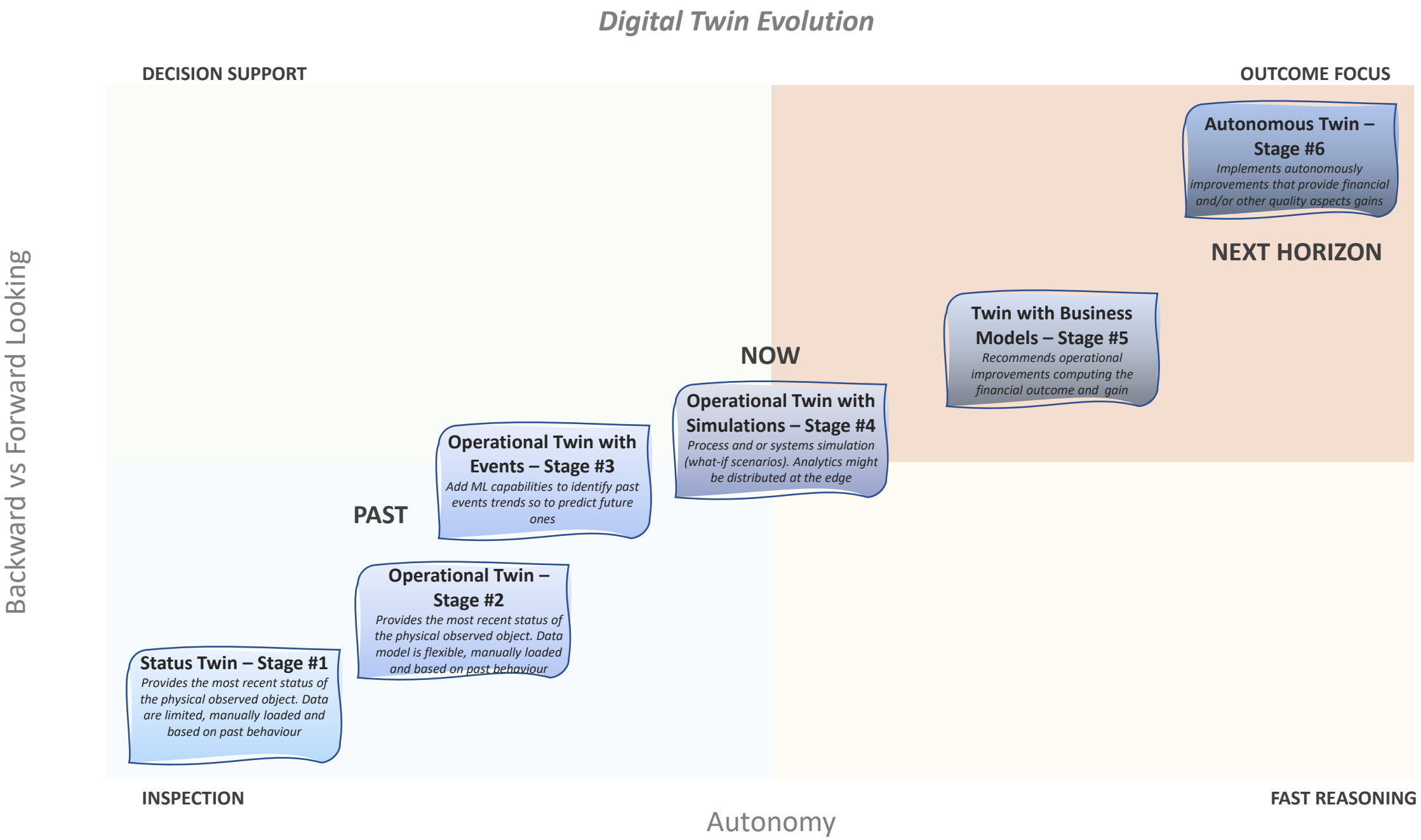
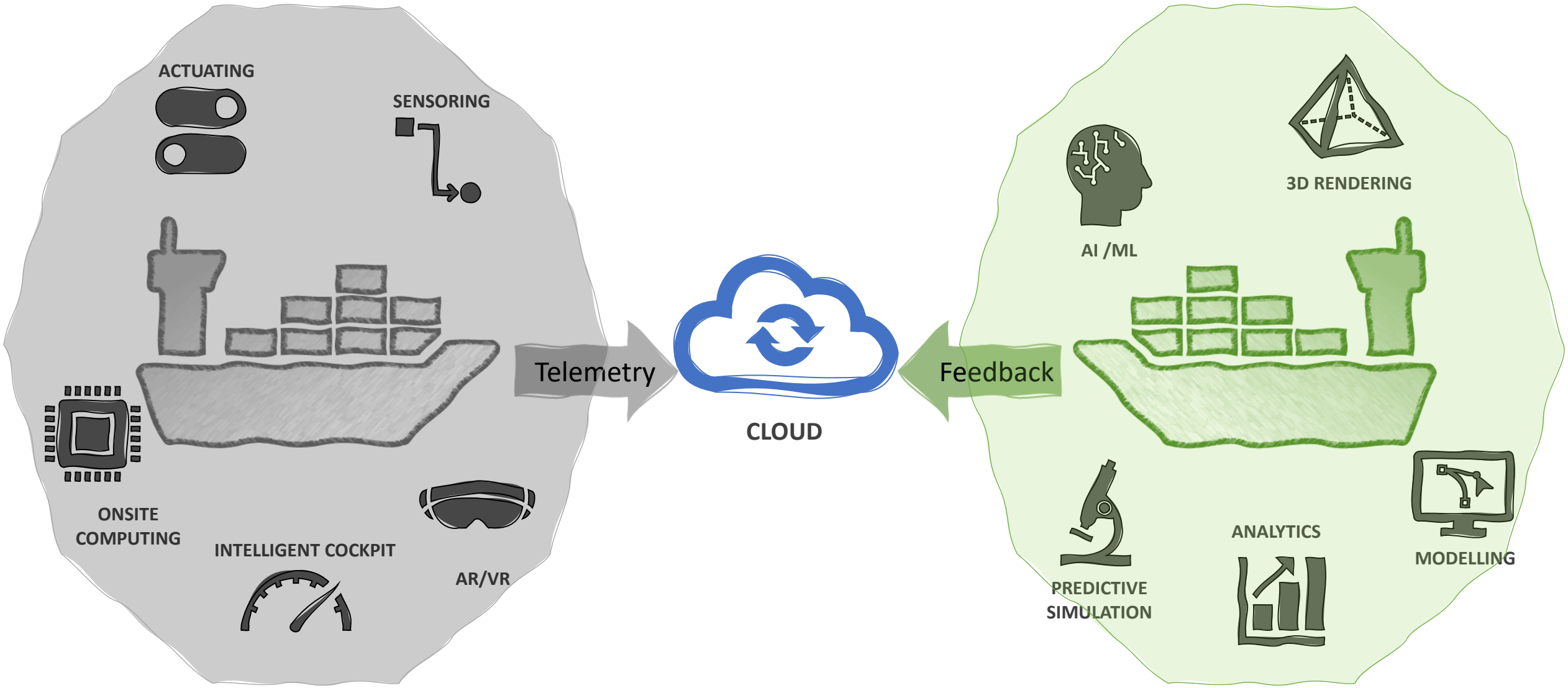

Digital Twin Evolution
DECISION SUPPORT
OUTCOME FOCUS
Backward vs Forward Looking
Autonomous Twin – Stage #6
Implements autonomously improvements that provide financial and/or other quality aspects gains
NEXT HORIZON
Twin with Business Models – Stage #5
Recommends operational improvements computing the financial outcome and gain
NOW
Operational Twin with Simulations – Stage #4
Process and or systems simulation (what-if scenarios). Analytics might be distributed at the edge
Operational Twin with Events – Stage #3
Add ML capabilities to identify past events trends so to predict future ones
PAST
Operational Twin – Stage #2
Provides the most recent status of the physical observed object. Data model is flexible, manually loaded and based on past behaviour
Status Twin – Stage #1
Provides the most recent status of the physical observed object. Data are limited, manually loaded and based on past behaviour
INSPECTION
FAST REASONING
Autonomy

Digital Twin Concept



PHYSICAL SPACE, the „Smart Object"

VIRTUAL SPACE, the „Digital Twin"

CPS Concept

CLOUD

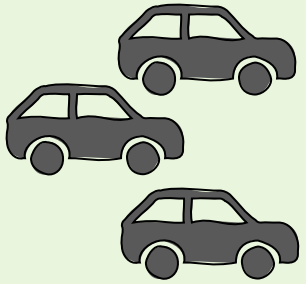
Wide Area Network

Traffic Monitoring System

Smart Traffic Light System

Other nodes – e.g. Smart buildings

SCI Nodes



Vehicular Nodes

SCiNaS

Controller

Connection Manager

Route Manager

Cruise Control

Metropolitan Area Network

Applications of Digital Twin Technology in Automotive Industry

INTELLIGENT DRIVER ASSISTANCE
- Vehicle Interaction Analysis
- Vehicle Safety Insights
- Decision Making using Deep Learning

AUTONOMOUS NAVIGATION
- Motion Planning
- Propulsion Drive Control
- Automated Motion Stabilization
- Predictive Motion Modelling

HEALTH MONITORING
- Entire Vehicle Health Monitoring
- Vehicle Breaking System Health Management
- Electric Motor Health Monitoring
- Vehicle Tires Health Management

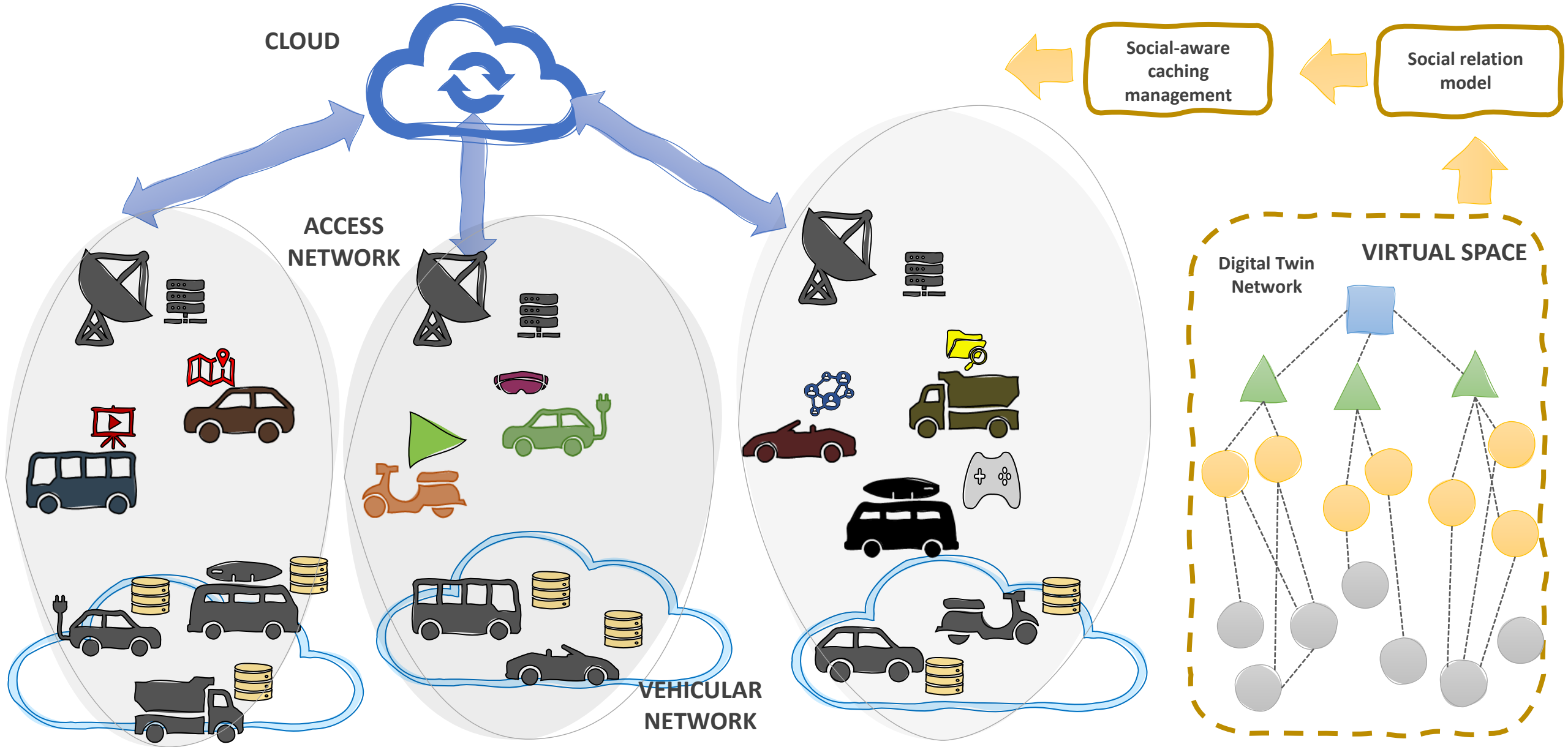
BATTERY MANAGEMENT SYSTEMS
- Smart Charge Control
- SoC, SoH, and RUL
- Vehicle to Grid Automation

CONVERTERS AND INVERTERS
- Non-Invasive Diagnosis
- Life-Accelerated Testing
- Present Degradation Estimation
- Remote Troubleshooting

