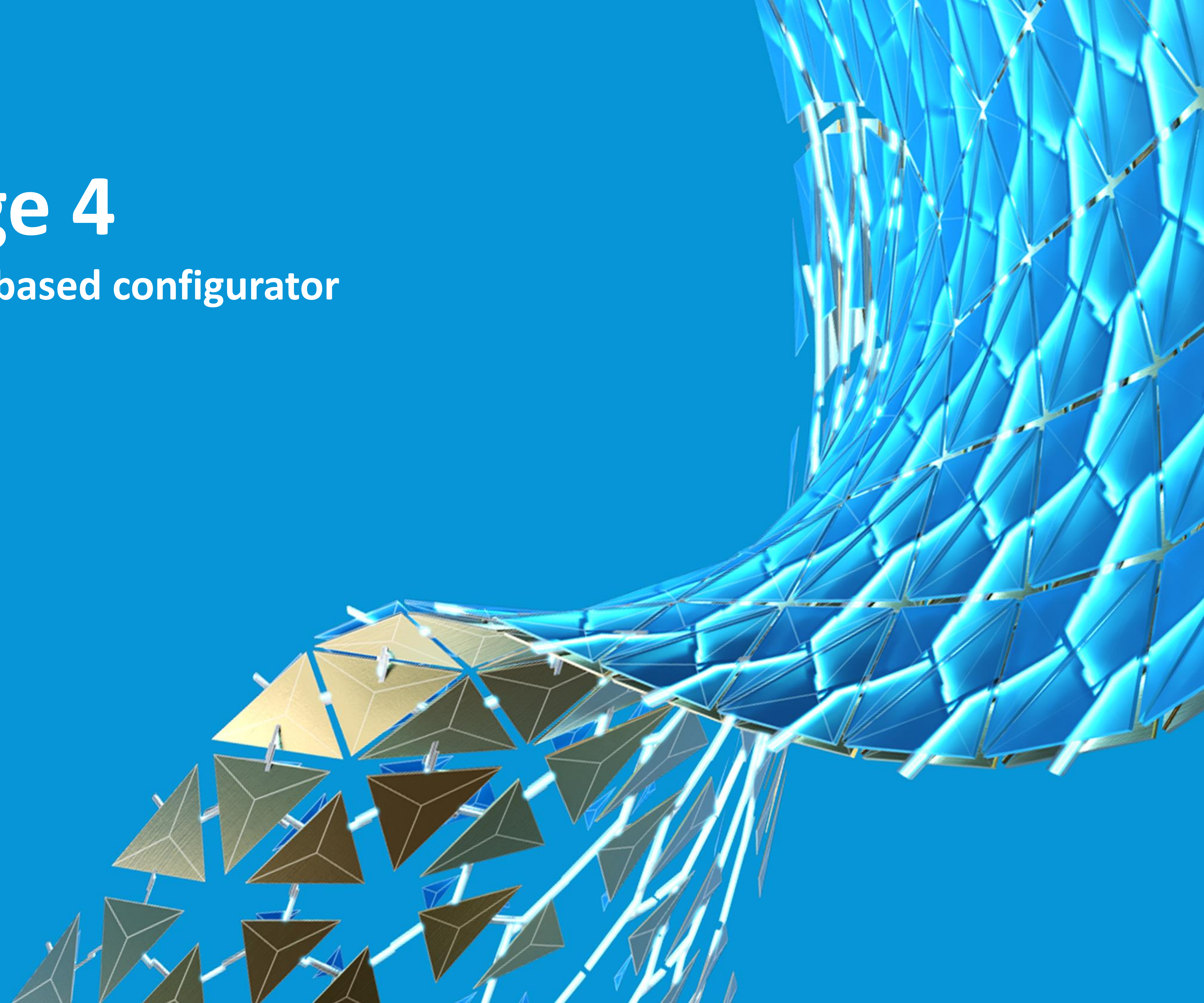
- Since Autodesk Forge allows as much as CAD operations to be done simultaneously and the web application is now accessible to a larger audience, the optimization jobs now get queued up on the 10 cloud HPC instances
- At the peak hours of productivity as per office timings, the web server gets overloaded with extensive usage of the application
- Since the web server is hosted at an USA based datacenter, the web application response is good within USA. But its performance degrades from oversea office locations.
- Database backup and restore becomes a system admin's manual activity
- There is downtime whenever the server machine is being upgraded or when it crashes

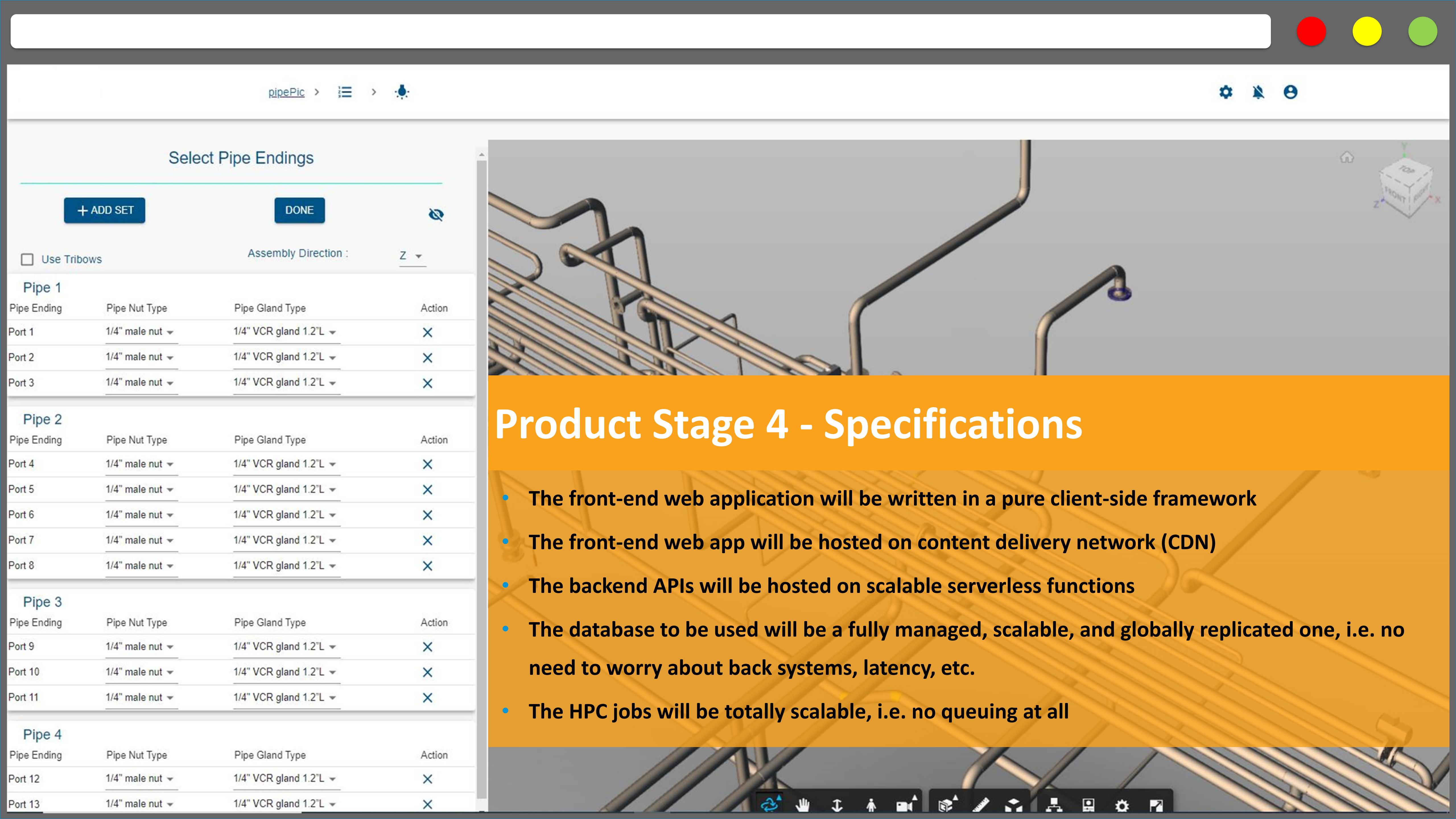
# Product Stage 3 – What to do next!

