



# A Manufacturing Exchange for Modular, Composable, and Interoperable Mass Customization (ECCS-1543872)

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## Motivation and Challenges

### Predictive Analysis:

- Feasibility of manufacturing orders (admission control)
- Modular and composable production planning

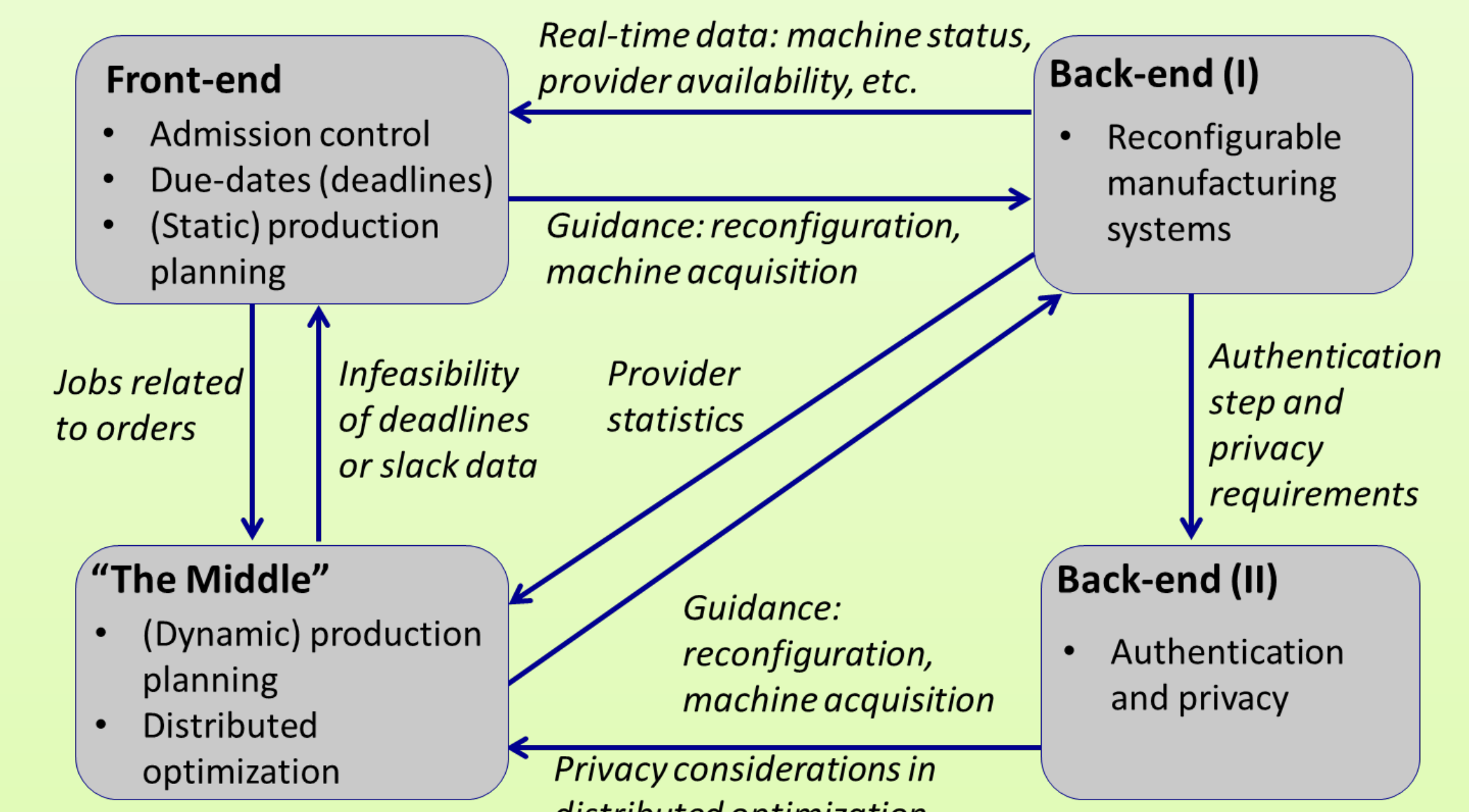
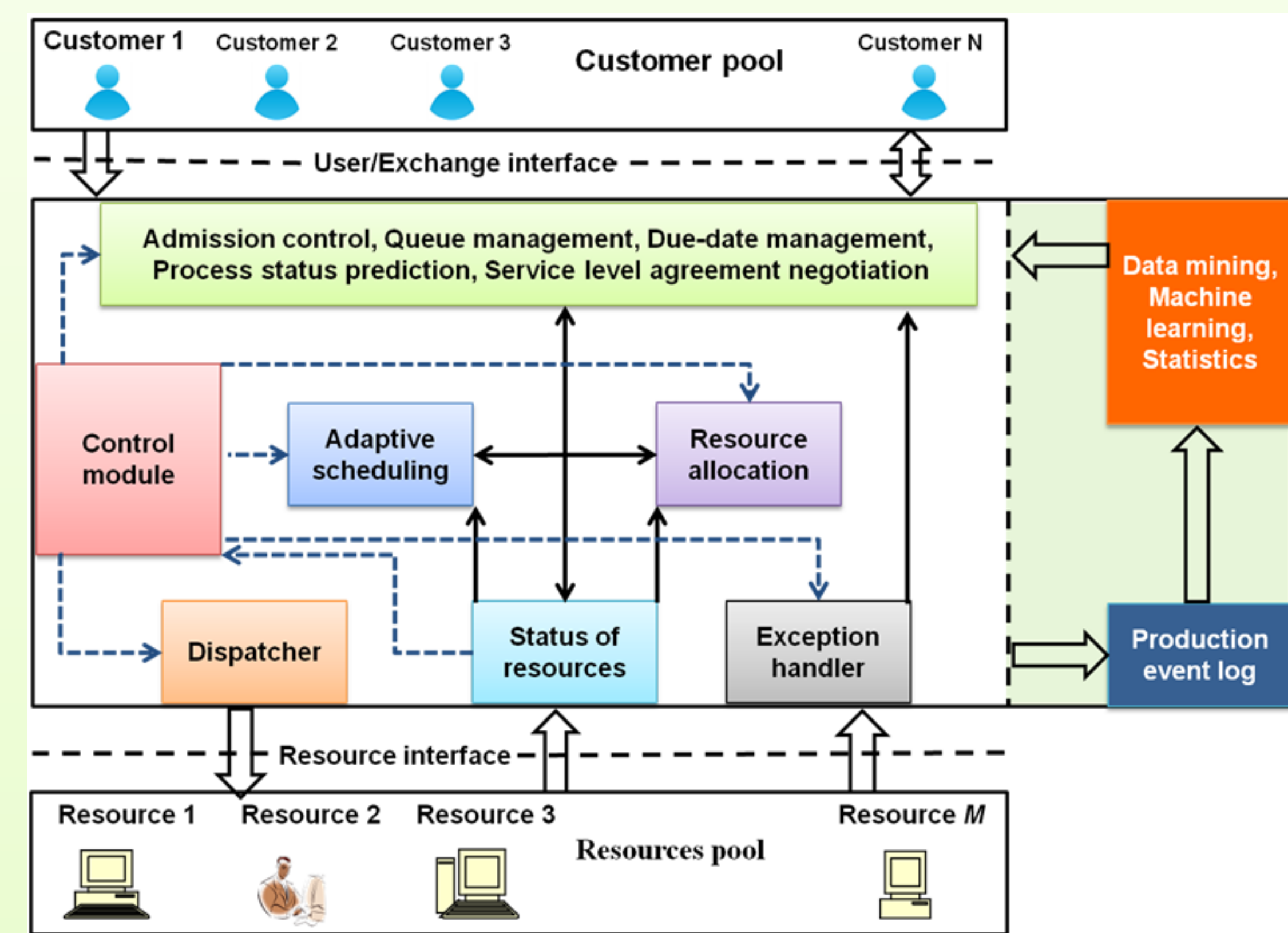
### Flexibility and Resilience:

- Dynamic demands, changes in the group of providers
- Serve large number of users concurrently (distributed optimization)

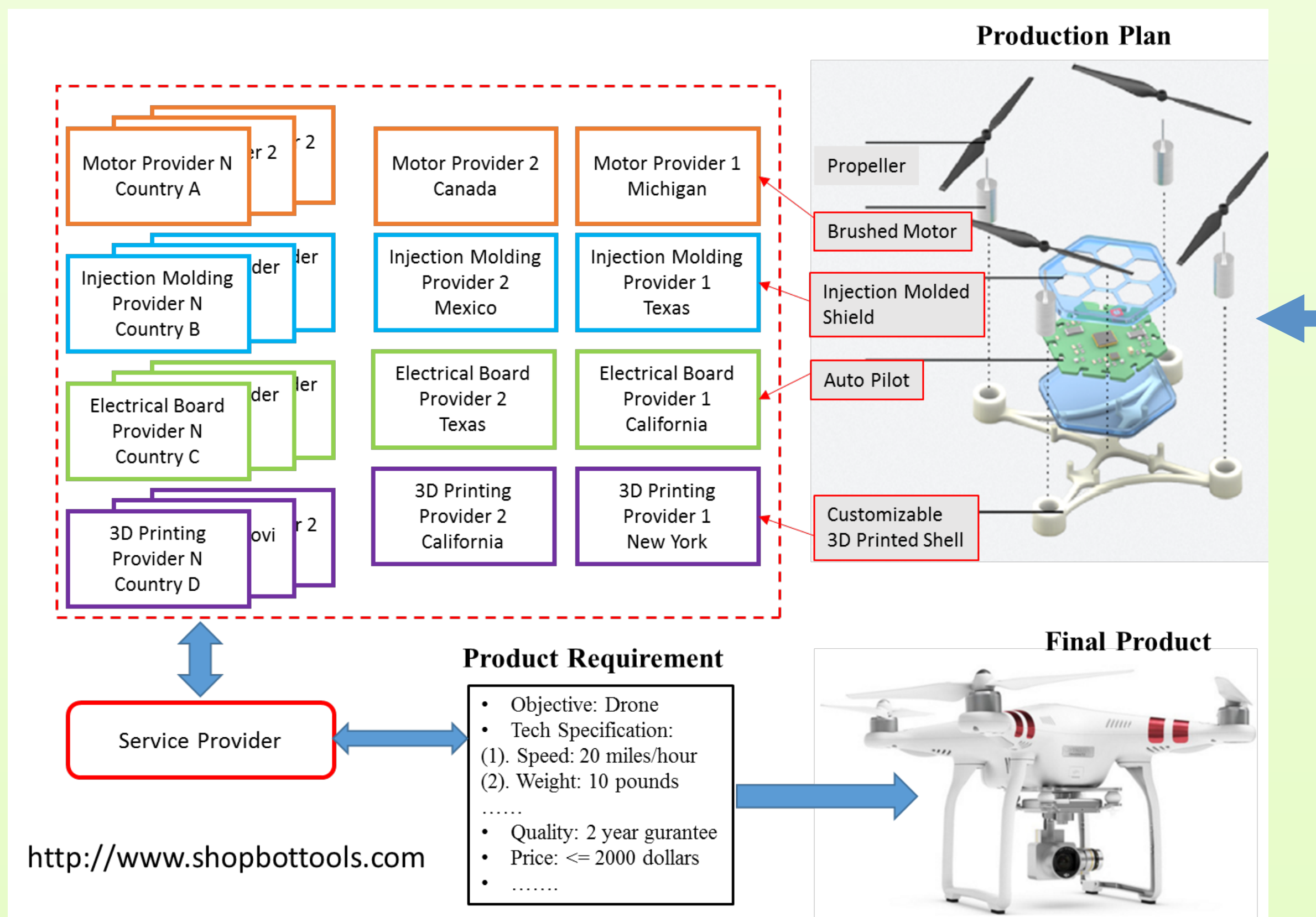
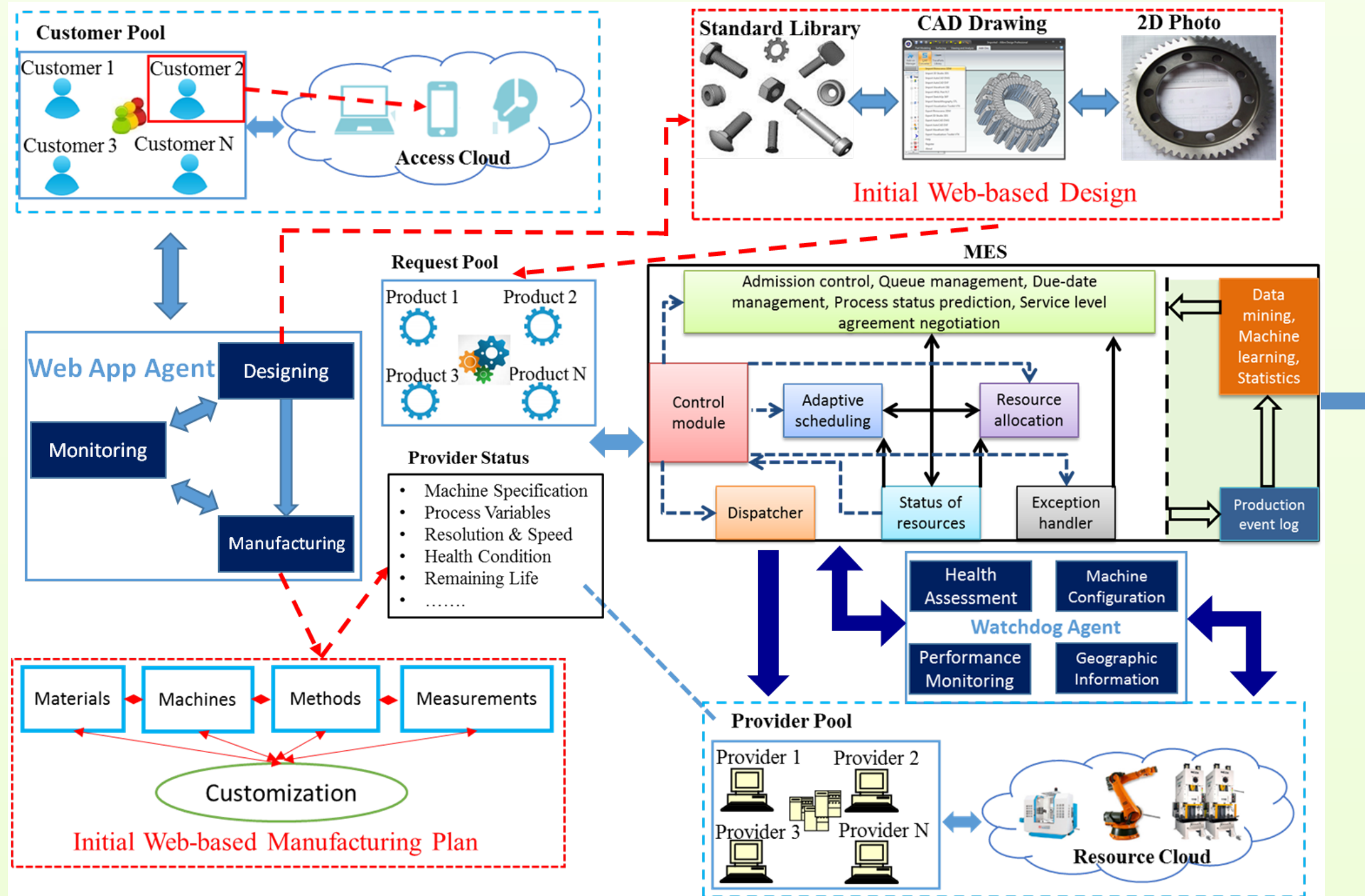
### Reconfiguration and Fault Tolerance:

- Easily integrated, scalable, convertible, and self-diagnosable
- Predict failures and identify malicious intrusions

## Manufacturing Exchange (ME)



## Work Flow of Manufacturing Exchange



### Web App Agent:

- Customizable manufacturing plans for different customers

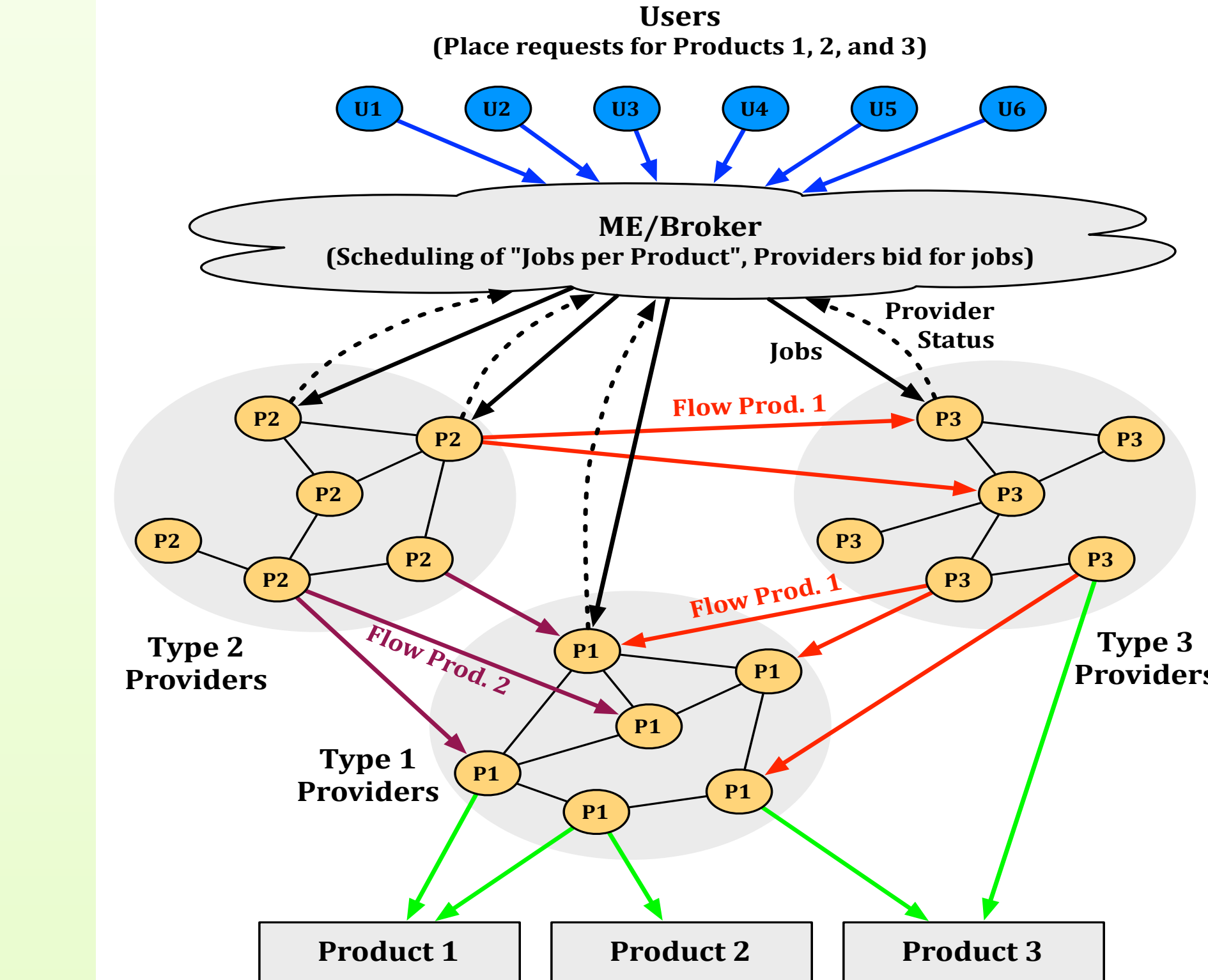
### Admission Agent:

- Evaluate feasibility of incoming manufacturing orders
- Monitor dynamic demands from large number of customers

### Watchdog Agent:

- Monitor changing status of different service providers
- Fault-tolerant task scheduling and dispatching

## Distributed Optimization in ME



Each agent  $i$  observes local time varying objective:

$$f_{li,t} \quad \text{Cost: } \sum_{i=1}^n f_{li,t}(x_{li}(t))$$

$$f_{li,t+1} \quad \text{Constraint: } \sum_{i=1}^n g_{li}(x_{li}(t)) \leq 0$$

Regret in objective and constraint:

$$R(T) = \sum_{t=1}^T \sum_{i=1}^n f_{li,t}(x_{li}(t)) - f^*$$

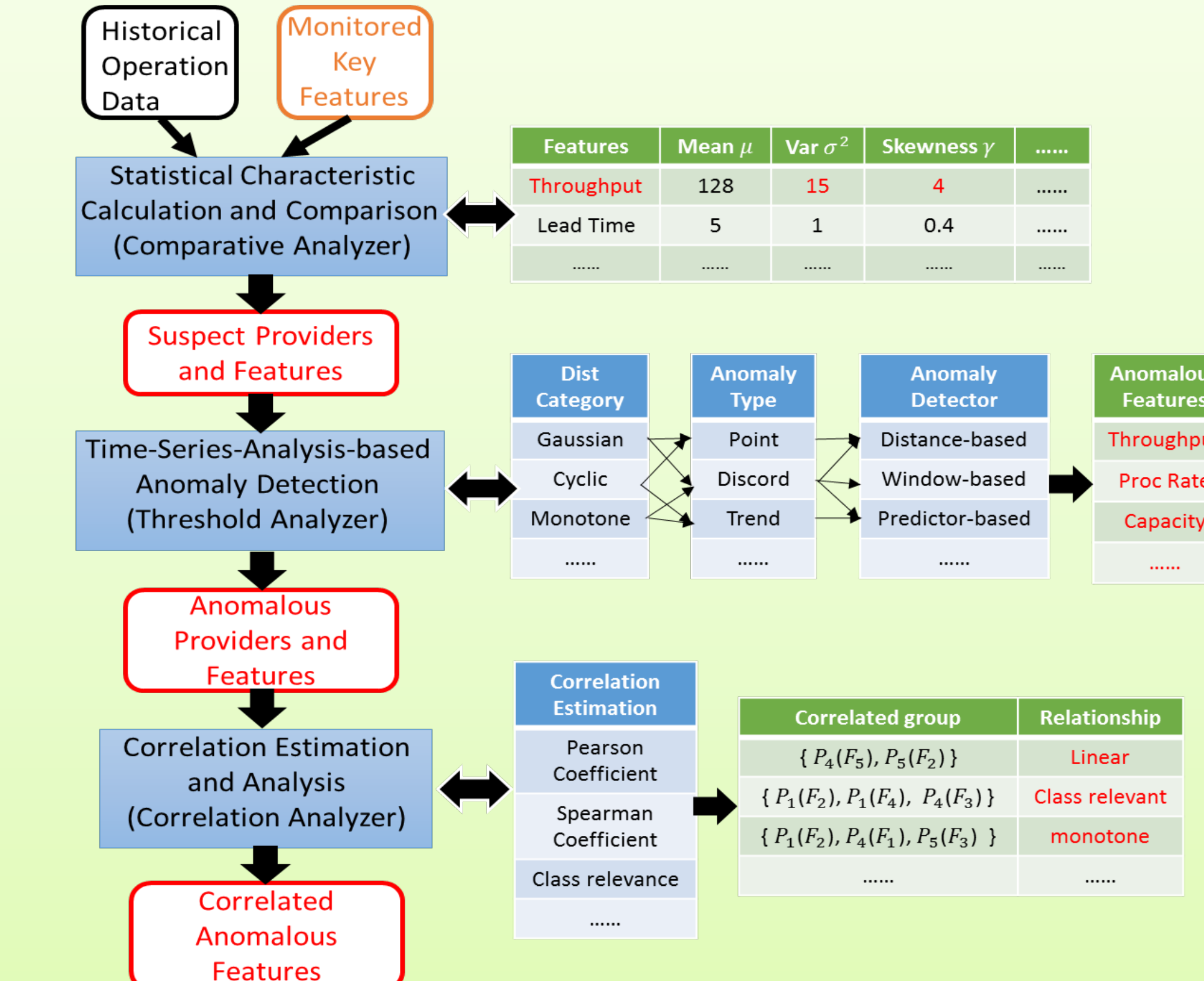
$$\text{where } f^* = \min_{x_{li}} \sum_{i=1}^n g_{li}(x_{li}) \leq 0 \quad \sum_{t=1}^T \sum_{i=1}^n f_{li,t}(x_{li}(t))$$