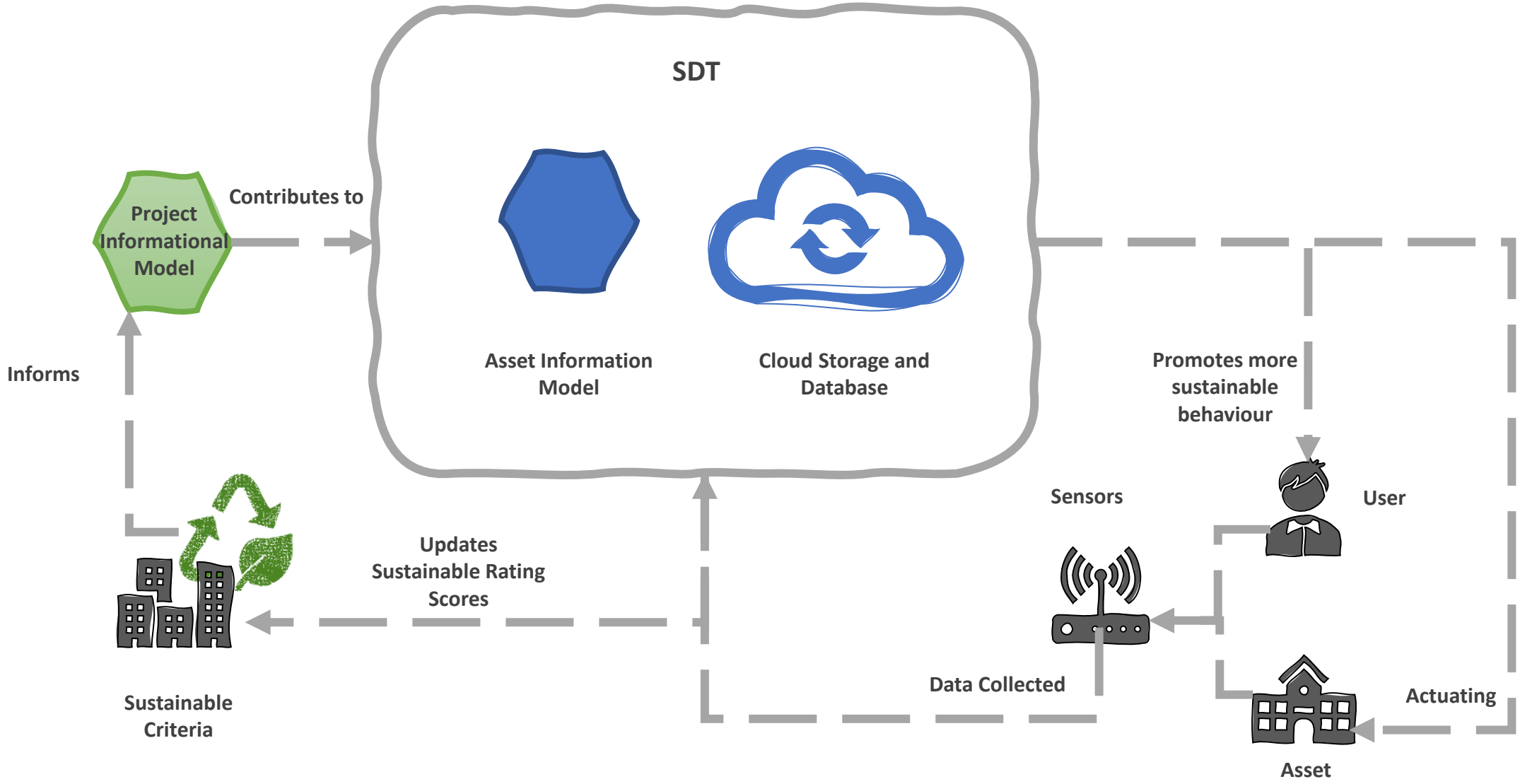
DIGITAL DESIGN AND MANUFACTURING
- Flexible-cell Manufacturing Realization
- Product Efficiency Optimization
- Rapid and Sustainable Design Assessment

CONSUMER CENTERED DEVELOPMENT
- Virtual Passenger Comfort Testing
- Safety Contingency Empirical Development
- Virtual Test Drive Experience for Potential Consumer

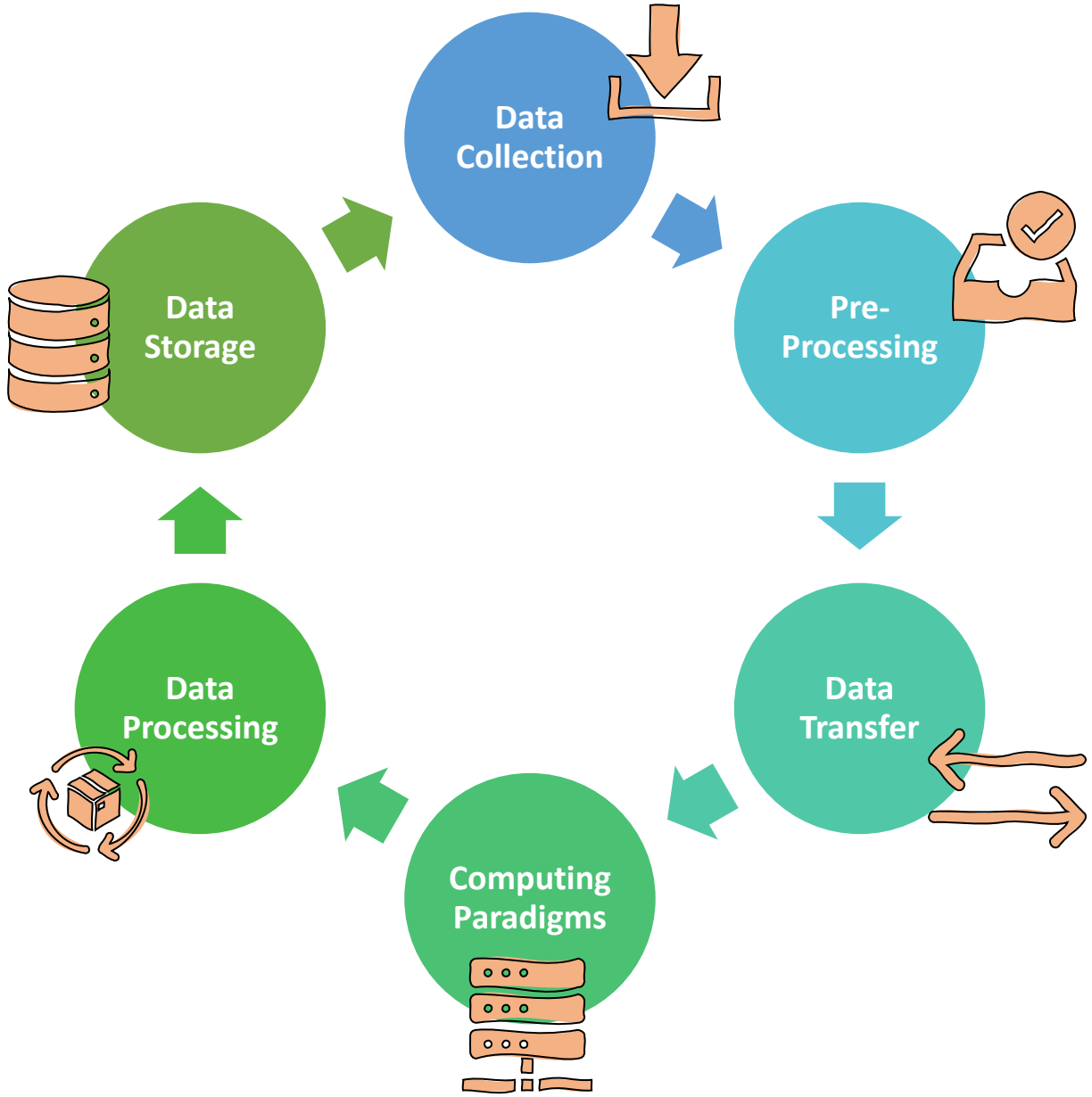
Digital Twin in Vehicular Social Edge Network Concept



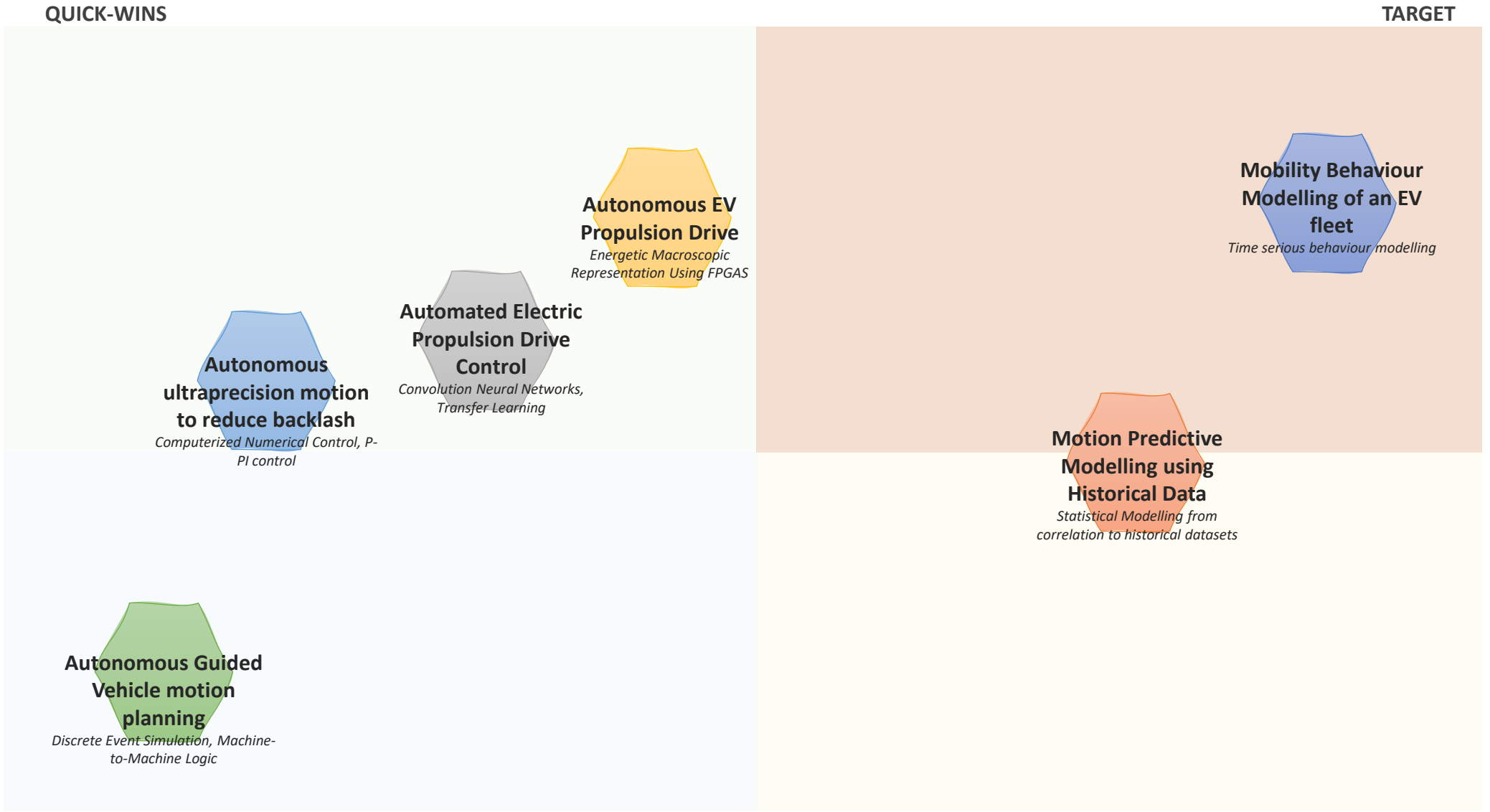
Sustainable Digital Twin (SDT) Framework



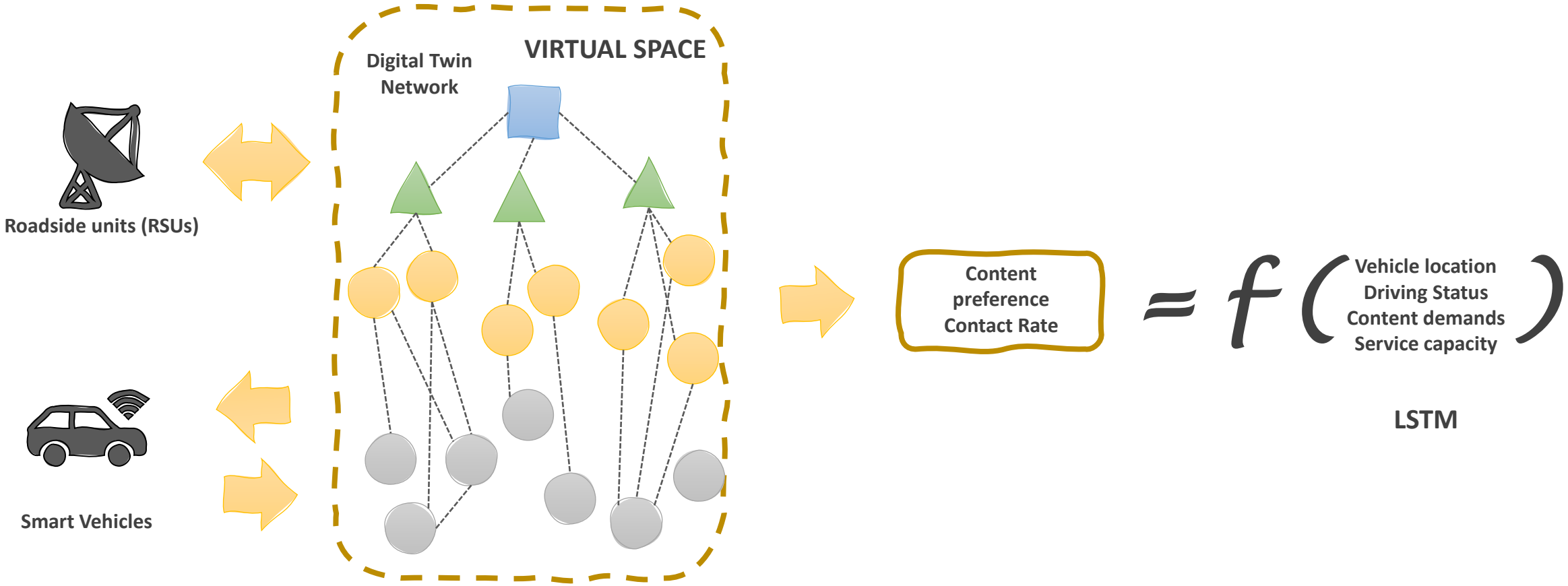
Wearable Data Processing Lifecycle



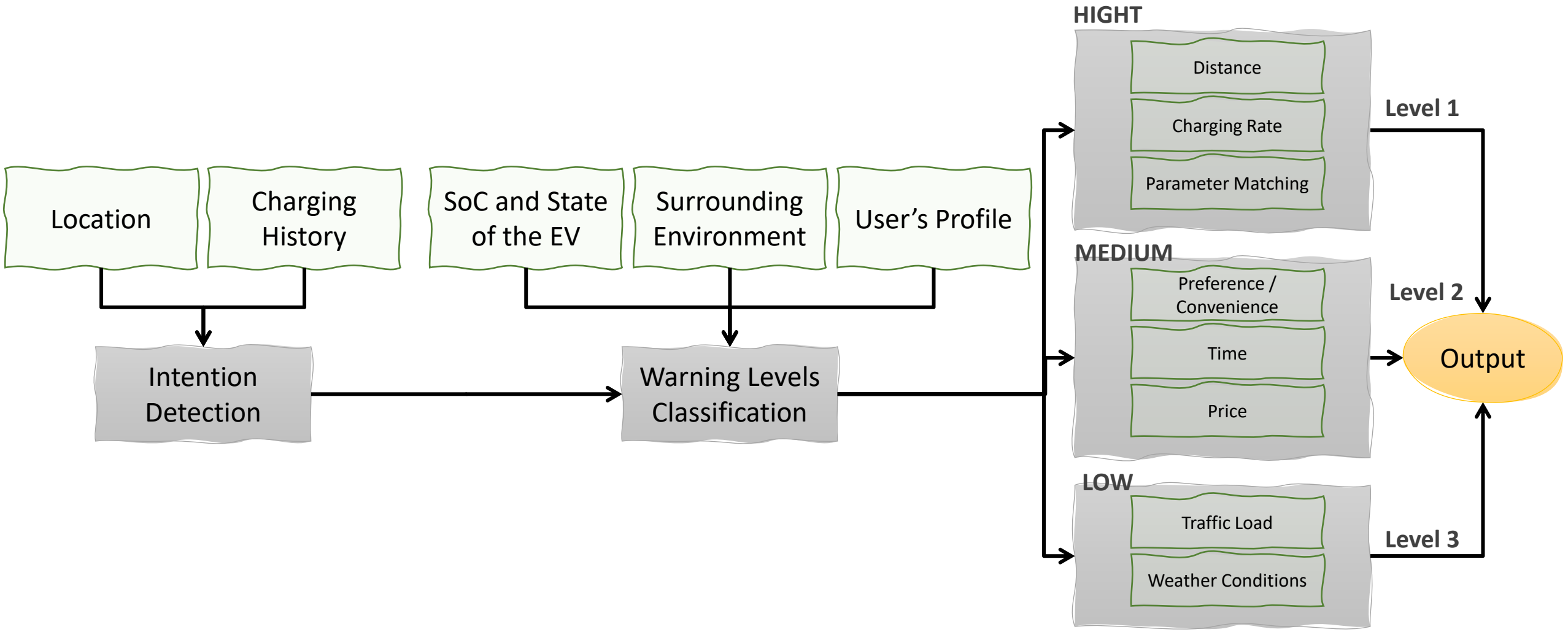
Predictive mobility and autonomous motion control