- There is a need to run the optimization workloads on HPC machines to reduce the time consumption
- Every employee of the organization should have access to CAD configurators
- The app needs to be free from CAD licensing limits
- **The web hosted system and HPC infrastructure needs to be also scalable**

# Product Stage 4

Massively Scalable web-based configurator





Select Pipe Endings

+ ADD SET      DONE     

☐ Use Tribows      Assembly Direction :      Z ▼

Pipe 1

Pipe Ending	Pipe Nut Type	Pipe Gland Type	Action
Port 1	1/4" male nut ▼	1/4" VCR gland 1.2"L ▼	✕
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Pipe 2

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Pipe 3

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Pipe 4

Pipe Ending	Pipe Nut Type	Pipe Gland Type	Action
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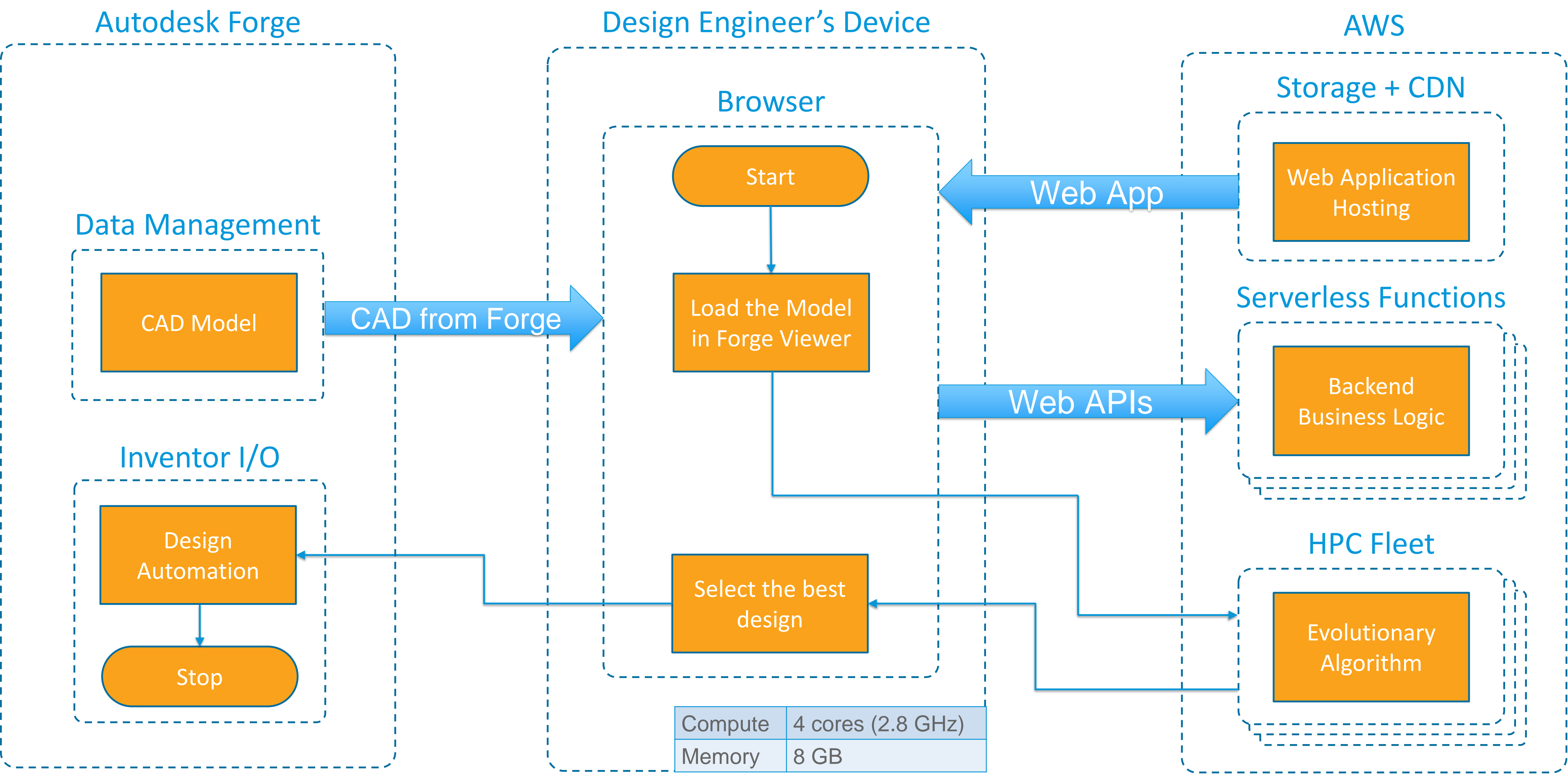
# Product Stage 4 - Specifications

