

# Computing Challenges and Opportunities in Modeling and Simulation

## A Practitioner's Perspective

**Dave Sturrock**  
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# Herman Kahn

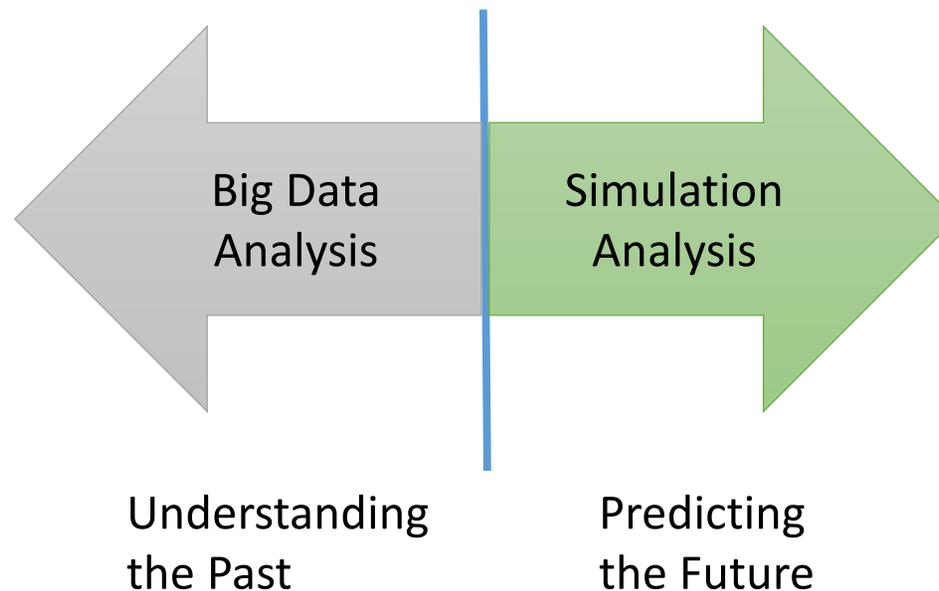
Anyone can learn from  
the past.  
What we need today is  
to learn from the future.



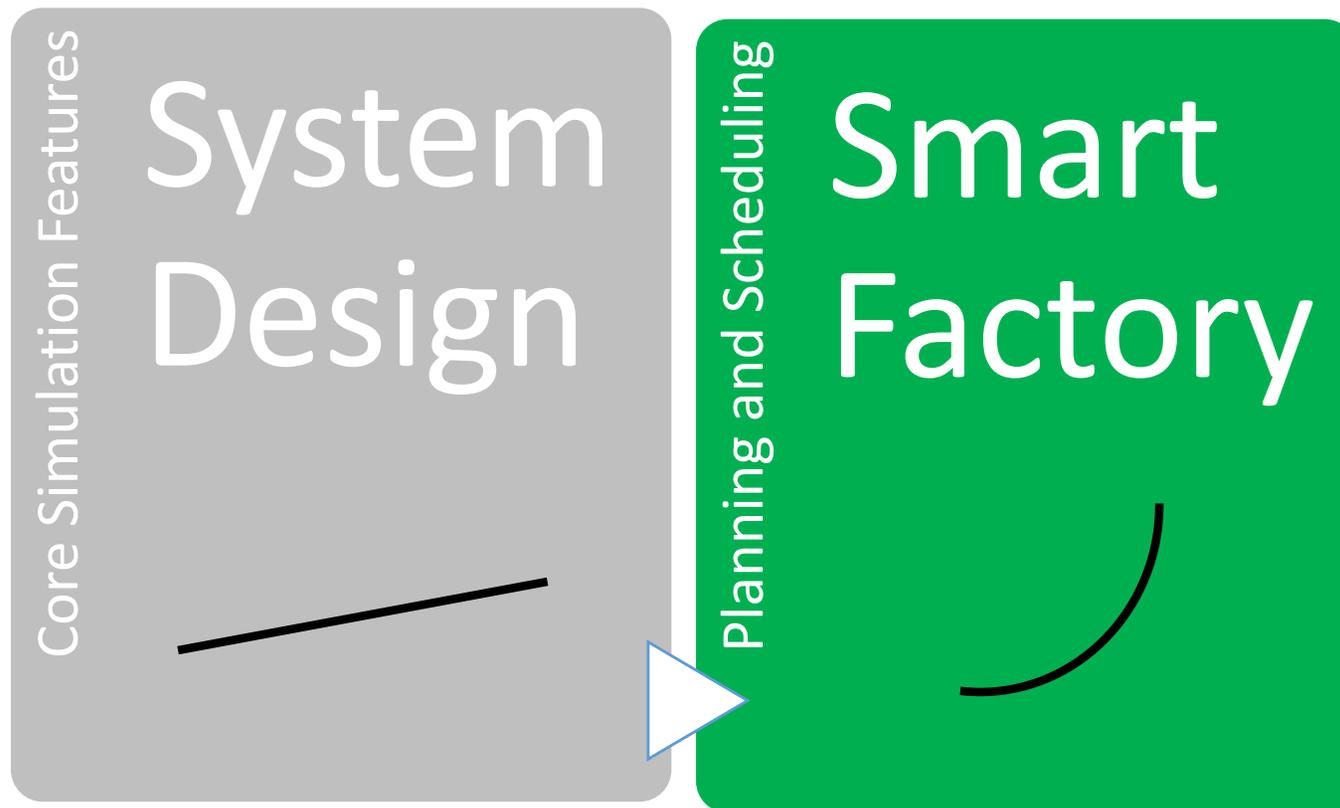
Herman Kahn was a founder of the Hudson Institute and one of the preeminent futurists of the latter part of the twentieth century.