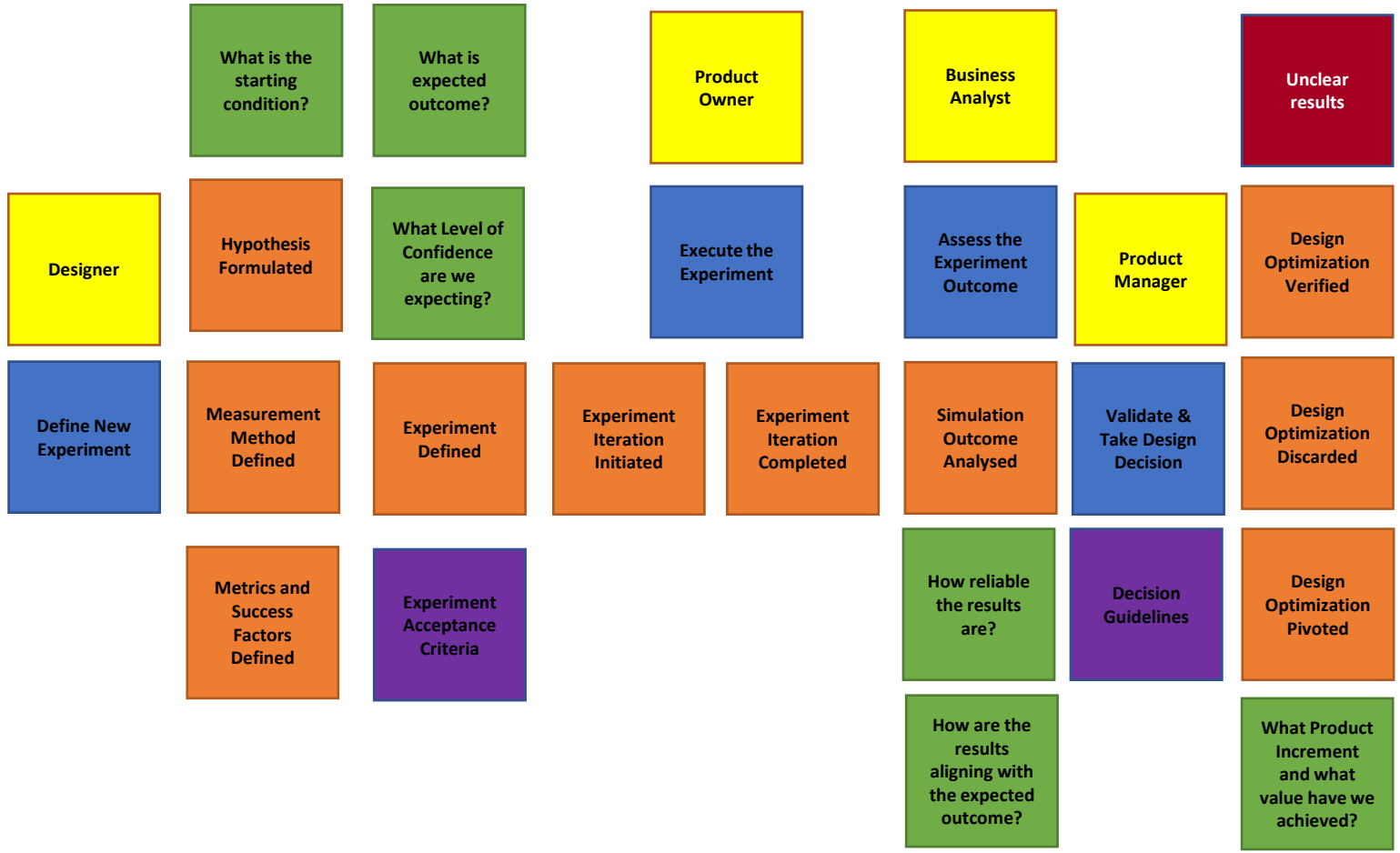
Digital Twin in Vehicular Social Edge Network LSTM Approach



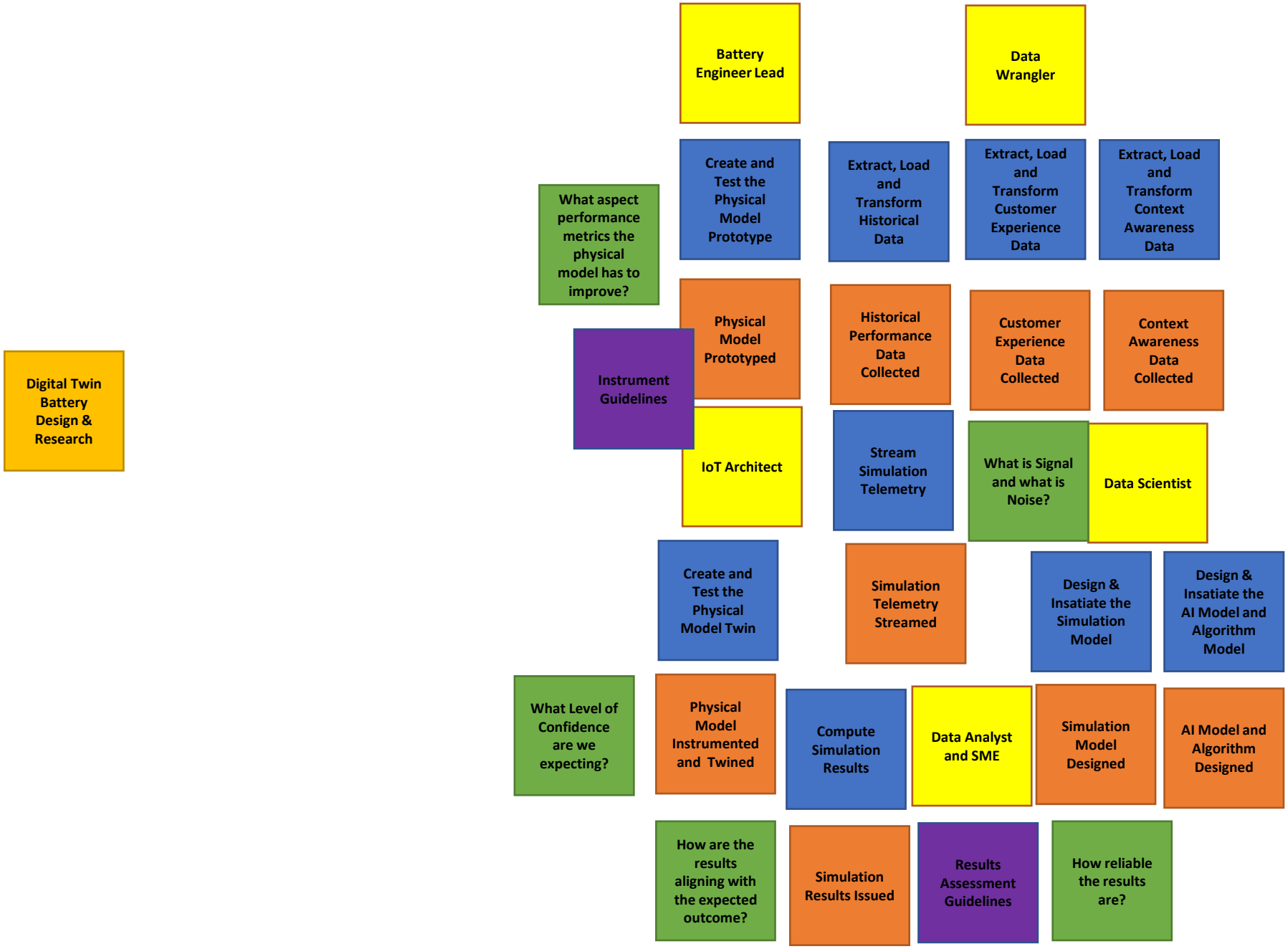
Chained Recommendation Sample Concept



Domain Event	An event that occurs in the business process. Written in past tense.
Actor	A person who executes a command through a view.
Command	A command executed by a user through a view on an aggregate that results in the creation of a domain event
Aggregate	Cluster of domain objects that can be treated as a single unit.
External System	A third-party service provider such as a payment gateway or shipping company.
Hot Spot	Hotspots are used to visualise and capture hot conflicts. Conflicts caused by, and not exclusive to, inconsistencies (in language), frictions, questions, dissent, objections, issues or procrastinating going deep to explore for later.
Policy	In essence, a policy is a reaction that says “whenever X happens, we do Y”. Eventually ending up with in the flow between a Domain Event and a Command/action.
Read Model	his represents data that may be critical for a user or system to make a decision. I have not seen this one used often, but it can be helpful when there needs to be an emphasis on what data the user sees



Physical Battery Design & Research


Digital Twin Battery Design & Research
Battery Engineer Lead
Data Wrangler
Create and Test the Physical Model Prototype
Extract, Load and Transform Historical Data
Extract, Load and Transform Customer Experience Data
Extract, Load and Transform Context Awareness Data
What aspect performance metrics the physical model has to improve?
Physical Model Prototyped
Historical Performance Data Collected
Customer Experience Data Collected
Context Awareness Data Collected
Instrument Guidelines
IoT Architect
Stream Simulation Telemetry
What is Signal and what is Noise?
Data Scientist
Create and Test the Physical Model Twin
Simulation Telemetry Streamed
Design & Insatiate the Simulation Model
Design & Insatiate the AI Model and Algorithm Model
What Level of Confidence are we expecting?
Physical Model Instrumented and Twined
Compute Simulation Results
Data Analyst and SME
Simulation Model Designed
AI Model and Algorithm Designed
How are the results aligning with the expected outcome?
Simulation Results Issued
Results Assessment Guidelines
How reliable the results are?


Governance
Business Analyst
Connectivity Issues
Design & Insatiate the Feature Analysis
Data Analyst and SME
How reliable the results are?
Data Quality Guidelines
Subscribe To Customer Feedback Data Stream
Customer Feedback Data Received
What is Signal and what is Noise?
Feature Analysis Identified
Assess Simulated vs Observed Data
Results Assessment Guidelines
Data Quality
Data Wrangler
Subscribe To Research & Design Data Stream
Research & Design Data Received
Product Owner
Execute the Feature Analysis
Data Analysis Executed
Real Time Physical & DT Battery Data Compared
What is Signal and what is Noise?
Real Time Physical Battery Data Received
Subscribe To Real Time Physical Battery Data Stream
Data Wrangler
Subscribe To Manufacturing Data Stream
Manufacturing Data Received
Data Analyst and SME
Extrapolate Behaviour Patterns
Behaviour Extrapolated
What Level of Confidence are we expecting?
Real Time DT Battery Simulated Data Received
Subscribe To Real Time DT Battery Simulated Data Stream


Workshop
Workshop Manager
Analyse Product Quality Data
Data Analyst and SME
Aggregate Product Quality Analysis Results
Connectivity Issues
Offline Guidelines
Issue Product Quality Control Command
Product Quality Data Analysed
Data Quality
Product Quality Data Aggregated
Instrument Guidelines
Product Quality Control Command Issued
What are the attributes of the Product Quality Control Command?
Workshop Manager
Data Quality Guidelines
What is Signal and what is Noise?
Digitalize Workshop
IoT Architect
Product Quality Control Command Executed
Execute Workshop Operations Optimization Control Command
Workshop Instrumented and Twined
Virtual Workshop Telemetry Streamed
Virtual Workshop Modelled
What Level of Confidence are we expecting?
Execute Product Quality Control Command
Workshop Operations Optimization Control Command Executed
Workshop Operations Guidelines
Data Analyst and SME
How reliable the results are?
Workshop Manager
Workshop Operations Optimization Control Command Issued
What aspect performance metrics the physical product has to improve?
Perform Workshop Operations Data Analysis
Aggregate Workshop Operations Data Analysis Results
Results Assessment Guidelines
Issue Workshop Operations Optimization Control Command
Workshop Manager
Workshop Operations Data Analysed
Workshop Operations Data Aggregated
How are the results aligning with the expected outcome?


Connectivity Issues
Battery Engineer Lead
Extract, Load and Transform Historical Data
Data Wrangler
Extract, Load and Transform Design Data
Offline Guidelines
Create and Test the Physical Model Prototype
What is Signal and what is Noise?
Historical Performance Data Collected
Data Quality
Design Data Collected
Data Quality Guidelines
Data Scientist
What aspect performance metrics the physical model has to improve?
Physical Model Prototyped
Simulation Model Designed
Design & Insatiate the Simulation Model
Data Scientist
What Level of Confidence are we expecting?
AI Model and Algorithm Designed
Design & Insatiate the AI Model and Algorithm Model
Instrument Guidelines
What Level of Confidence are we expecting?
Physical Model Instrument and Twine
How reliable the results are?
Simulation Telemetry Streamed
Stream Simulation Telemetry
IoT Architect
Product Owner
IoT Architect
Create and Test the Physical Model Twin
Simulation Results Issued
Compute Simulation Results
Data Analyst and SME
Define & Implement Assembly Plan
Workshop Digital Twin
What is the Forecast vs Planned? What are the Remediation Actions?
Production Line Guidelines
What is the Forecast vs Planned? What are the Remediation Actions?
Results Assessment Guidelines
What is the Forecast vs Planned? What are the Remediation Actions?
Processing Plan Defined
Processing Plan Executed
Scheduling Defined
Scheduling Executed
Assembly Plan Defined
Assembly Plan Executed
Product Owner
Define & Implement Processing Plan
Product Owner
Define & Implement Scheduling
Data Analyst and SME
Aggregate Assembly Outcome Data
Assembly Outcome Data Processed


Data Quality Guidelines
Offline Guidelines
Connectivity Issues
Battery Pack
5G Provider
Data Quality
Driver Assistant
Reliability
Observe & Detect Customer Driving Behaviour
Issue Battery Performances Notification
Customer Battery Adjustment Command Issued
What are the attributes of the Customer Battery Adjustment Command ?
What are the attributes of the Customer Driving Behaviour?
Customer Driving Behaviour Detected
Customer Notified on Battery Performances
What are the scores for SoH, SoC, RUL??
Issue Battery Adjustment Command
Customer
Confidentiality & Security
Customer
5G Provider
Connectivity Issues
Offline Guidelines
Driving Experience
Terms and Conditions – Consent Form
Publish Customer Feedback
Publish Customer Social Behaviour
Social Media
Weather Forecast
Road and Traffic Controller
What is the Customer Sentiment? What is the NPS?
Customer Feedback Shared
Customer Social Behaviour Shared
What is the Customer Relationship Graph and its attributes?