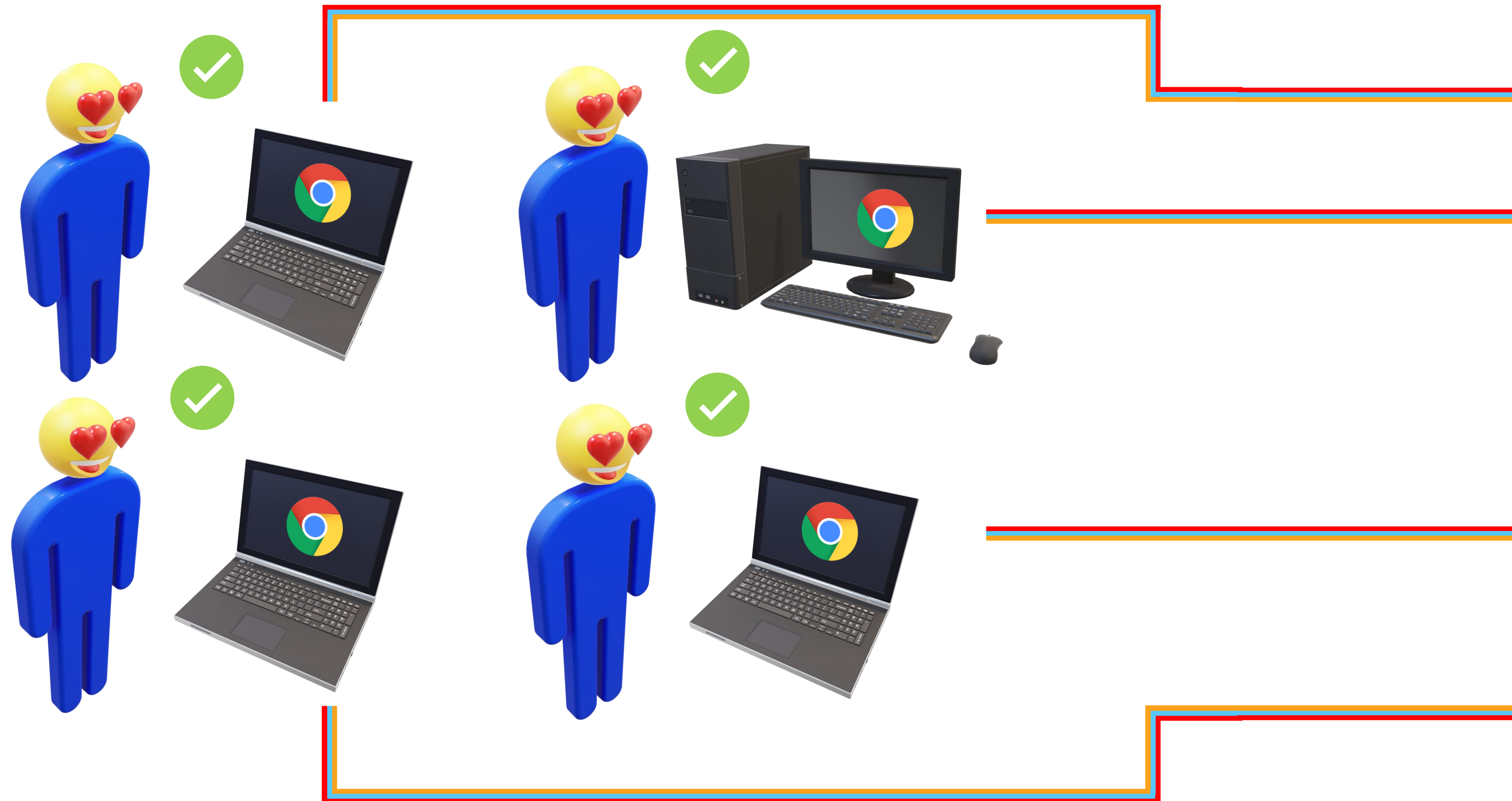
- The front-end web application will be written in a pure client-side framework
- The front-end web app will be hosted on content delivery network (CDN)
- The backend APIs will be hosted on scalable serverless functions
- The database to be used will be a fully managed, scalable, and globally replicated one, i.e. no need to worry about back systems, latency, etc.
- The HPC jobs will be totally scalable, i.e. no queuing at all

# Product Stage 4 - Benefits

- It would save a lot of time for all engineers involved in the process
- It would lead to reduction in errors as the whole process gets automated
- It would need very less knowledge to use the plugin compared to a CAD software
- It would take between 30 mins to 2 hours for the optimization jobs to complete
- The users can run this application from Tablets and Phones as well
- All employees of the organization can access the application
- There is no need to worry about backing up database
- The web app has no latency issues when accessed from any part of the globe
- Peak loads are easily handled as scaling happens in real time
- Since there is no server present, the system admin requirement goes away
- Due to fully serverless infrastructure, during nighttime, weekends, and holiday seasons, billing almost reduces to nothing
- Since most of the managed services are used, the development time of web app reduced drastically