# Analytics: Reshaping the World

Analytics: Discovery and communication of meaningful data patterns.

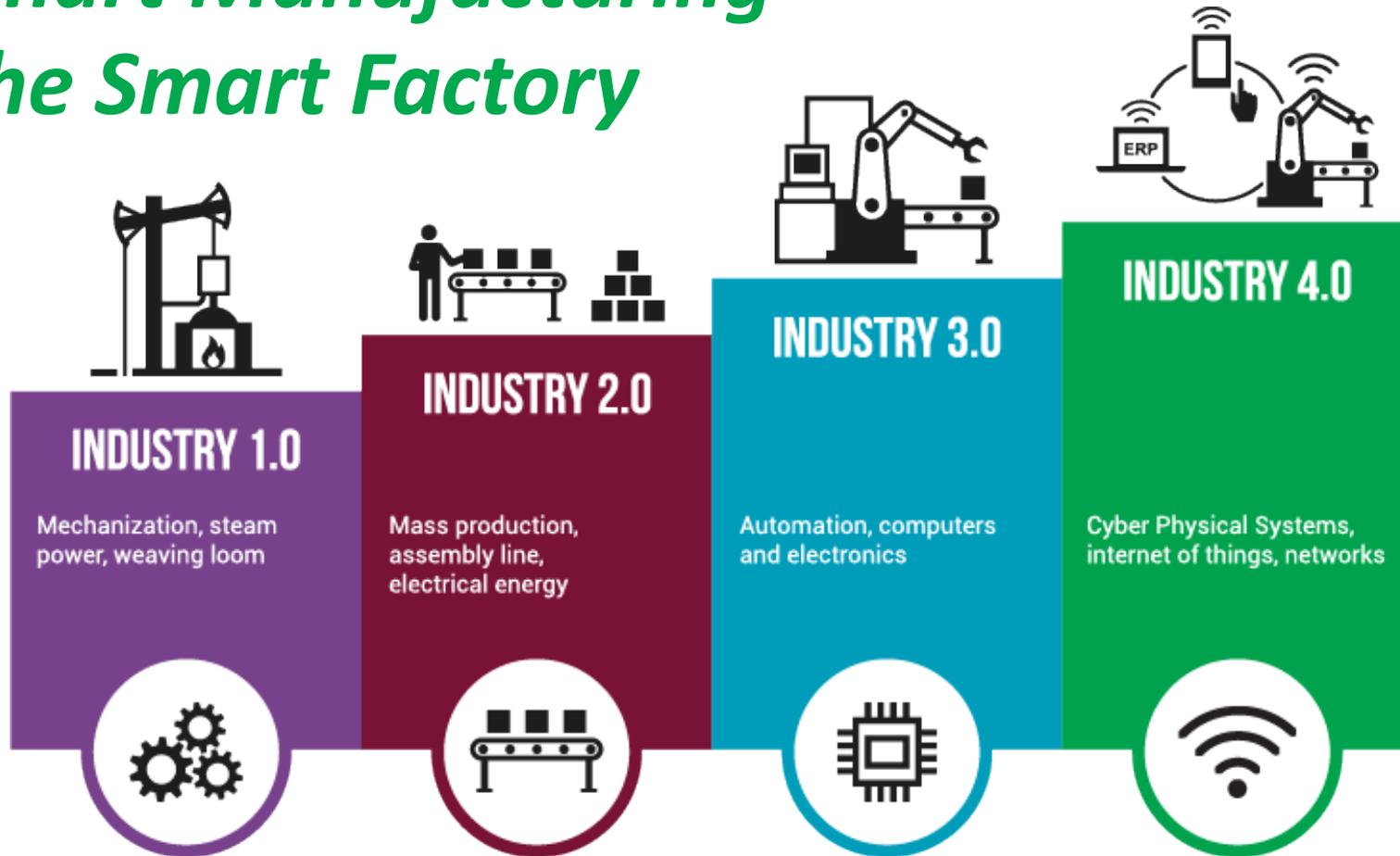


# Simulation Revolution

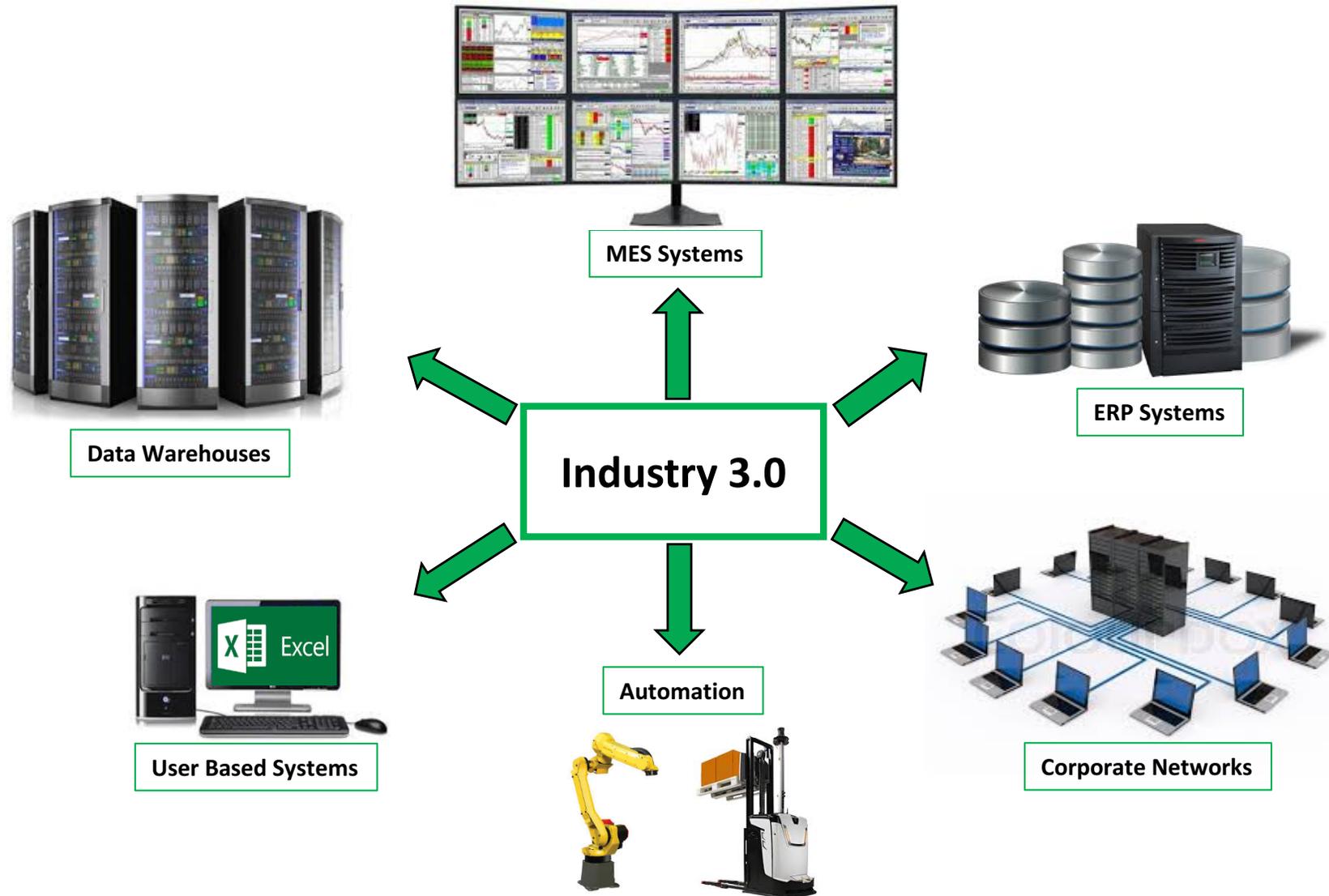