Data Quality
Data Quality Guidelines
State of Charge threshold
State of Health threshold
Remaining Useful Life threshold
Data Quality
Data Quality Guidelines
Battery Pack Managing
Battery Assistant
Raise State Sensor Alter
State Sensor Alerted
Real Time Battery Pack Telemetry Streamed
Stream Real Time Battery Pack Telemetry
Battery Assistant
Subscribe to and Process Real Time Battery Pack Telemetry
Real Time Battery Pack Telemetry Processed
How reliable the results are?
What is Signal and what is Noise?
What is Signal and what is Noise?
What are the Control Issue Attributes?
Control Signal Executed
Execute Control Signal
Control Signal Issued
Issue Control Signal
What are the scores for SoH, SoC, RUL??
Battery Controller
Reliability
Battery Controller
Reliability Guidelines


Data Quality Guidelines
Data Quality
Battery Assistant Lightweight DT
Subscribe to and Process Real Time State Sensor Data
Data Wrangler
Offline Guidelines
Data Quality Guidelines
What Level of Confidence are we expecting?
Real Time State Sensor Data Received
Real Time State Sensor Data Processed
Filter Real Time State Sensor Data
Offline Guidelines
Data Quality
Real Time Control Signal Command Triggered
Trigger Real Time Control Signal Command
Real Time Control Signal Data Processed
Process Real Time Control Signal Command
Subscribe to Control Signal Command Data
Connectivity Issues
Data Wrangler
What Level of Confidence are we expecting?
What is Signal and what is Noise?
Battery Assistant Lightweight DT
How reliable the results are?
Reliability
Battery Assistant Lightweight DT
5G Provider
Extract, Load and Priority Context Awareness Data
Priority Context Awareness Data Received
Operation Anomaly Detection Lightweight Model Executed
Execute Operation Anomaly Detection Lightweight
Battery Thermal System Monitoring & Control Model Lightweight Executed
Execute Battery Thermal System Monitoring & Control
Weather Forecast
Road and Traffic Controller
What aspect performance metrics the Lightweight model has to improve?
Battery Controller Lightweight DT
What are the scores for SoH, SoC, RUL??
Battery Controller Lightweight DT
State of Charge threshold
State of Health threshold
Remaining Useful Life threshold
Cofidientiality & Security
Terms and Conditions – Consent Form
Battery Digital Twin – Low Fidelity

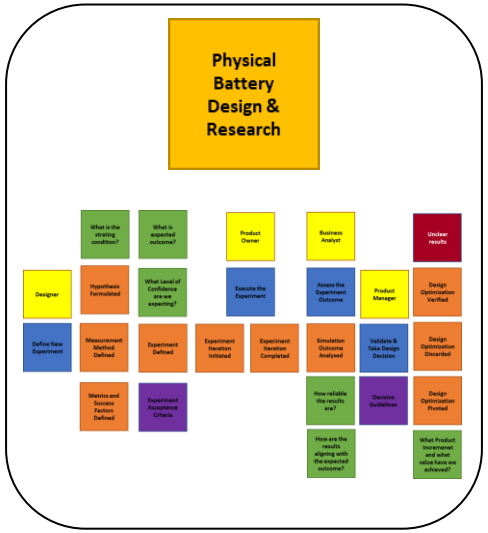

Battery Digital Twin – High Fidelity
Extract, Load and Transform Training Data
Data Wrangler
Data Quality Guidelines
Data Quality
Trained Data Collected
What is Signal and what is Noise?
Data Wrangler
Subscribe to Real Time State Sensor Data
Filtered State Sensor Data Received
Reliability
Reliability Guidelines
What is Signal and what is Noise?
Filtered Control Signal Command Triggered
Filter and Trigger Control Signal Command
Battery Assistant High Fidelity DT
Battery Controller High Fidelity DT
Data Wrangler
Process Filtered Telemetry
Filtered Telemetry Processed
State of Charge threshold
State of Health threshold
Remaining Useful Life threshold
Execute Performance Management Model
How reliable the results are?
Performance Management Model Executed
What is Signal and what is Noise?
Execute Prediction Maintenance Model
Prediction Maintenance Model Executed
How reliable the results are?
Battery Controller High Fidelity DT
Data Wrangler
Extract, Load and Detailed Context Awareness Data
Detailed Context Awareness Data Received
Execute Operation Optimization Model
Operation Optimization Model Executed
Reliability
Reliability Guidelines
Terms and Conditions – Consent Form
Confidentiality & Security
Weather Forecast
Road and Traffic Controller
What is the context like (temperature, humidity, traffic, position, road, etc.)?

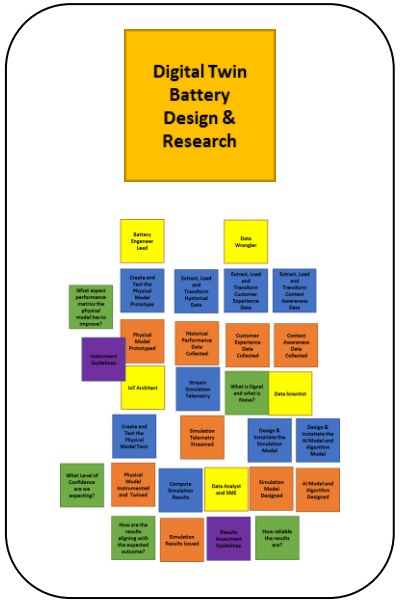

Smart Charghing Station
Offline Guidelines
Connectivity Issues
Weather Forecast
Reliability Guidelines
Road and Traffic Controller
Energy Provider
Reliability
Data Quality Guidelines
Data Quality
Smart Charging Station High Fidelity DT
Smart Charging Station Simulation Model Designed
Smart Charging Station High Fidelity DT
Terms and Conditions – Consent Form
Current Waiting Time, Predicted Waiting Time
Smart Charging Station Waiting Time Updated
Smart Charging Station Overall Status Updated
Update Smart Charging Station Overall Status and Waiting Time
What is Signal and what is Noise?
Design & Insatiate the Smart Charging Station Simulation Model
Aggregate Smart Charging Station Simulation Outcome
Confidentiality & Security
Smart Charging Station High Fidelity Sensor
Detect New Arrived Customer
Smart Charging Station Queue Increased
Smart Charging Station Queue Decreased
Detect Customer Checking Out
Smart Charging Station Simulation Telemetry Streamed
Stream Smart Charging Station Simulation Telemetry
Smart Charging Station Simulation Assessment Executed
How reliable the results are?
Current Queue Outlook, Predicted Queue Outlook
Smart Charging Station High Fidelity Sensor
Data Quality
Smart Charging Station High Fidelity DT
Reliability
Reliability Guidelines
Confidentiality & Security
Smart Charging Station High Fidelity Sensor
Detect Start Charging
Smart Charging Single Station Disengaged
Smart Charging Single Station Engaged
Detect Charging Completing
Data Quality Guidelines
Compute Smart Charging Station Simulation Results
Terms and Conditions – Consent Form
Smart Charging Guidelines
Charging Time ETC, Temperature
Smart Charging Station Simulation Results Issued
How reliable the results are?

Local Smart Area


Data Quality Guidelines
Connectivity Issues
Offline Guidelines
Data Quality
Extract, Load and Transform Real Time Battery Behaviour Data
Data Wrangler
Confidentiality & Security
Terms and Conditions – Consent Form
Real Time Battery Behaviour Data Received
Process Real Time Battery Behaviour Data
What is Signal and what is Noise?
Reliability
Reliability Guidelines
Optimization Specifications
Real Time Battery Behaviour Data Processed
Engine Simulation Model Designed
Design & Insatiate the Engine Simulation Model
Aggregate Engine Simulation Outcome
Data Scientist
Business Analyst
Battery Optimization Suggestions Issued
Publish Battery Optimization Suggestions
Engine Telemetry Streamed
Stream Engine Simulation Telemetry
Engine Simulation Assessment Executed
Engine Performance and Battery Outcome
Disclaimer
Liability
Product Manager
Engine Simulation Results Issued
Compute Engine Simulation Results
Data Analyst and SME
How reliable the results are?
Engine

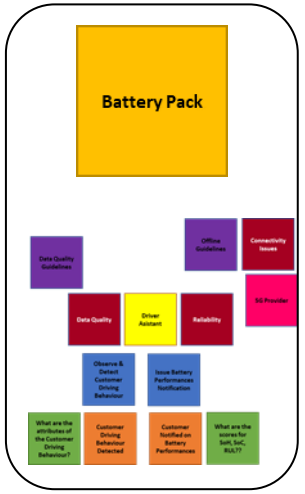

Data Quality Guidelines
Data Quality
Data Wrangler
Extract, Load and Transform Real Time Battery Behaviour Data
Connectivity Issues
Offline Guidelines
Data Wrangler
Real Time Battery Behaviour Data Received
Confidentiality & Security
Terms and Conditions – Consent Form
Business Analyst
Electric Motor
Process Real Time Battery Behaviour Data
Real Time Battery Behaviour Data Processed
Electric Motor Simulation Model Designed
Design & Instantiate the Electric Motor Simulation Model
Data Scientist
Aggregate Electric Motor Simulation Outcome
What is Signal and what is Noise?
Stream Electric Motor Simulation Telemetry
Reliability
Electric Motor Simulation Assessment Executed
Optimization Specifications
Battery Optimization Suggestions Issued
Publish Battery Optimization Suggestions
Electric Motor Telemetry Streamed
Compute Electric Motor Simulation Results
Reliability Guidelines
Electric Motor Performance and Battery Outcome
Disclaimer
Liability
Product Manager
How reliable the results are?
Data Analyst and SME
Electric Motor Simulation Results Issued