# Product Stage 4 – Board diagram



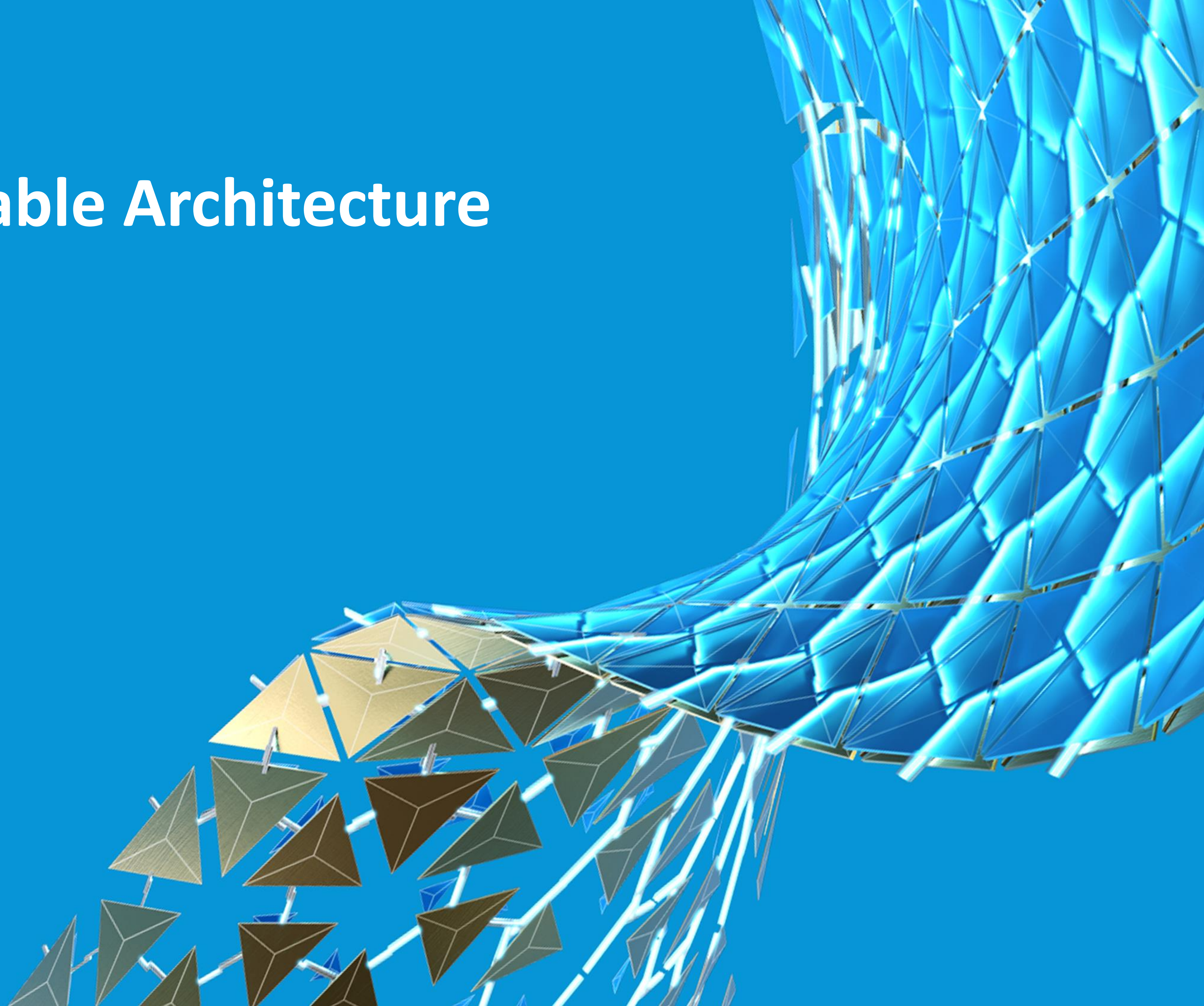


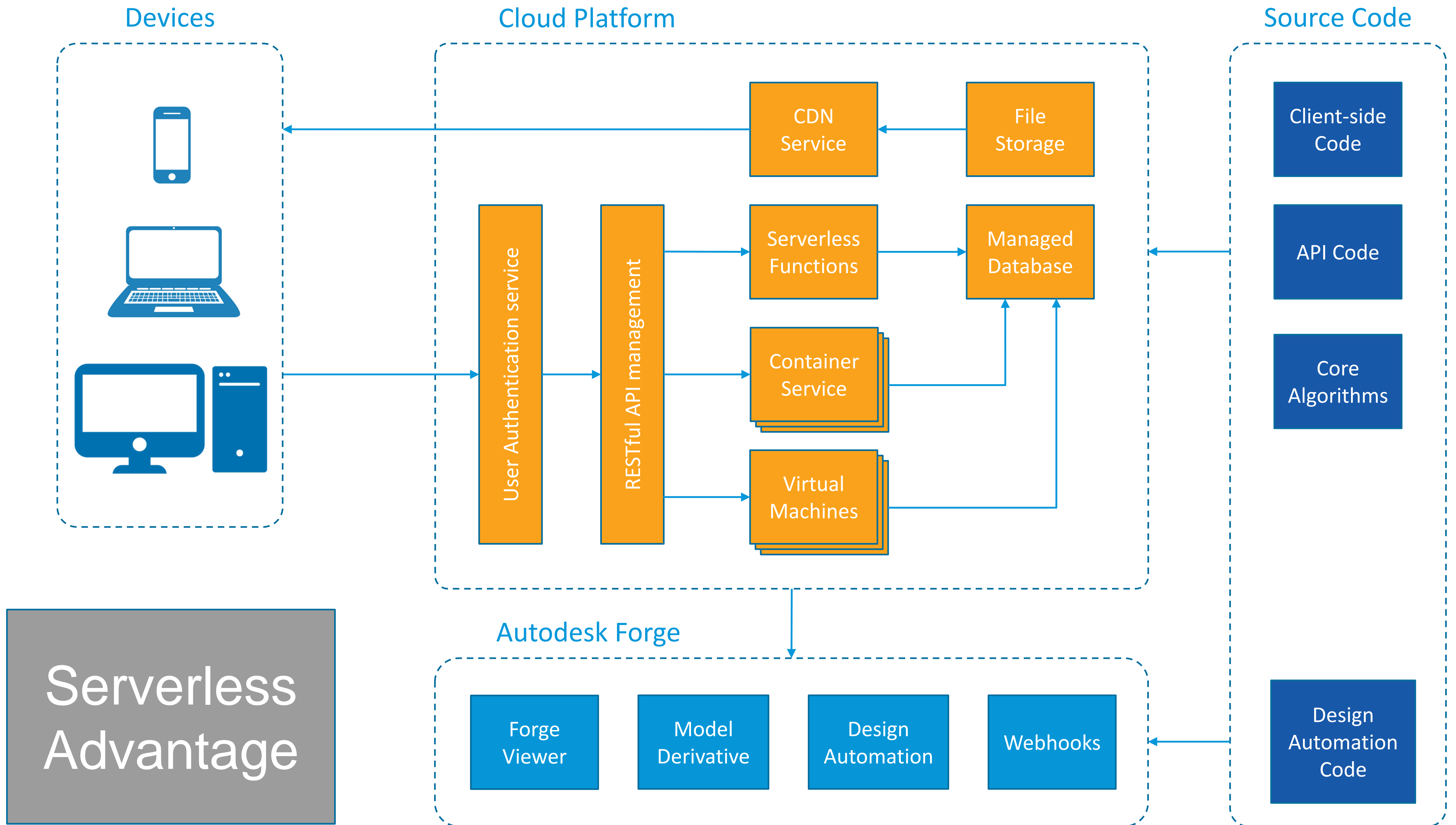
Product Stage 4 – No limitations

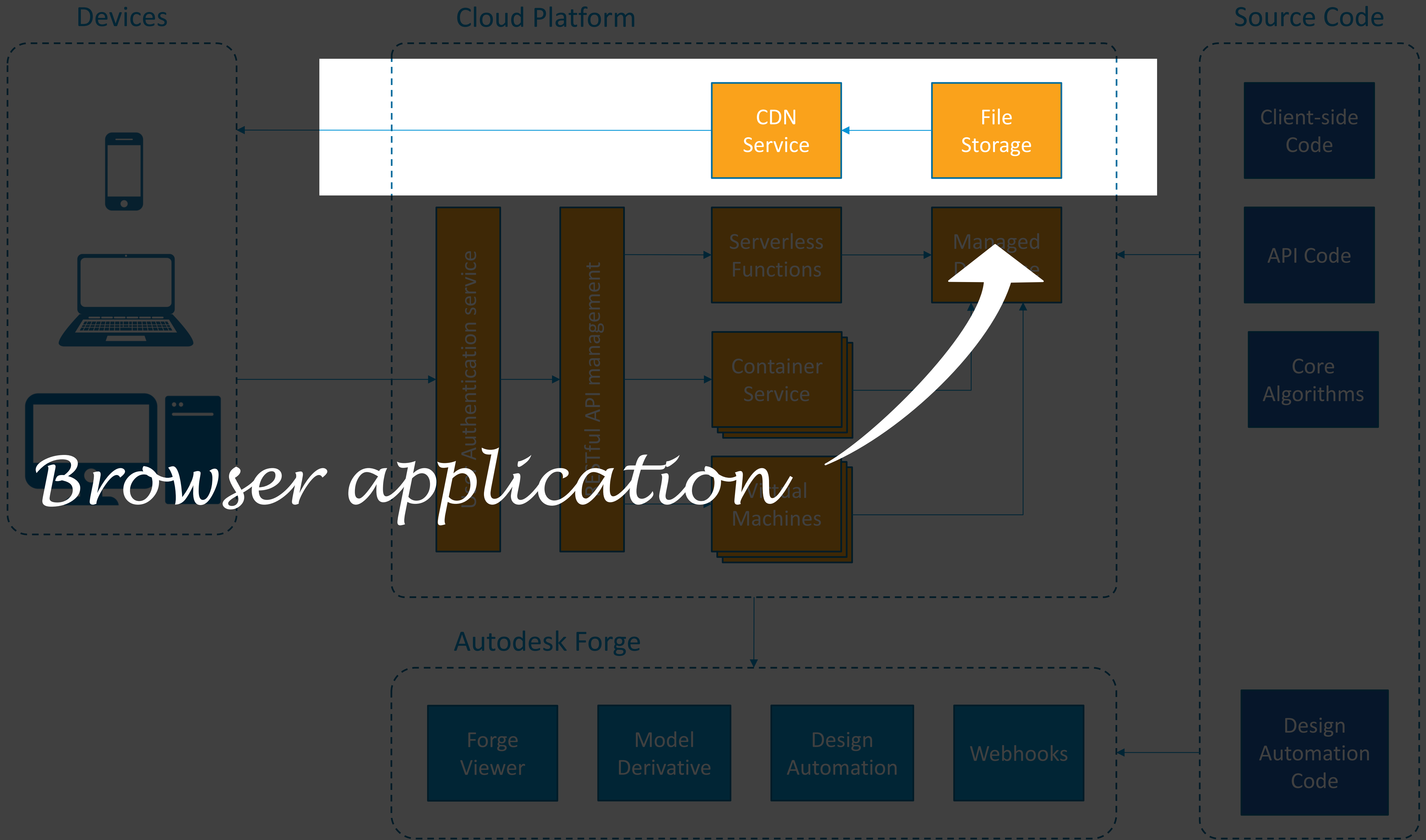
# What we have achieved!