# What is Industry 4.0

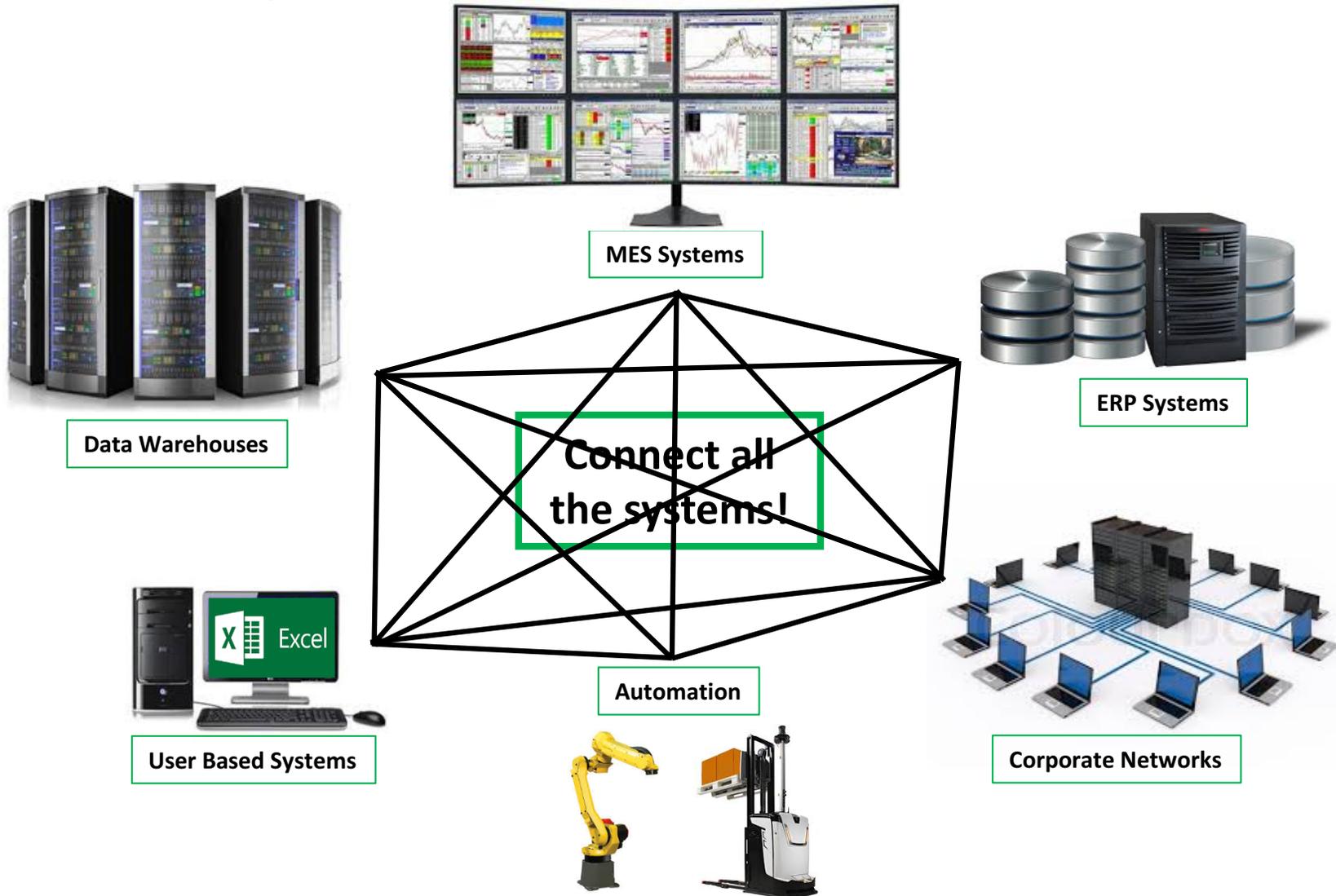
## *Smart Manufacturing* *The Smart Factory*