Physical Battery Design & Research


Digital Twin Battery Design & Research


Workshop Digital Twin


Workshop

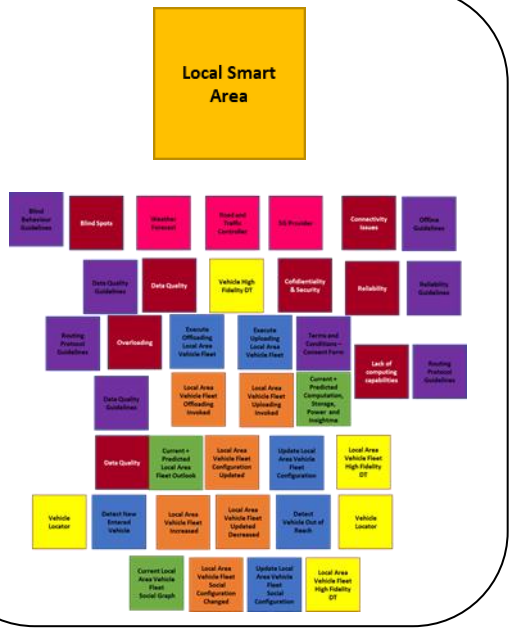

Battery Pack

Battery Pack Managing

Governance

Driving Experience

Local Smart Area



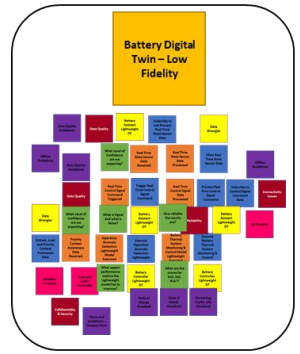
Smart Charghing Station

Battery Digital Twin – Low Fidelity

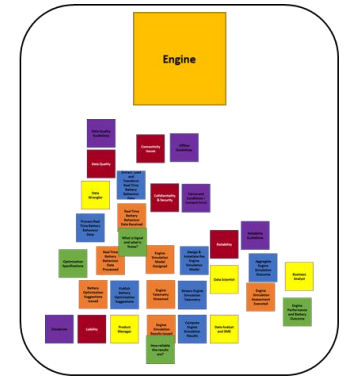
Battery Digital Twin – High Fidelity

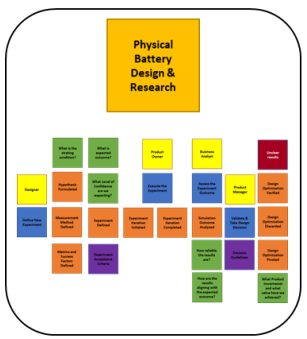
Engine

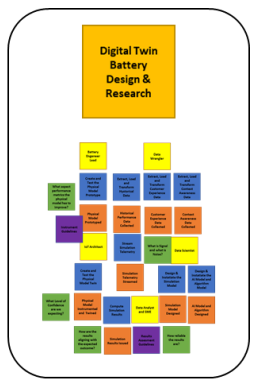
Eletric Motor


Battery Digital Twin – Low Fidelity


Battery Digital Twin – High Fidelity

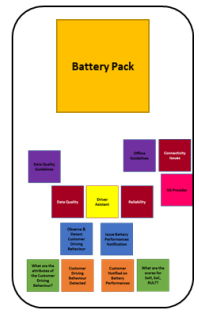

Engine

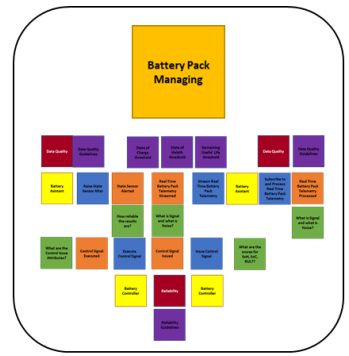

Physical Battery Design & Research

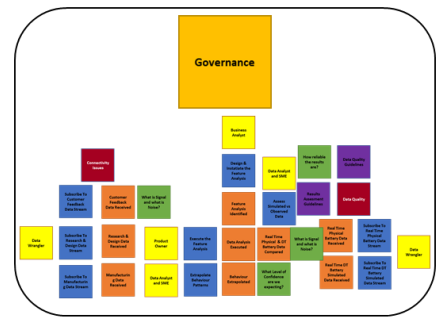

Digital Twin Battery Design & Research


Workshop Digital Twin


Workshop


Battery Pack


Battery Pack Managing

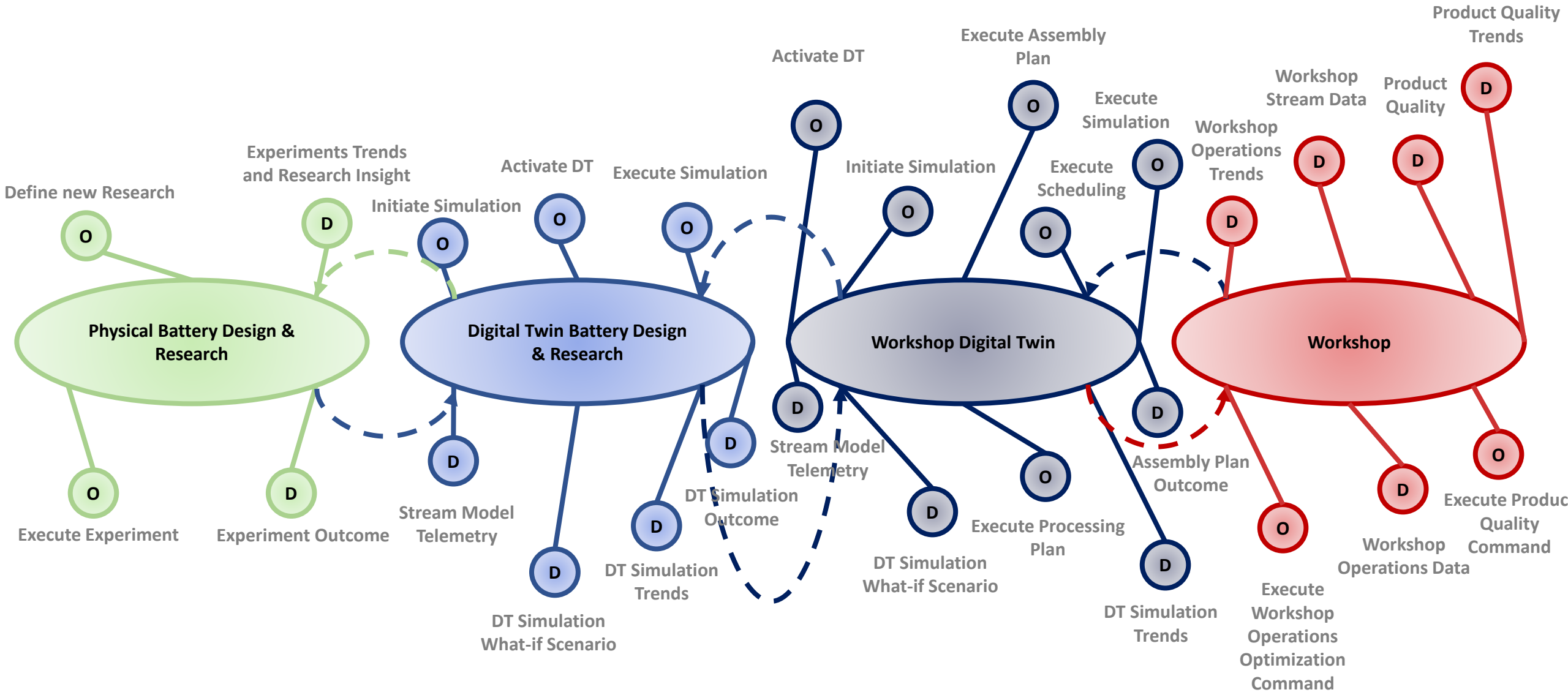

Governance

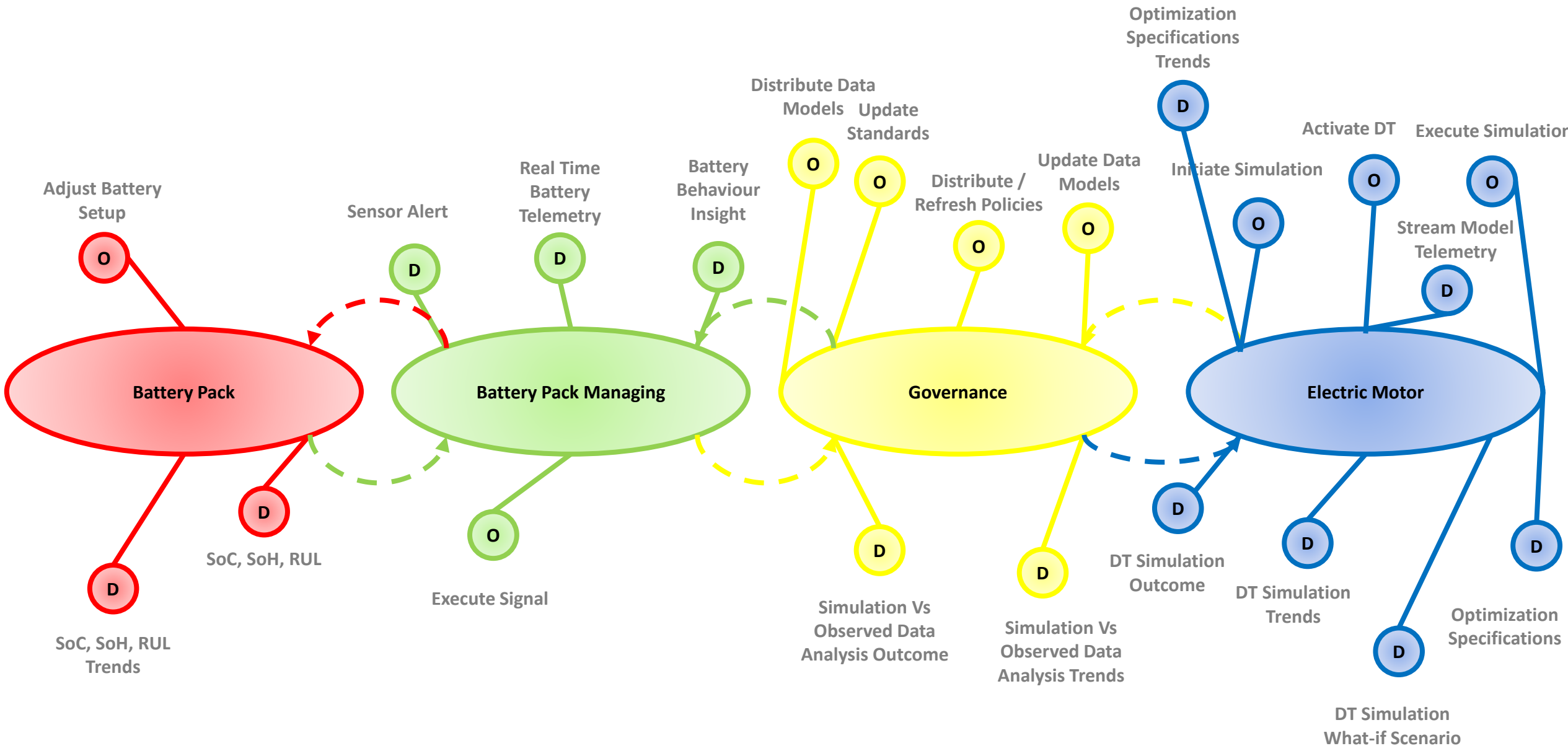

Eletric Motor

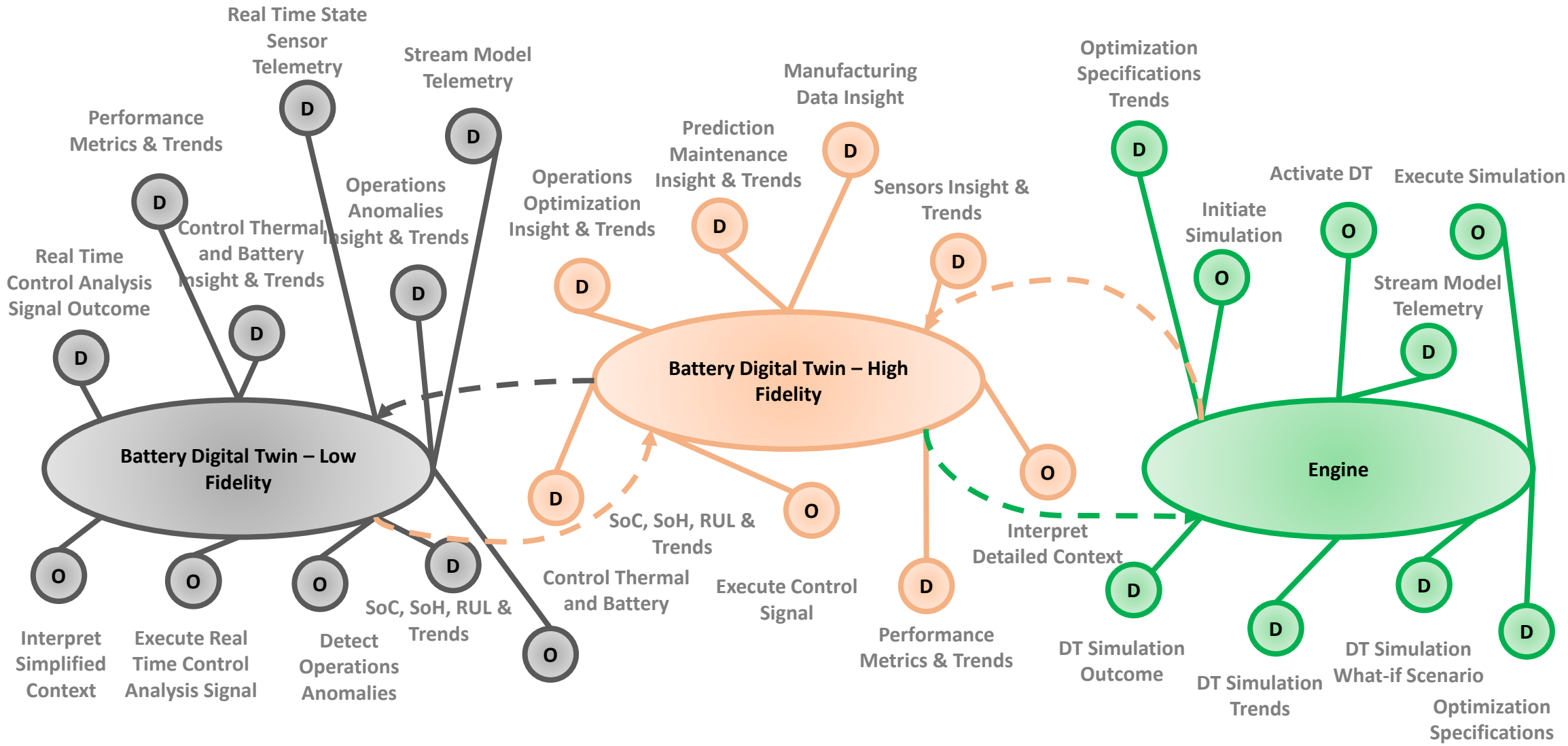

Driving Experience

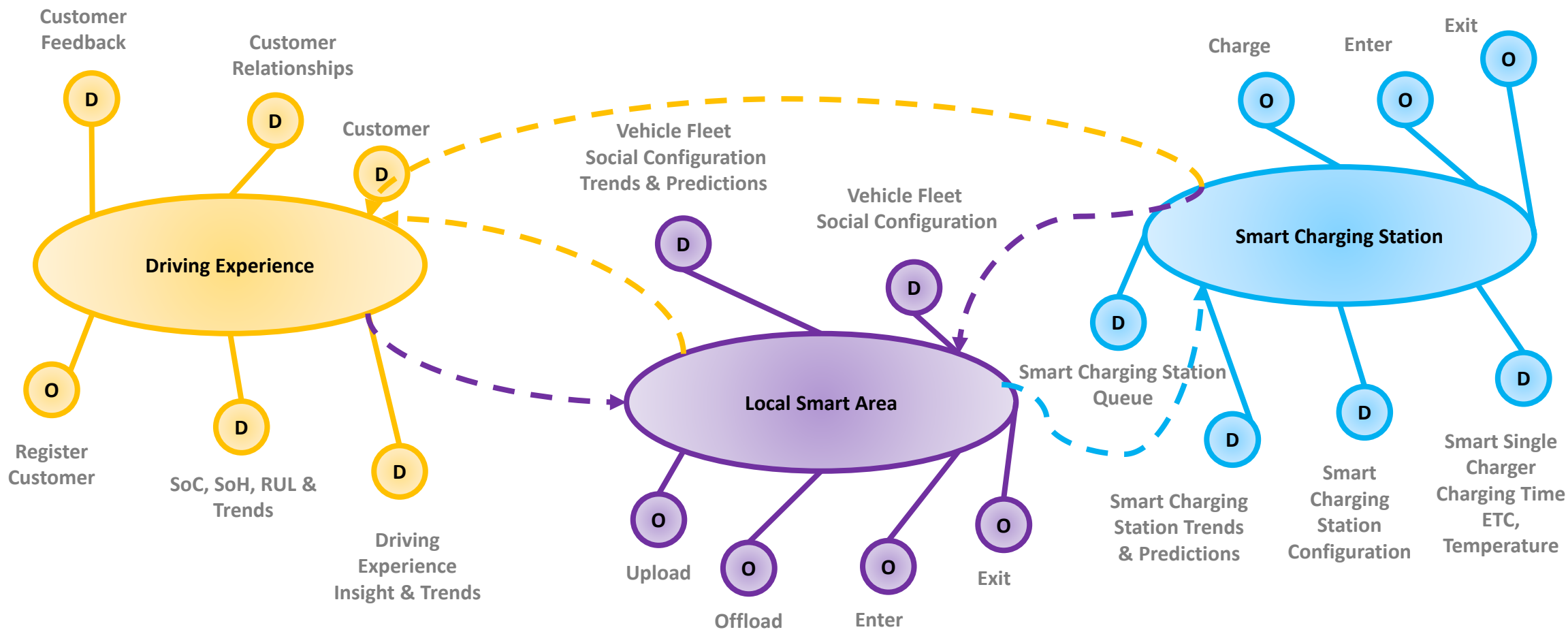

Local Smart Area

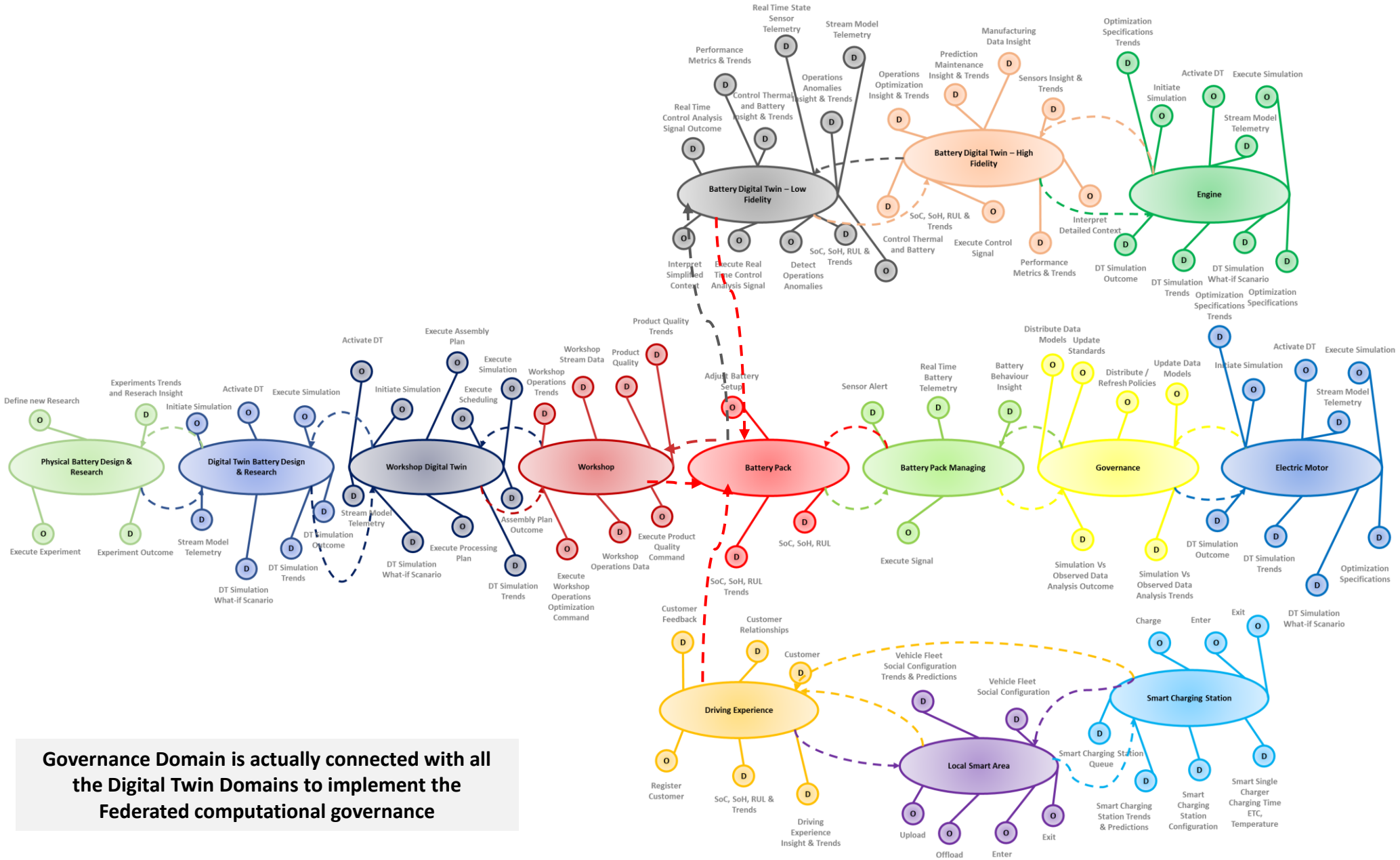

Smart Charghing Station


Physical Battery Design & Research
Digital Twin Battery Design & Research
Workshop Digital Twin
Workshop
Define new Research
Execute Experiment
Experiments Trends and Research Insight
Experiment Outcome
Initiate Simulation
Stream Model Telemetry
Activate DT
Execute Simulation
DT Simulation Outcome
DT Simulation Trends
DT Simulation What-if Scenario
Activate DT
Initiate Simulation
Stream Model Telemetry
Execute Assembly Plan
Execute Processing Plan
DT Simulation What-if Scenario
Execute Scheduling
Execute Simulation
Assembly Plan Outcome
DT Simulation Trends
Workshop Operations Trends
Execute Workshop Operations Optimization Command
Workshop Stream Data
Workshop Operations Data
Product Quality
Product Quality Trends
Execute Produc Quality Command

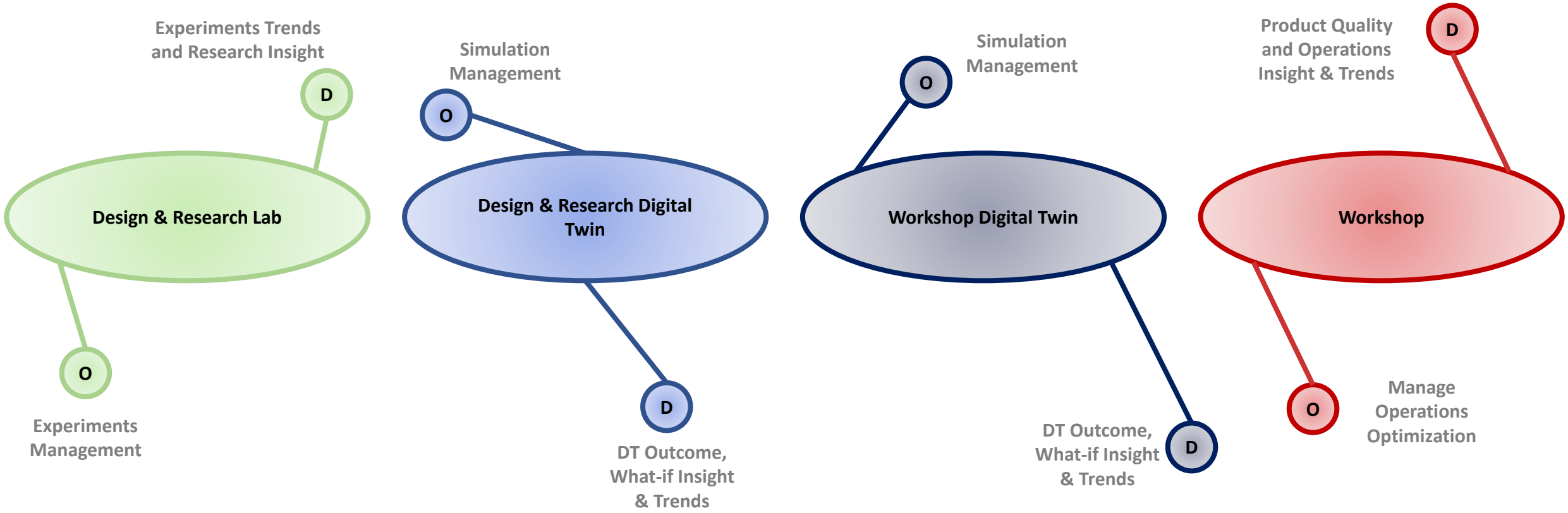

Adjust Battery Setup
O
Battery Pack
D
SoC, SoH, RUL Trends
D
SoC, SoH, RUL
Sensor Alert
D
Real Time Battery Telemetry
D
Battery Behaviour Insight
D
Battery Pack Managing
O