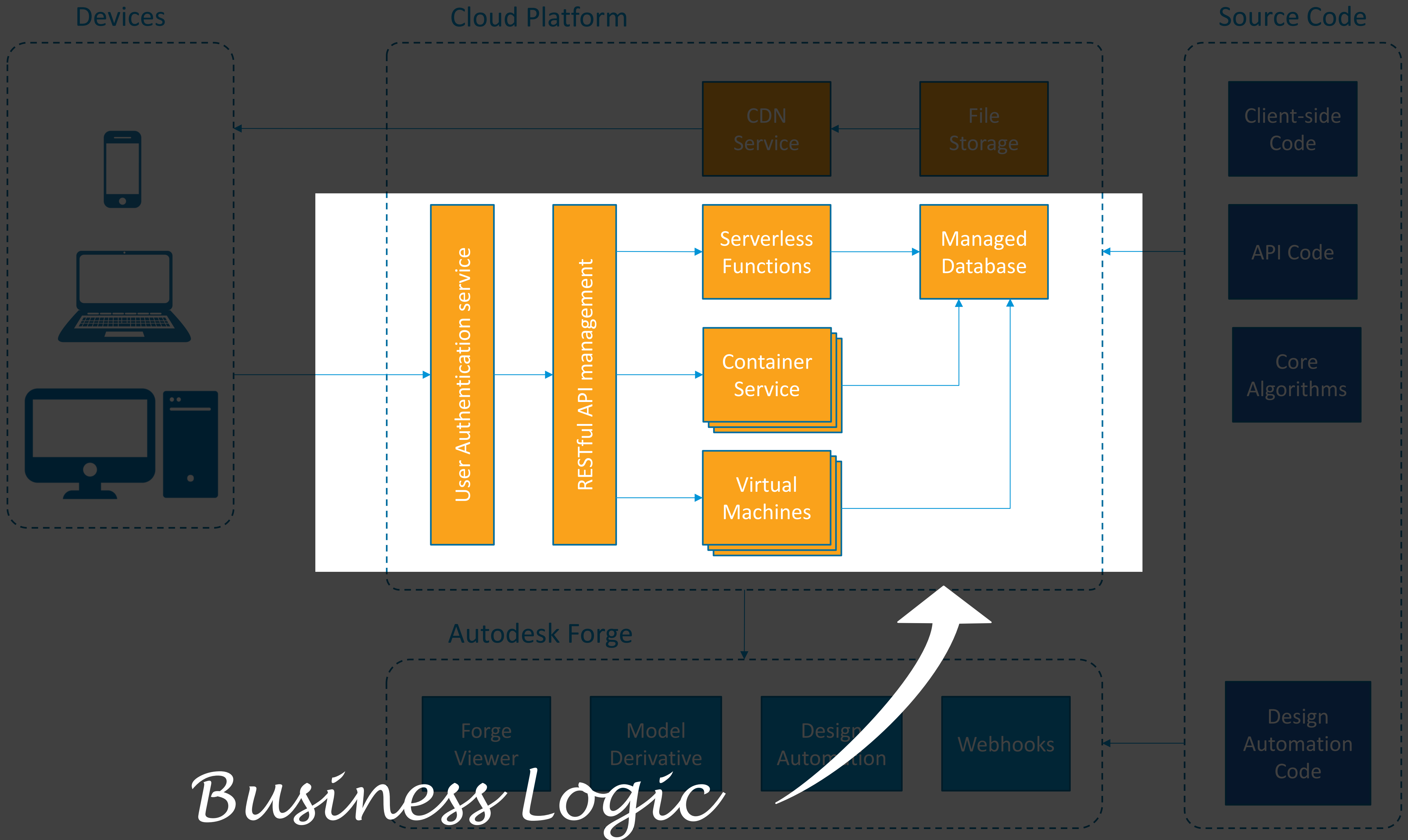
- A **highly accessible & scalable** CAD configurator made possible using Forge & serverless cloud services
- Running **cost is extremely low** as you would only pay for what you consume
- **No maintenance**, as the application being completely serverless, becomes cloud provider's responsibility to look after the infrastructure
- **Reduction in time in development** of newer features