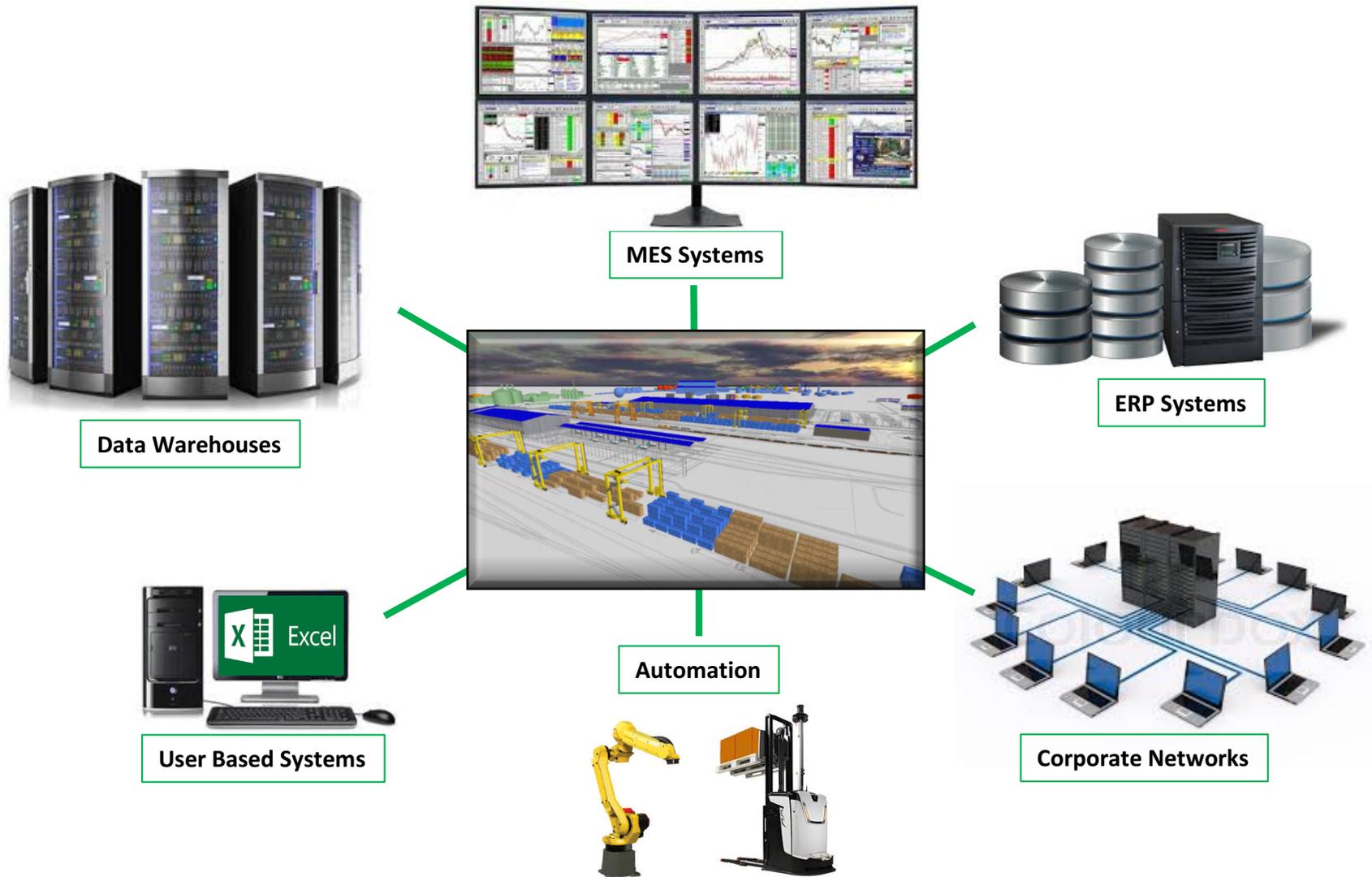
# Typical Current Architecture



# How Do We Enable Industry 4.0?



# Intelligent Use of the Enterprise Data



# Digital Twin

- ▶ Reference model for multiple purposes
- ▶ Must answer many different questions both design and operational
- ▶ Data driven and Data generated
- ▶ Produces large data of the future and gives managers forward visibility

# Computational Challenges of a “Digital Twin”

- ▶ More detailed models
- ▶ Need for large scale execution of both optimizations and design of experiments, both on premise and cloud
- ▶ Computational cloud might be hybrid with data and outputs saved on premise, but large scale replications (1000’s or 10,000’s) executed on the public cloud.
- ▶ Need for large data stores to hold all the detailed simulation results.

# Computational Challenges of “Digital Twin” (continued)

- ▶ Operational models put more pressure on fast execution since the answer is needed in seconds or minutes.
- ▶ Operational models also create much larger output data sets including detailed logs of entity (order) and object (device) activities.
- ▶ Reference models put more pressure on model detail and fast execution.