Execute Signal
Distribute Data Models
O
Update Standards
O
Distribute / Refresh Policies
O
Update Data Models
O
Governance
D
Simulation Vs Observed Data Analysis Outcome
D
Simulation Vs Observed Data Analysis Trends
Optimization Specifications Trends
D
Initiate Simulation
O
Activate DT
O
Execute Simulation
O
Stream Model Telemetry
D
Electric Motor
D
DT Simulation Outcome
D
DT Simulation Trends
D
DT Simulation What-if Scenario
D
Optimization Specifications

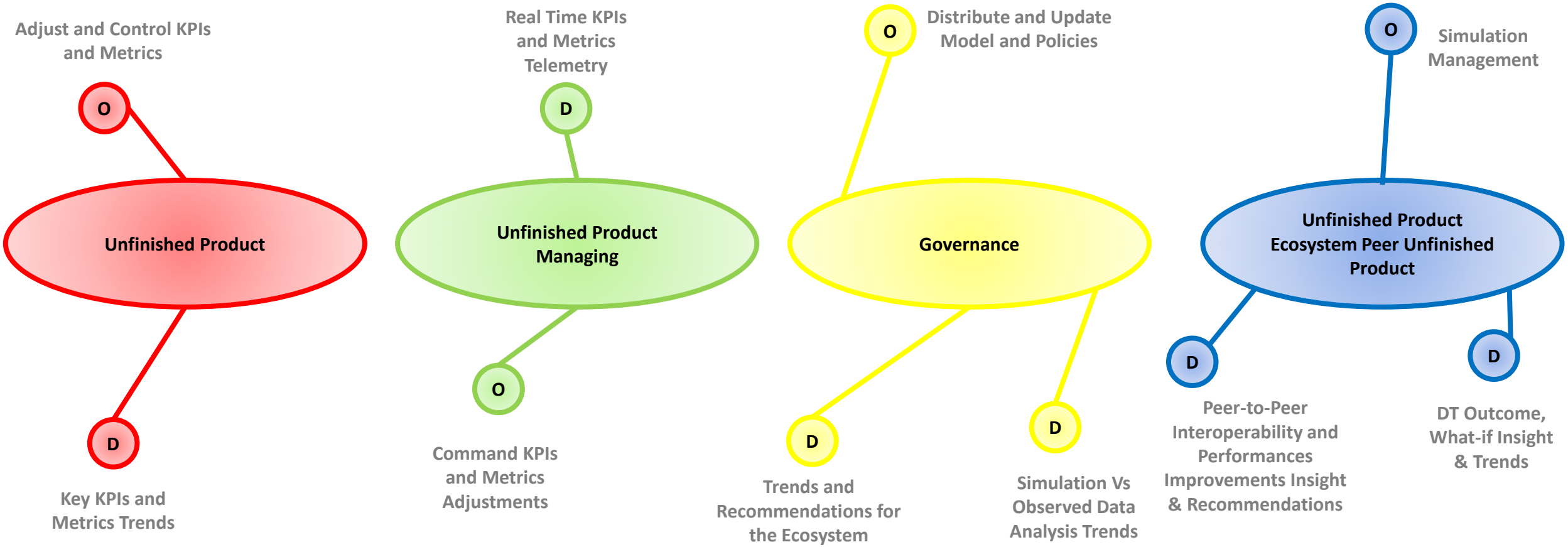

Real Time State Sensor Telemetry
Stream Model Telemetry
Performance Metrics & Trends
Control Thermal and Battery Insight & Trends
Operations Anomalies Insight & Trends
Real Time Control Analysis Signal Outcome
Battery Digital Twin – Low Fidelity
Interpret Simplified Context
Execute Real Time Control Analysis Signal
Detect Operations Anomalies
SoC, SoH, RUL & Trends
Manufacturing Data Insight
Prediction Maintenance Insight & Trends
Operations Optimization Insight & Trends
Sensors Insight & Trends
Battery Digital Twin – High Fidelity
SoC, SoH, RUL & Trends
Control Thermal and Battery
Execute Control Signal
Performance Metrics & Trends
Optimization Specifications Trends
Activate DT
Execute Simulation
Initiate Simulation
Stream Model Telemetry
Interpret Detailed Context
Engine
DT Simulation Outcome
DT Simulation Trends
DT Simulation What-if Scenario
Optimization Specifications

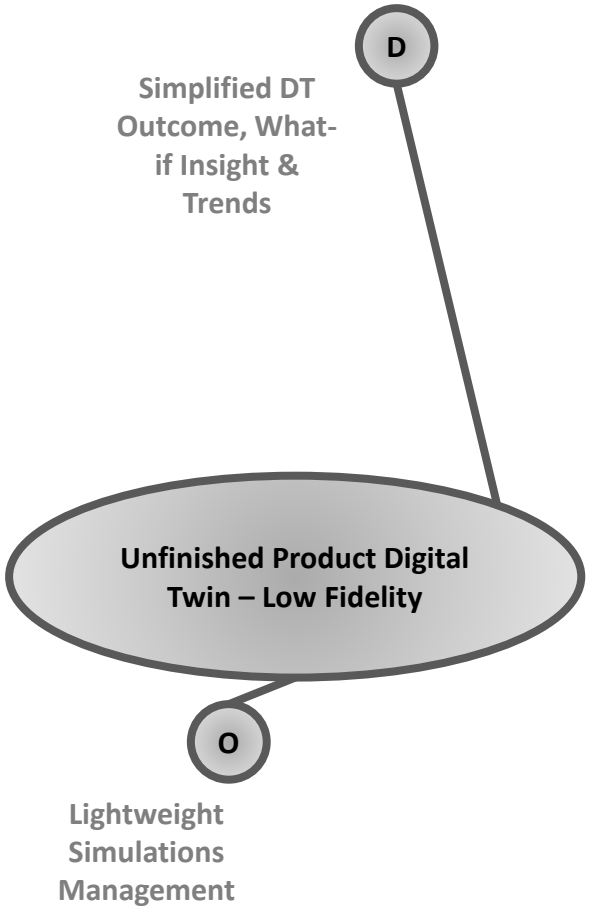

Customer Feedback
Customer Relationships
Customer
D
D
D
Driving Experience
O
D
D
Register Customer
SoC, SoH, RUL & Trends
Driving Experience Insight & Trends
Vehicle Fleet Social Configuration Trends & Predictions
Vehicle Fleet Social Configuration
D
D
Local Smart Area
O
O
O
O
Upload
Offload
Enter
Exit
Charge
Enter
Exit
O
O
O
Smart Charging Station
D
D
D
D
Smart Charging Station Queue
Smart Charging Station Trends & Predictions
Smart Charging Station Configuration
Smart Single Charger Charging Time ETC, Temperature

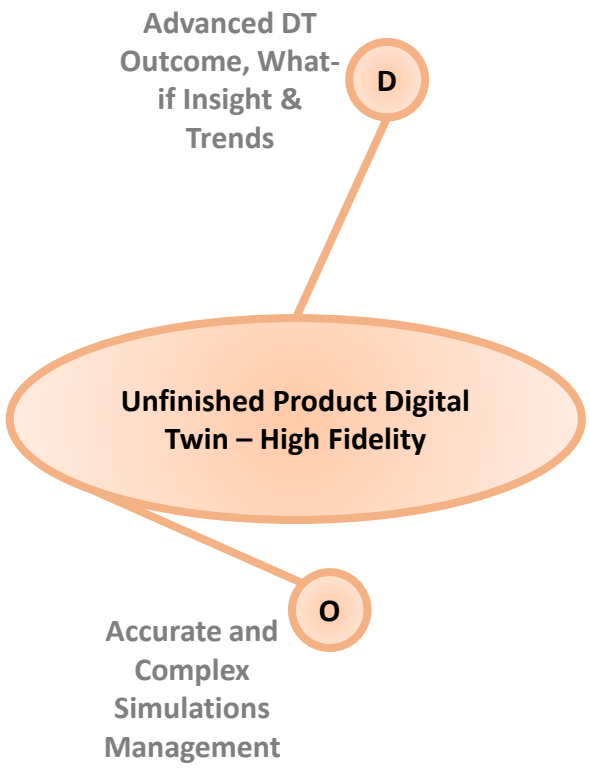


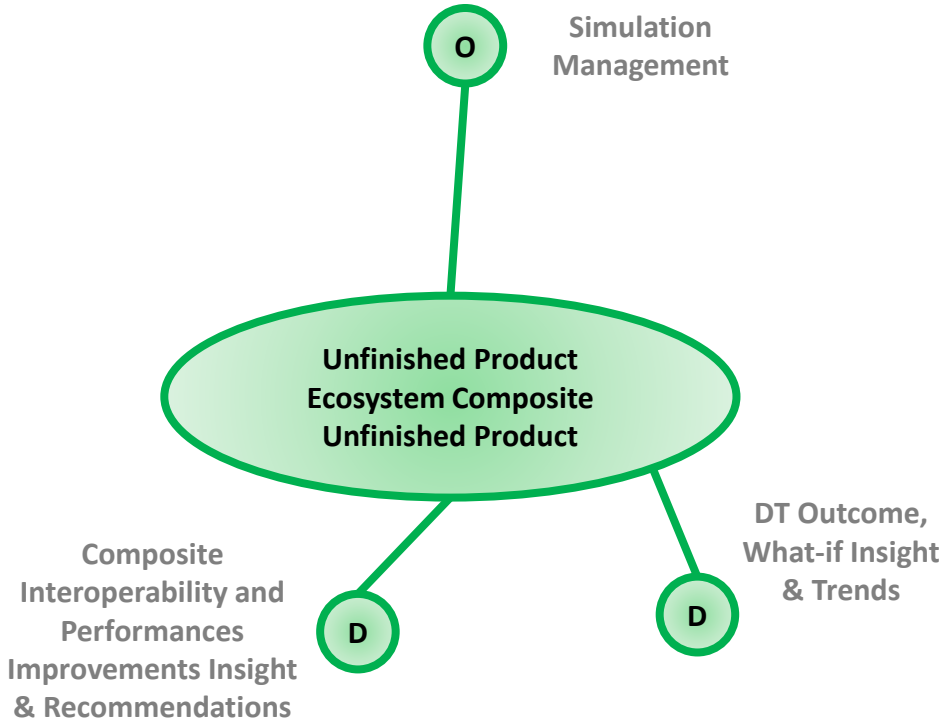
Governance Domain is actually connected with all the Digital Twin Domains to implement the Federated computational governance