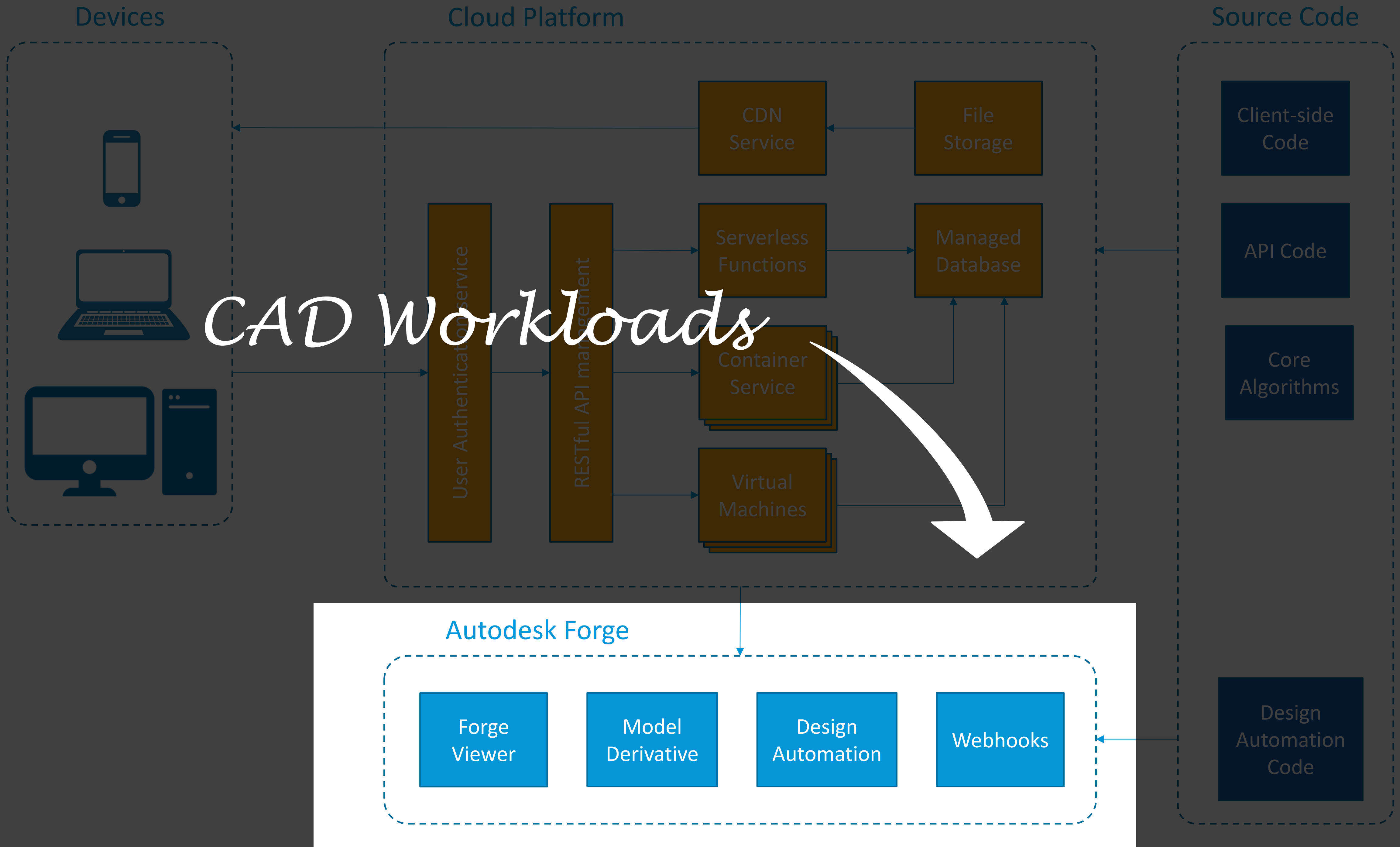
# Massively Scalable Architecture







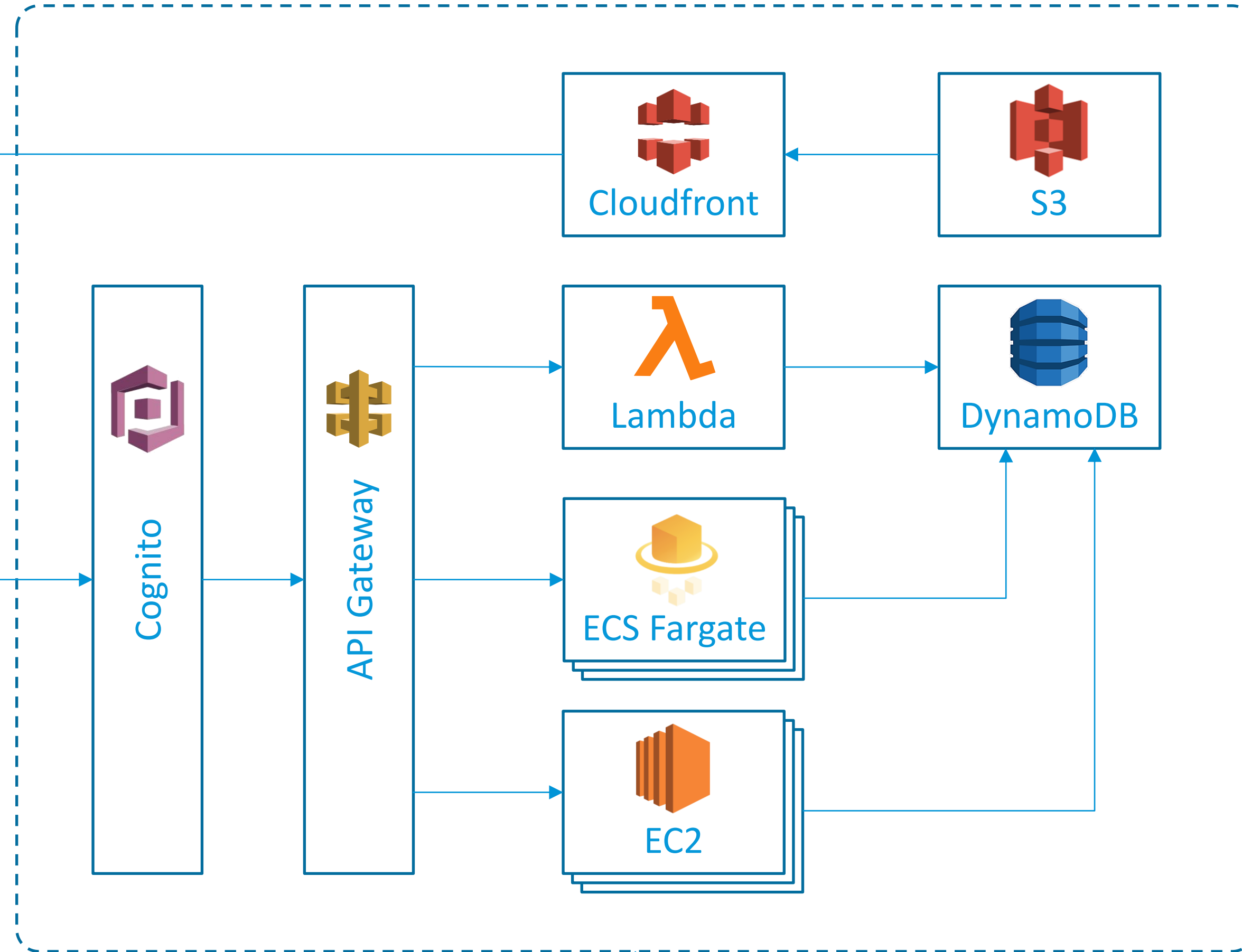




## Devices



## AWS



## Source Code

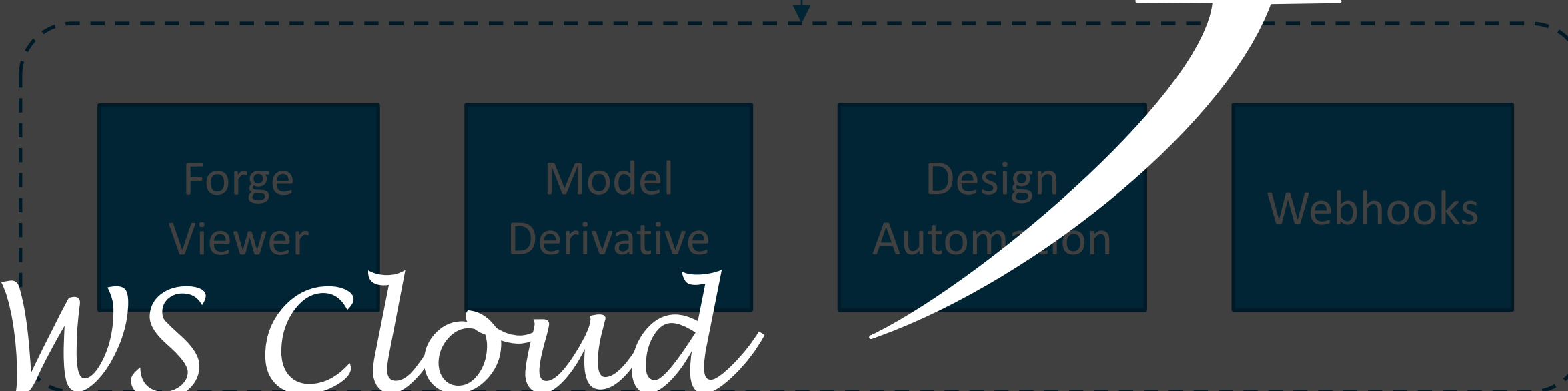
