

FROM MONITORING TO INTELLIGENCE IN CYBER PHYSICAL SYSTEMS

Dr. Sabari Nathan Anbalagan
s.n.anbalagan@utwente.nl

The Problem

How can we ensure reliability and resilience of CPS amidst increasing complexity and emergent issues?

Timeline of Solutions

**FAILURE
MONITORING**
Physical and
manual logging
leading to reactive
maintenance.

PRE-
2000

2000
-2010

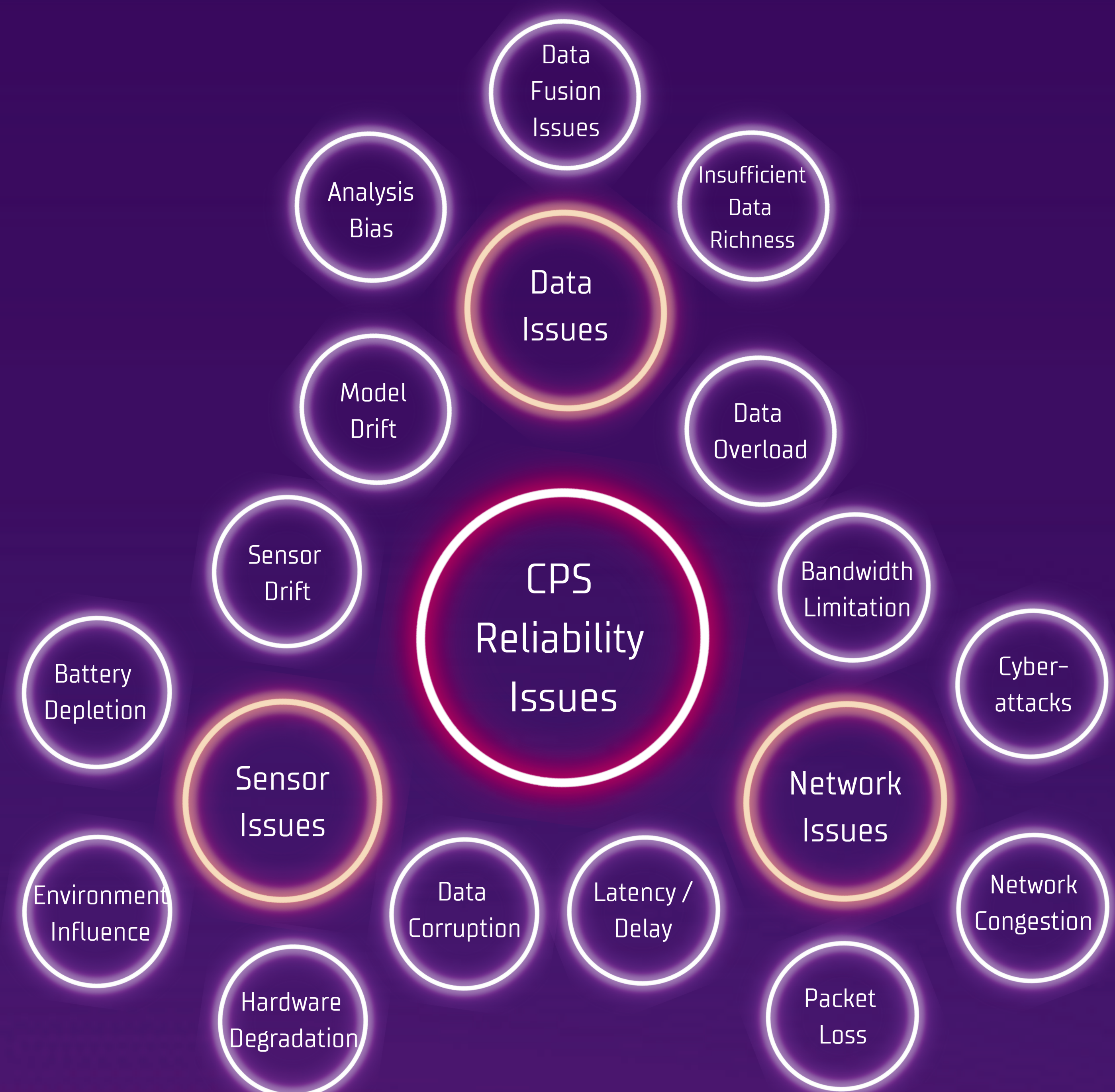
**FAULT
DIAGNOSIS**
Primitive machine
learning era
characterized by
pattern recognition.

2010 -
2020

2020
- NOW

**OUTLIER
DETECTION**
Setting statistical
thresholds for
anomaly
detection.

**SYSTEM
AWARENESS**
Large-scale
sensor fusion and
early AI



The Future – Agentic AI for CPS Reliability

Agentic AI refers to **goal-based** AI models that can **Think**, **Execute** and **Observe** autonomously using tools to interact with external environments.

Goal-based

Agents operate with clear objectives, optimizing actions to achieve defined goals.

Think

Agents can analyse data using AI models. They can form hypothesis and plan strategies

Observe

Agents monitor systems continuously, gathering feedback to refine their strategies.

Execute

Agents act autonomously, applying strategies through tools to influence the environment.

Goal: Zero Unscheduled Downtime

- Think
 - Analyse data from sensors (temperature, vibration) and networks (latency, communication quality)
 - Form hypothesis by combining information from above and Plan a predictive maintenance and workload distribution to prevent failure.
- Execute
 - Acts by adjusting the workload, increases bandwidth on the network and schedules maintenance
 - Optimizes the parameters continuously to strategies to meet the goal
- Observe
 - Monitors all parameters across systems – sensors, networks, data.
 - Learns and incorporates to improve strategies over time.