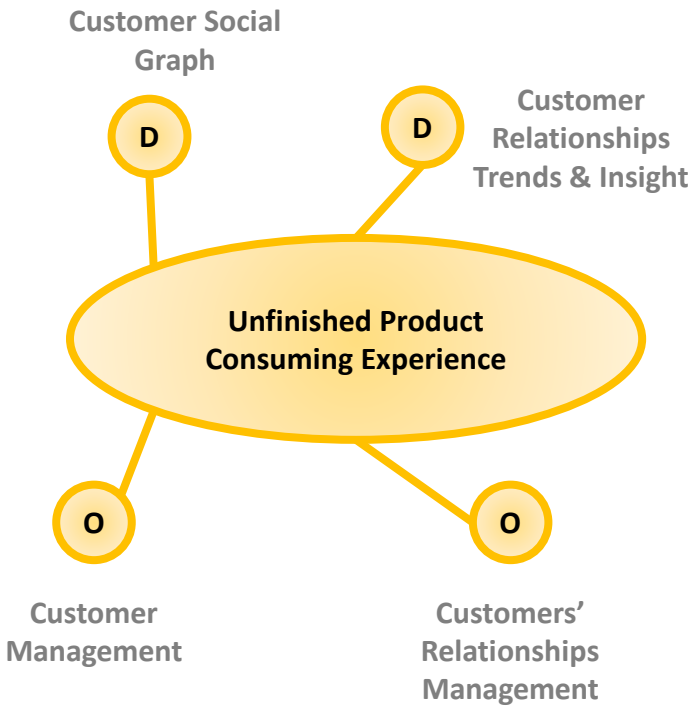

Experiments Trends and Research Insight
D
Design & Research Lab
O
Experiments Management
Simulation Management
O
Design & Research Digital Twin
D
DT Outcome, What-if Insight & Trends
Simulation Management
O
Workshop Digital Twin
DT Outcome, What-if Insight & Trends
D
Product Quality and Operations Insight & Trends
D
Workshop
O
Manage Operations Optimization

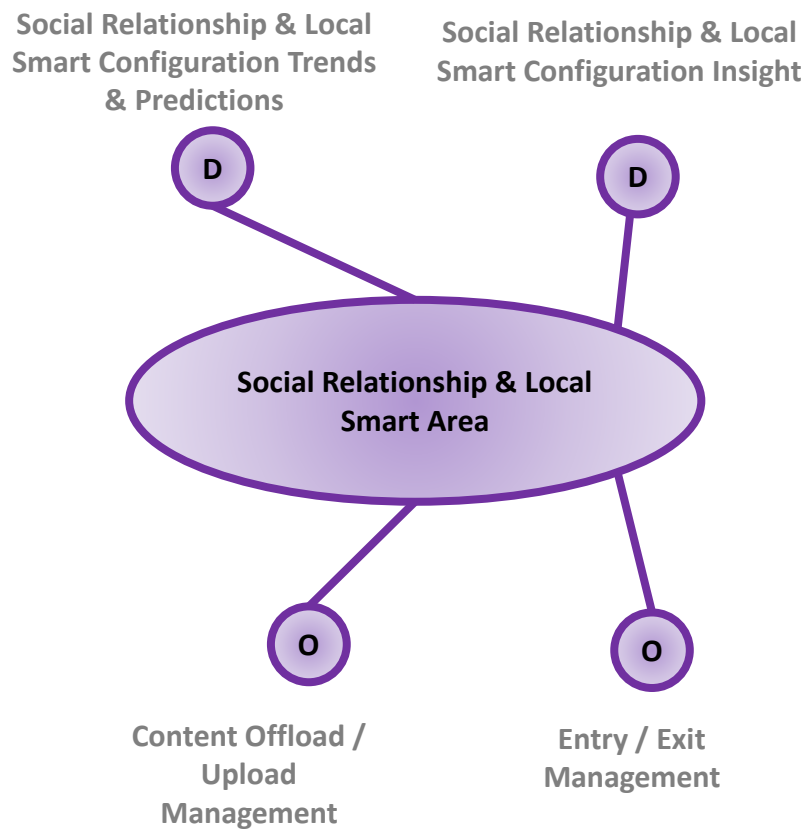

Adjust and Control KPIs and Metrics
O
Unfinished Product
D
Key KPIs and Metrics Trends
Real Time KPIs and Metrics Telemetry
D
Unfinished Product Managing
O
Command KPIs and Metrics Adjustments
O
Distribute and Update Model and Policies
Governance
D
Trends and Recommendations for the Ecosystem
D
Simulation Vs Observed Data Analysis Trends
O
Simulation Management
Unfinished Product Ecosystem Peer Unfinished Product
D
Peer-to-Peer Interoperability and Performances Improvements Insight & Recommendations
D
DT Outcome, What-if Insight & Trends

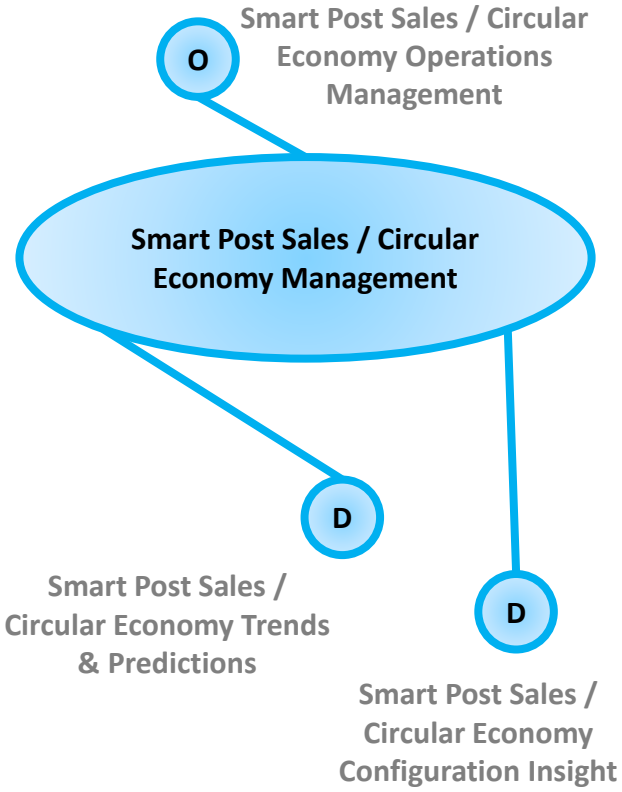

D
Simplified DT Outcome, What-if Insight & Trends
Unfinished Product Digital Twin – Low Fidelity
O
Lightweight Simulations Management

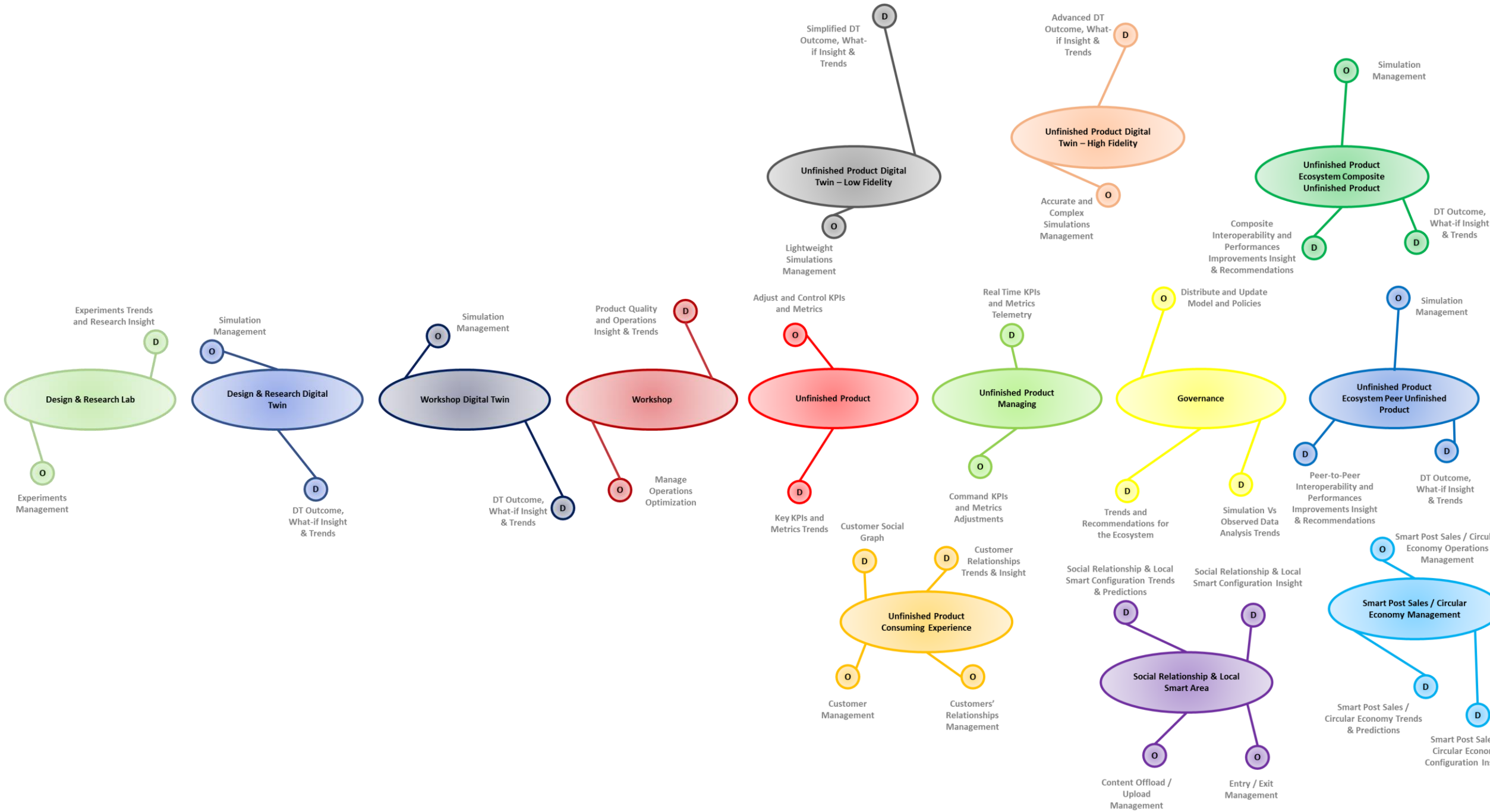

Advanced DT Outcome, What-if Insight & Trends
D
Unfinished Product Digital Twin – High Fidelity
O
Accurate and Complex Simulations Management


O
Simulation Management
Unfinished Product Ecosystem Composite Unfinished Product
Composite Interoperability and Performances Improvements Insight & Recommendations
D
D
DT Outcome, What-if Insight & Trends


Customer Social Graph
D
D
Customer Relationships Trends & Insight
Unfinished Product Consuming Experience
O
O
Customer Management
Customers' Relationships Management


Social Relationship & Local Smart Configuration Trends & Predictions
Social Relationship & Local Smart Configuration Insight
D
D
Social Relationship & Local Smart Area
O
O
Content Offload / Upload Management
Entry / Exit Management


O
Smart Post Sales / Circular Economy Operations Management
Smart Post Sales / Circular Economy Management
D
D
Smart Post Sales / Circular Economy Trends & Predictions
Smart Post Sales / Circular Economy Configuration Insight


Simplified DT Outcome, What-if Insight & Trends
Unfinished Product Digital Twin – Low Fidelity
Lightweight Simulations Management
Advanced DT Outcome, What-if Insight & Trends
Unfinished Product Digital Twin – High Fidelity
Accurate and Complex Simulations Management
Simulation Management
Unfinished Product Ecosystem Composite Unfinished Product
Composite Interoperability and Performances Improvements Insight & Recommendations
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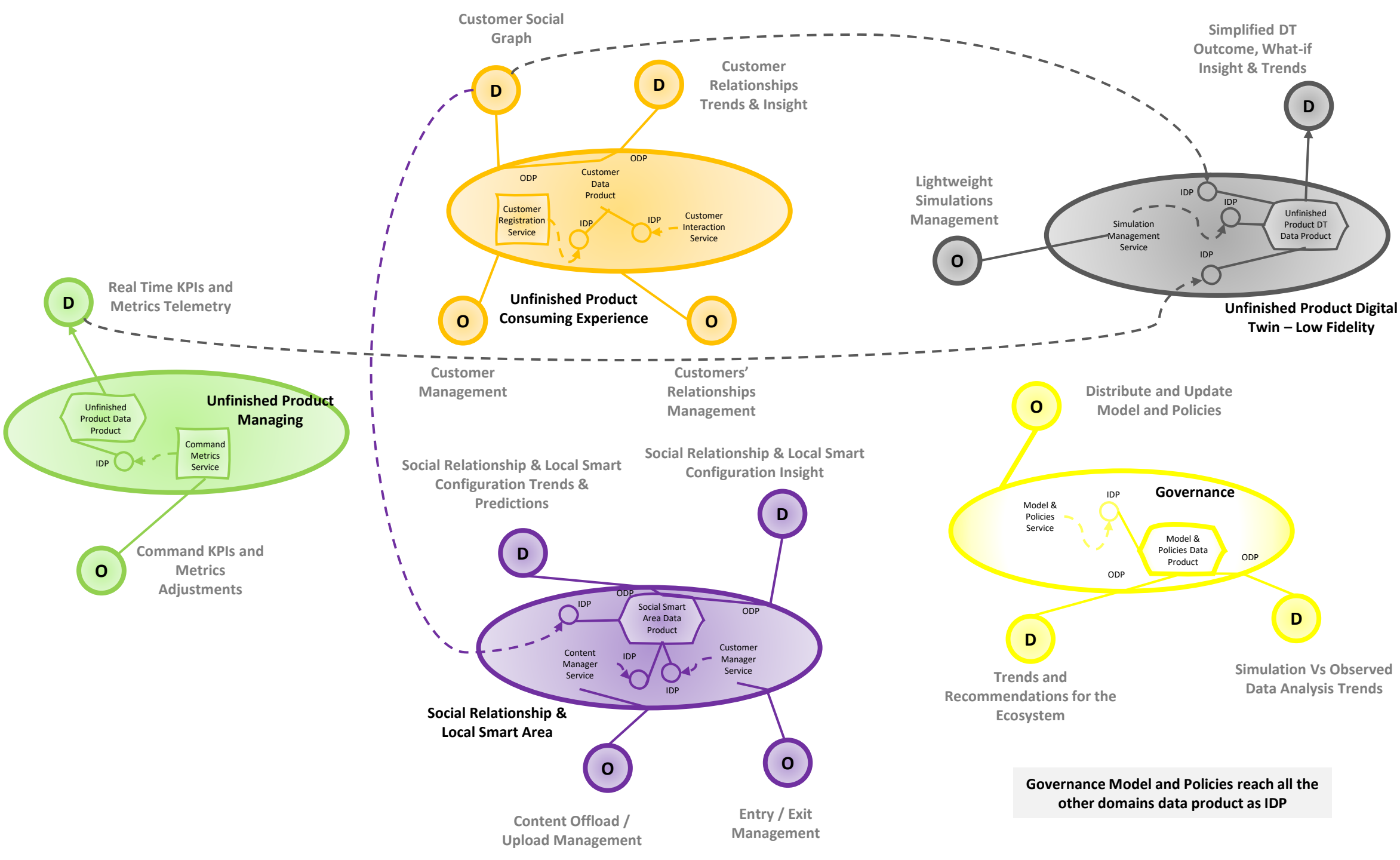
Smart Post Sales / Circular Economy Operations Management
Smart Post Sales / Circular Economy Management
Smart Post Sales / Circular Economy Trends & Predictions
Smart Post Sales / Circular Economy Configuration Insight