Client-side Code

API Code

Core Algorithms

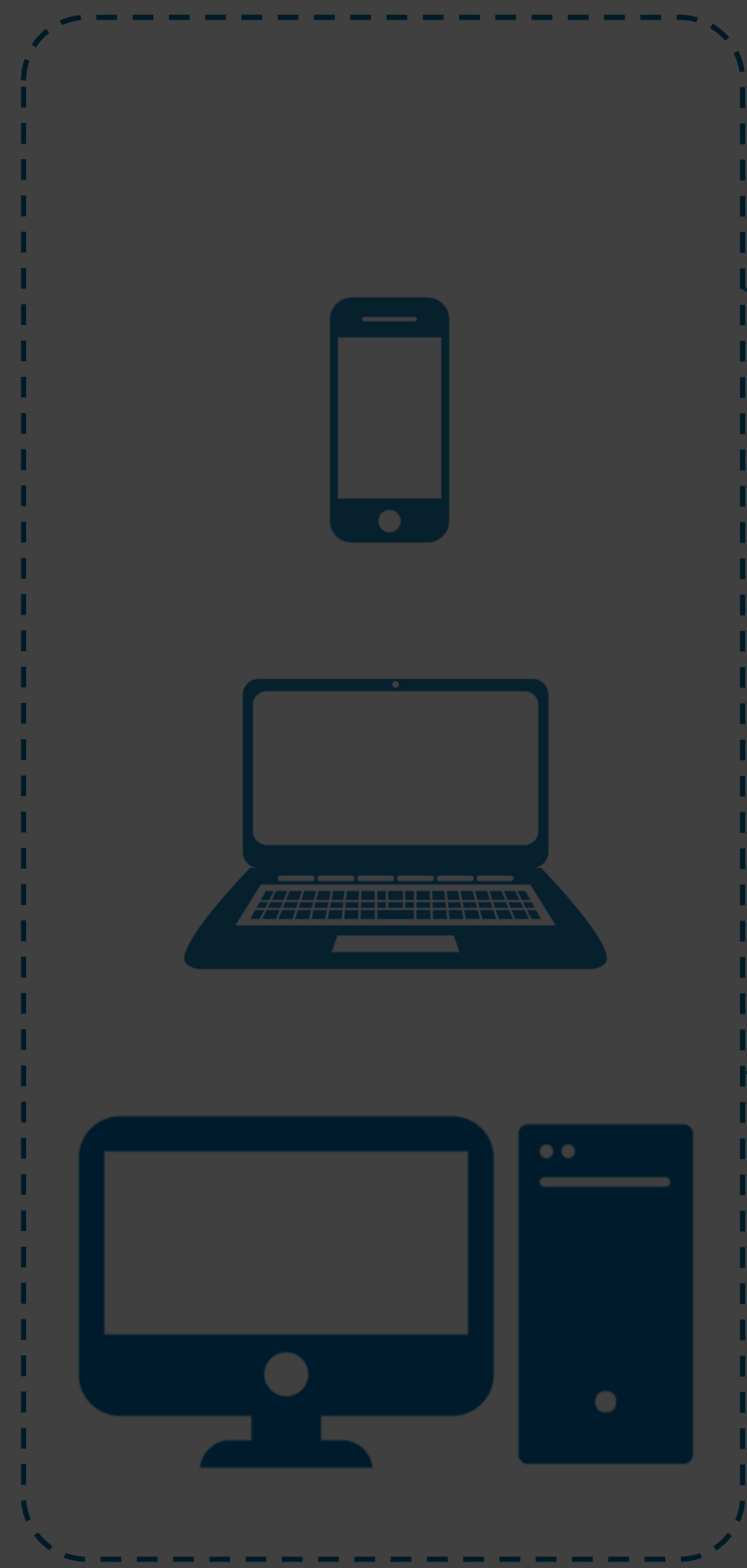
Design Automation Code

## Autodesk Forge

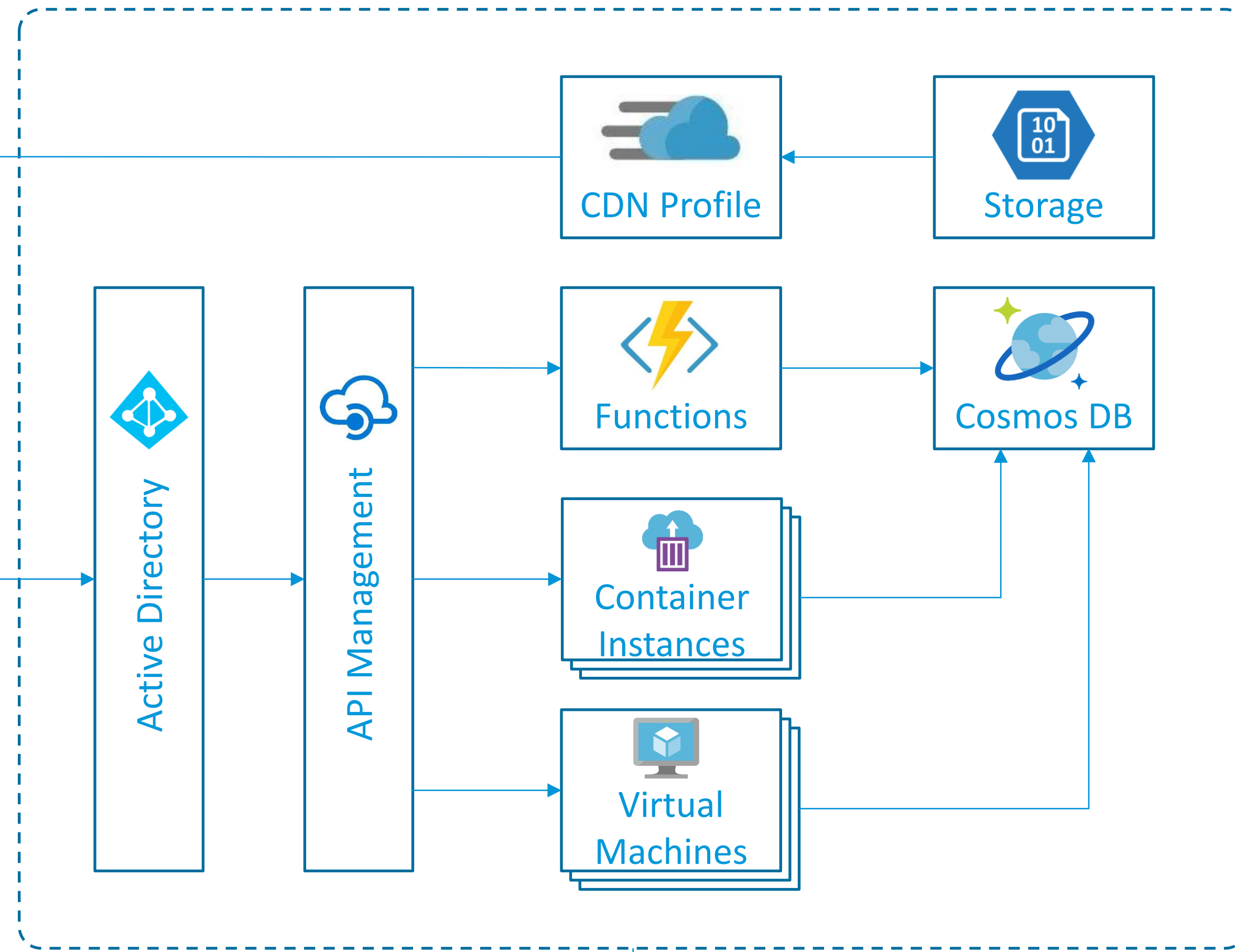


*AWS Cloud*