$$R_{lc}(T) = \sum_{t=1}^T \sum_{i=1}^n [g_{li}(x_{li}(t))]_{+}$$

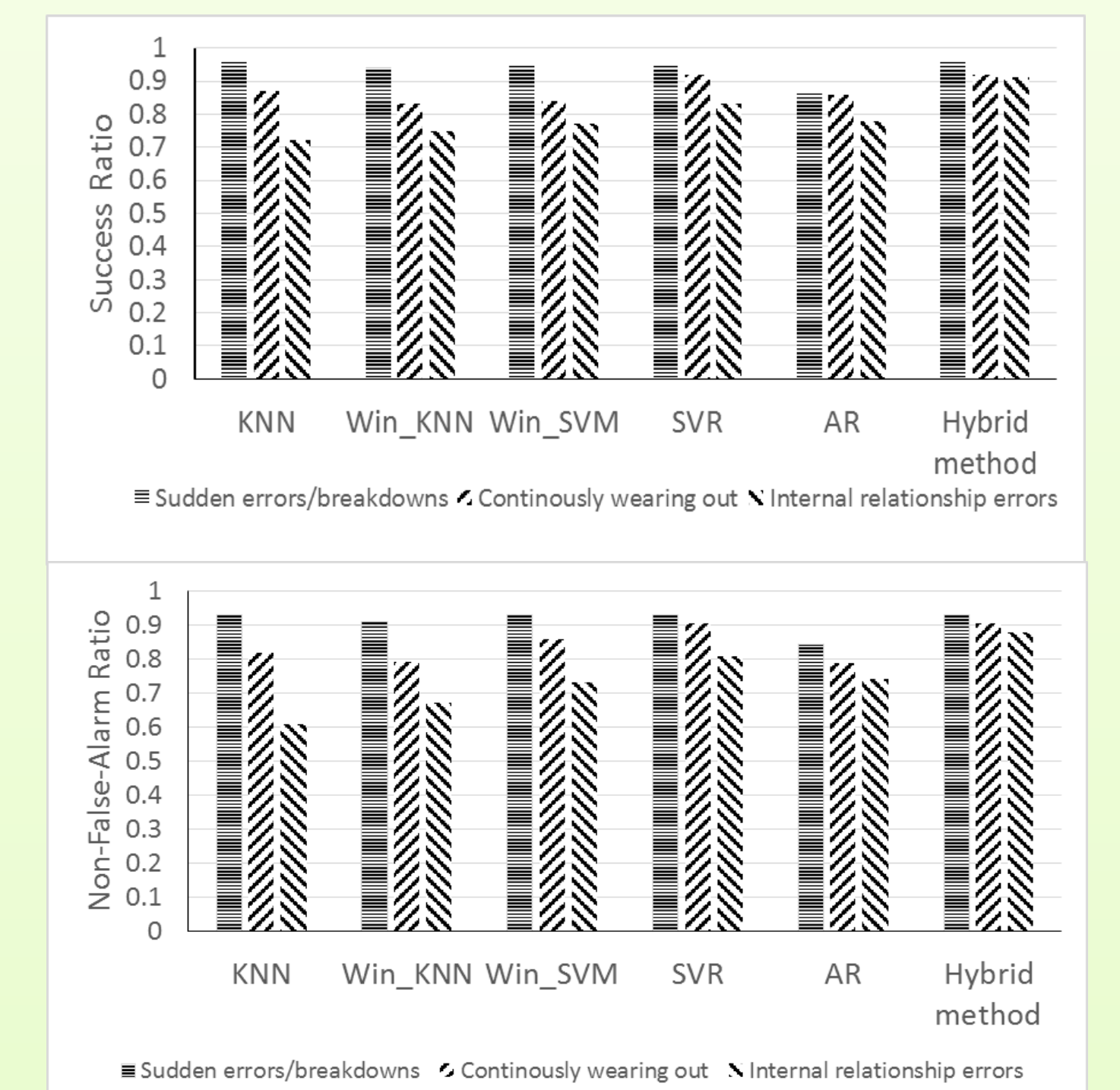
Goal: Design a local policy for choosing  $x_{li}(t)$  such that

$$R(T) = o(T) \text{ and } R_{lc}(T) = o(T)$$

## Anomaly Detection in ME



- **Comparative Analyzer:** Filter stable features
- **Threshold Analyzer:** Identify anomalous features
- **Correlation Analyzer:** Remove irrelevant anomalies



- (1) Distance-based (KNN) anomaly detection:
  - Perform well for sudden errors/breakdowns and bad for internal relationship errors.
- (2) Window-based anomaly detection:
  - Accurate when errors have cyclic trend.
- (3) Prediction-based anomaly detection:
  - Able to detect internal relationship errors
- (4) Hybrid anomaly detection:
  - Incorporate the above three kinds of anomaly detection methods.

## Conclusions

1. Manufacturing Exchange viewed as a compiler
  - Transfer customizable customer requests to executable code
2. Manufacturing Exchange viewed as a distributed operating system
  - Distributed task management, scheduling, reconfiguration
3. Manufacturing Exchange is flexible and fault tolerant
  - Accurate identification and fast recovery for different types of errors