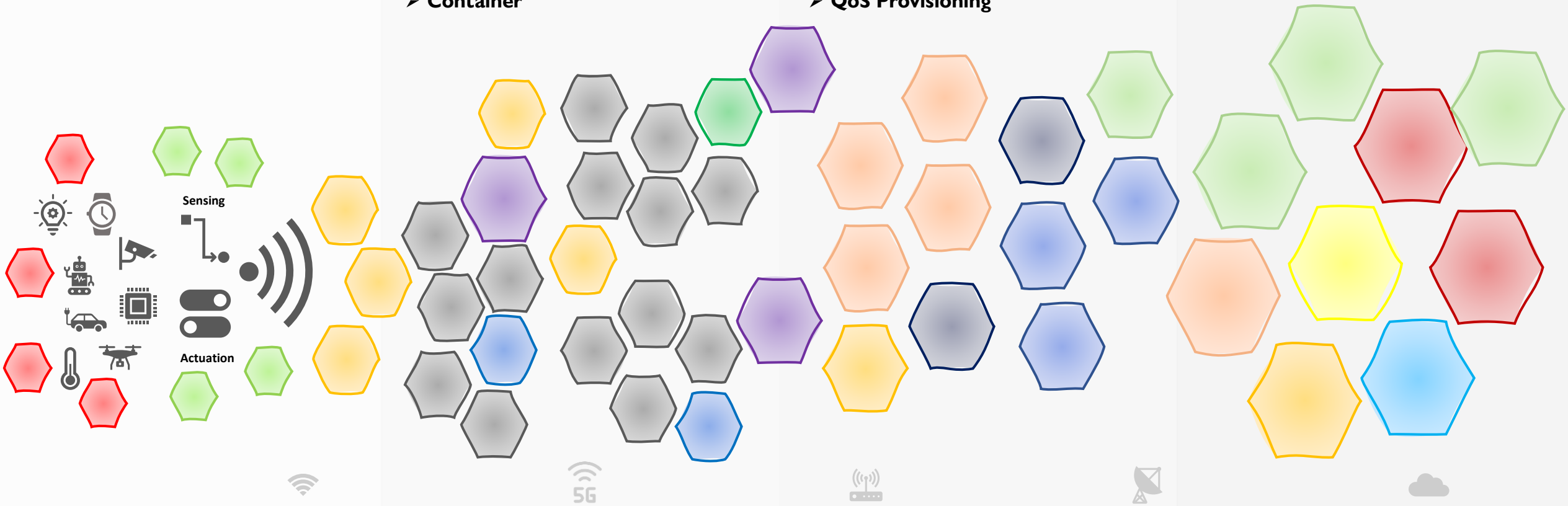

Customer Social Graph
Customer Relationships Trends & Insight
Simplified DT Outcome, What-if Insight & Trends
Lightweight Simulations Management
Real Time KPIs and Metrics Telemetry
Unfinished Product Consuming Experience
Unfinished Product Digital Twin – Low Fidelity
Unfinished Product Managing
Unfinished Product Data Product
Command Metrics Service
Command KPIs and Metrics Adjustments
Customer Management
Customers' Relationships Management
Social Relationship & Local Smart Configuration Trends & Predictions
Social Relationship & Local Smart Configuration Insight
Social Relationship & Local Smart Area
Content Offload / Upload Management
Entry / Exit Management
Distribute and Update Model and Policies
Governance
Trends and Recommendations for the Ecosystem
Simulation Vs Observed Data Analysis Trends
Governance Model and Policies reach all the other domains data product as IDP

- Embedded Software Firmware
- Over-the-air (OTA) updates
- Automatic Device Configuration
- Container

- Light Digital Twin / Analytics
- Light Real Time Services
- Light Real Time Visualization
- Product2Product Communication
- Collaboration
- QoS Controlling
- Data caching and short term storage service
- Container

- Digital Twin / Advanced Analytics
- Advanced Real Time Services
- Advanced Real Time Visualization
- Collaboration and Control
- Data caching and mid-term storage service
- PaaS
- Task Management
- QoS Provisioning

- High Performance Computing
- AI Model Development & Distribution
- Batch & Long Run processing
- Large and Scalable data storage
- Extended Native Cloud Architecture Platform
- Enterprise Architecture



End Device | **Nano Edge** | **Edge** | **Fog** | **Cloud**

Cloud Continuum

- Real Time
- Sovereignty
- Localization

- Computational Power
- „Infinitive" Data Storage
- Integration Services

Unfinished Product

This is the physical part of the Unfinished Product. It mainly provides actuating and sensing/telemetry functionalities. Based on firmware embedded technology.

Unfinished Product Managing

This is the meta part of the Unfinished Product, the smart product. It address the where, what, how, when real time question on the Unfinished Product key metrics. Based on firmware embedded technology or container [advanced].

Unfinished Product Consuming Experience

Provides the Customer Social Graph and the Customer Relationships Trends & Insight . It spans across all the Cloud Continuum scaling capabilities, speed and depth optimizing the underneath available resources.

Unfinished Product Digital Twin – Low Fidelity

Lightweight DT of the Unfinished Product implemented at the edge (ideally nano). Powered by AI/ML able to provide what-if limited scenarios with an agreed minimal accuracy. Container based; the model is trained elsewhere.

Social Relationship & Local Smart Area

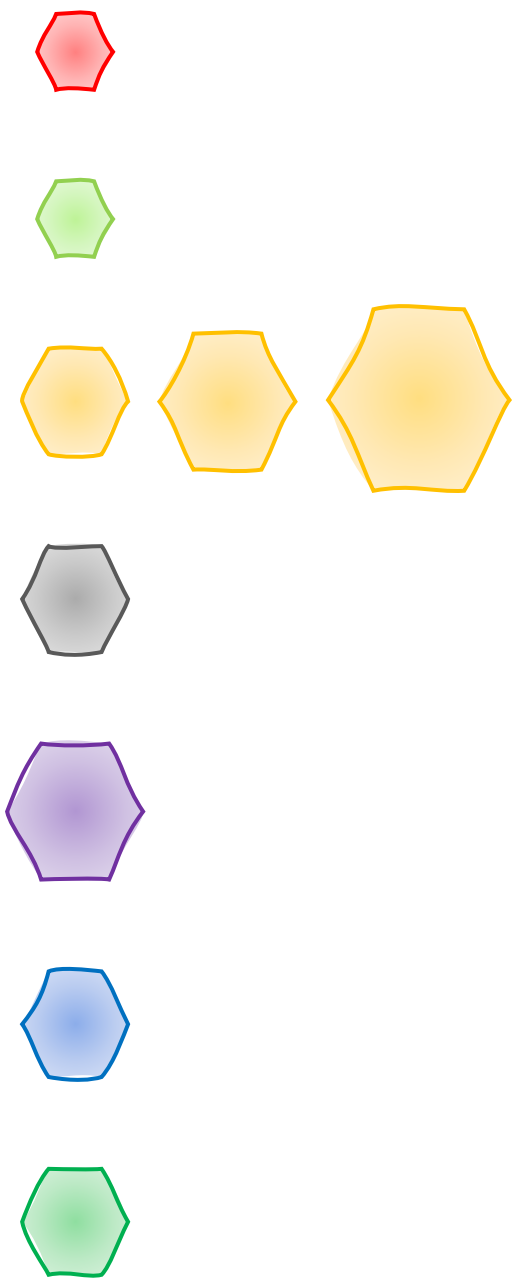
It is defined by the social interactions the owner of the Unfinished Product established as well as the dependencies between Unfinished Product themselves. Powered by AI/ML able to provide what-if scenarios with good accuracy. Container based; the model is trained locally or elsewhere.

Unfinished Product Ecosystem Peer Unfinished Product

Another Unfinished Product of the ecosystem , act independently and collaborate in a topology based on mesh and peers. The Unfinished Products exchange value The collaboration is happening at least at edge level.

Unfinished Product Ecosystem Composite Unfinished Product

Another Unfinished Product of the ecosystem, The Unfinished Products creates value together thanks to a dynamic topologies and common objectives. The collaboration is happening at least at edge level.



Workshop Digital Twin

Meta space symbiosis engine by performing simulations of the workshop operations. Powered by advanced AI/ML model. Real-time is not the primary requirement.

Design & Research Digital Twin

Meta space symbiosis engine by performing simulations of the experiments, trends and predicted outcomes. Powered by advanced AI/ML model. Real-time is not the primary requirement but some specific scenarios.

Workshop

This is the physical and meta space where manufacturing operations and product quality activities are formulated and performed. Use AL/ML models and HPC computing processes. Requires large resources and scale. Develops the intelligence models deployed to the ecosystem DTs.

Governance

It does engage the federated computational governance. Distribute the intelligence models and policies to the ecosystem DTs. Requires a Central Cloud like scale of resources. Real-time is not the primary requirement.

Smart Post Sales / Circular Economy Management

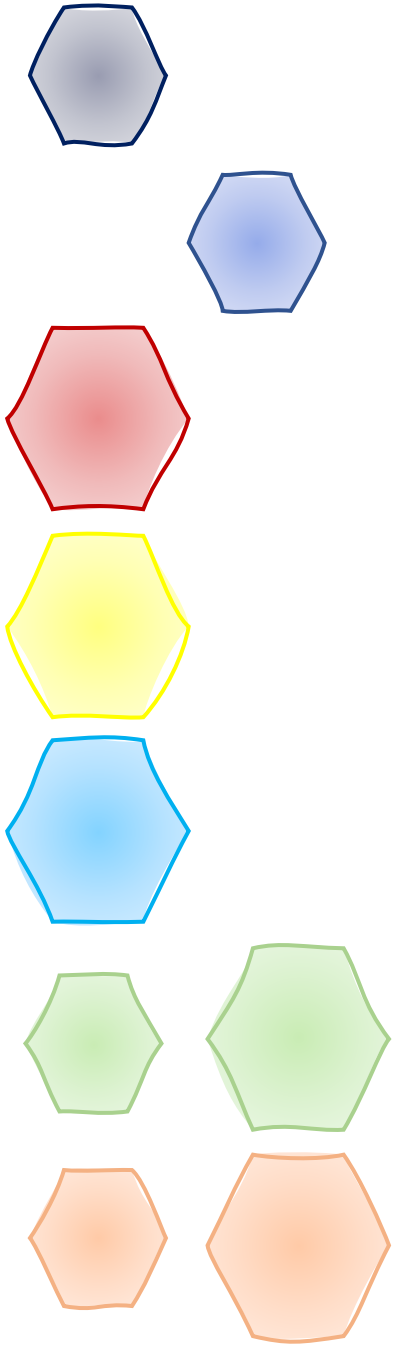
It handles the challenges of circular economy and the marketspace that can be built around the Unfinished Product.. Use AL/ML models and HPC computing processes. Requires large resources and scale. Develops circular models deployed to the ecosystem DTs.

Design & Research Lab

This is the physical and meta space where innovation hypotheses are formulated, and experiments are performed . Use AL/ML models and HPC computing processes. Requires large resources and scale. Develops the intelligence models deployed for experiments DTs.

Unfinished Product Digital Twin – High Fidelity

Advanced DT of the Unfinished Product implemented at the edge and/or fog. Powered by AI/ML and potentially cognitive services, able to provide what-if advanced scenarios with an agreed minimal accuracy. Container based; the model could be trained locally (edge, fog, Cloud).

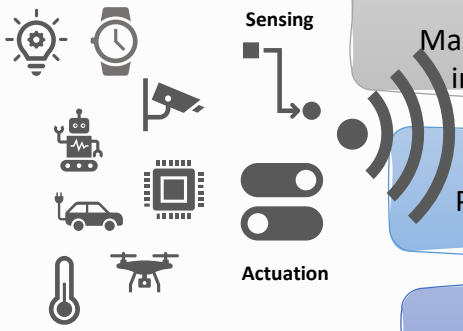


SYMBIOTIC RELATIONSHIPS

Actuation Commands | Scripting & Notifications | Rule Based Decisions | Cognitive Decisions | Human In The Loop | Intensive Analysis / Historical Trend Analysis

Assets Quality Inspection
Mainly machine to machine interactions focused on operations and connected products firmware embedded capabilities.

Multi-Platform
Mainly machine to machine interactions leveraging the Social IoT enabled by the engaged digital platforms.



Infrastructural Sensors
Mainly machine to machine collaborations based on intelligent models / decision tree interactions via DTs. Humans are notified and engaged in case of crisis situations.

Human Collaboration
Partnership between a human and digital platform. Computational resources are substantial but not infinitive.

System of Systems
Complex partnership between a human and various digital platforms. Computational resources might be intensive with high degree of integrations

5G

End Device | **Nano Edge** | **Edge** | **Fog** | **Cloud**

Cloud Continuum

- **Real Time**
- **Sovereignty**
- **Localization**

- **Computational Power**
- **„Infinitive" Data Storage**
- **Integration Services**