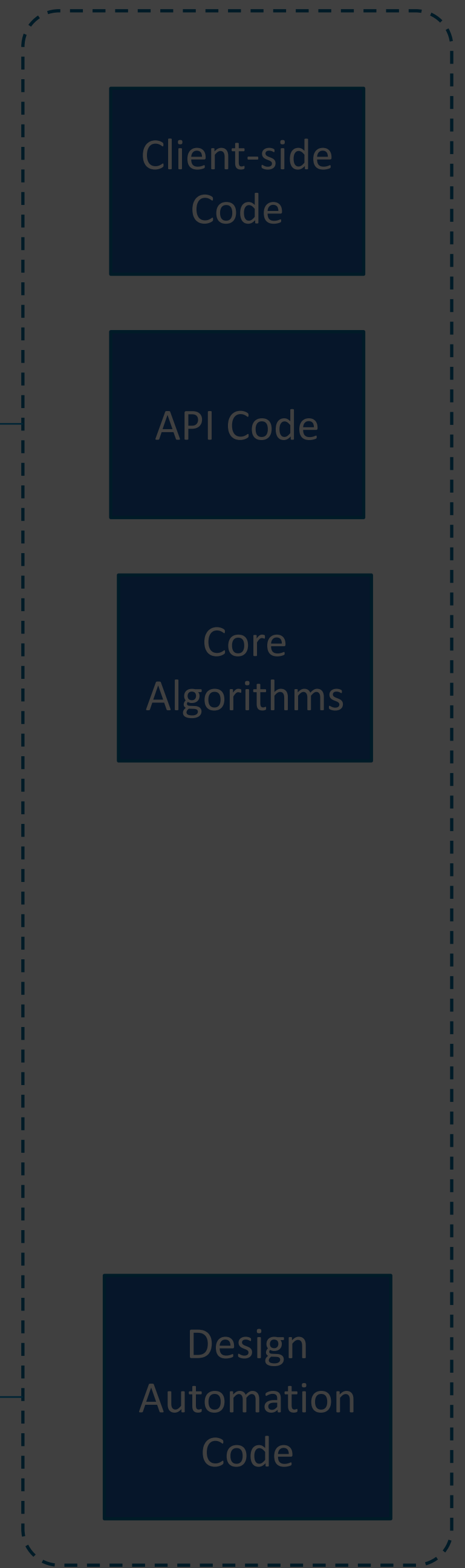
## Devices



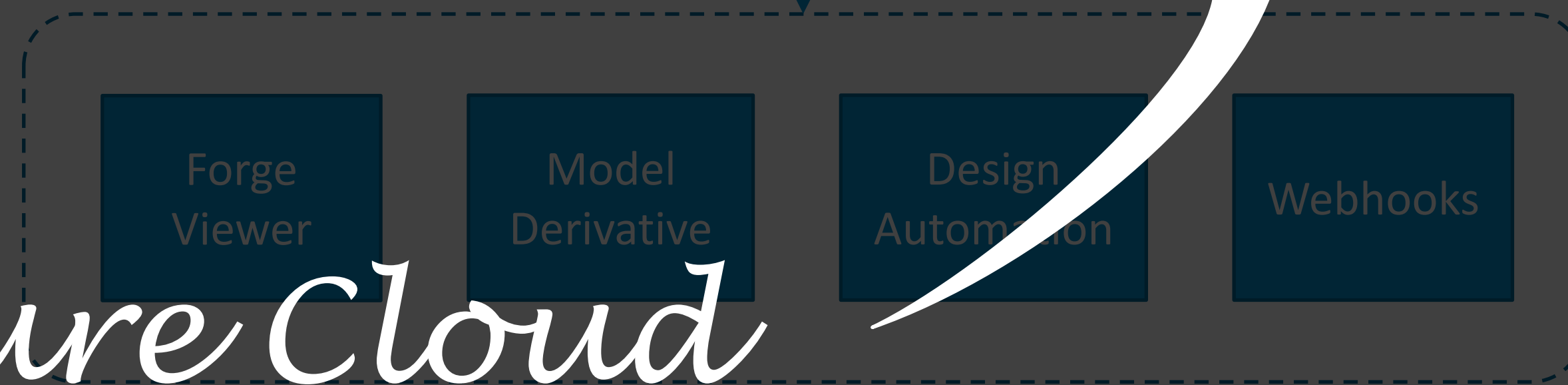
## Azure



## Source Code



## Autodesk Forge



*Azure Cloud*



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