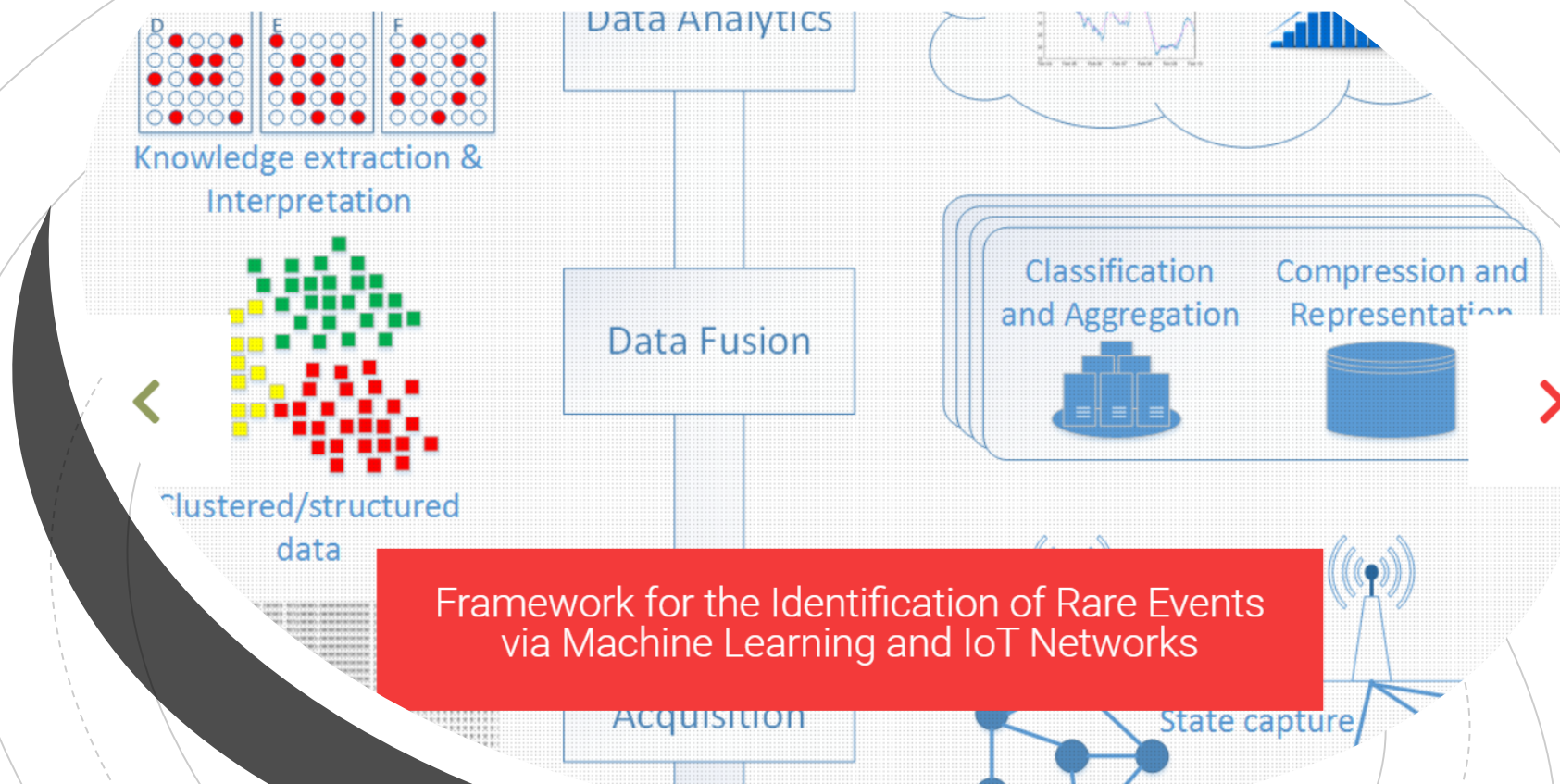




FIREMAN

Pedro Nardelli

March 29, 2022





Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin



FIREMAN approach

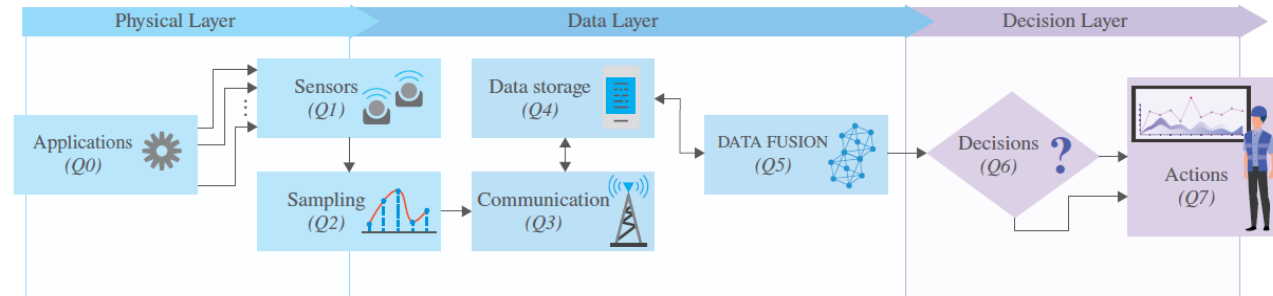
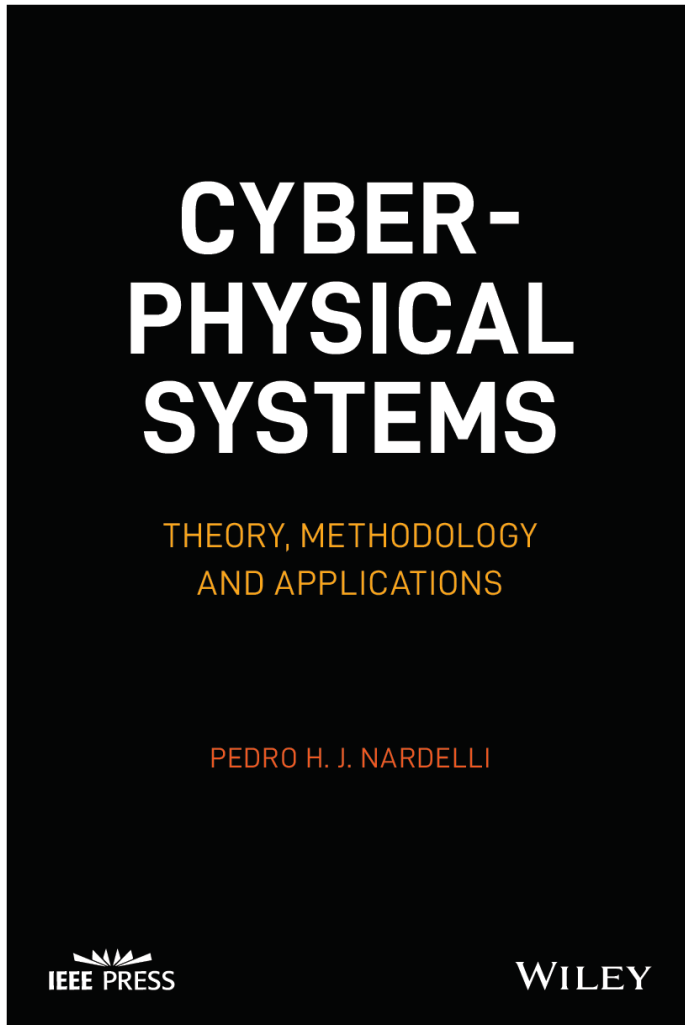
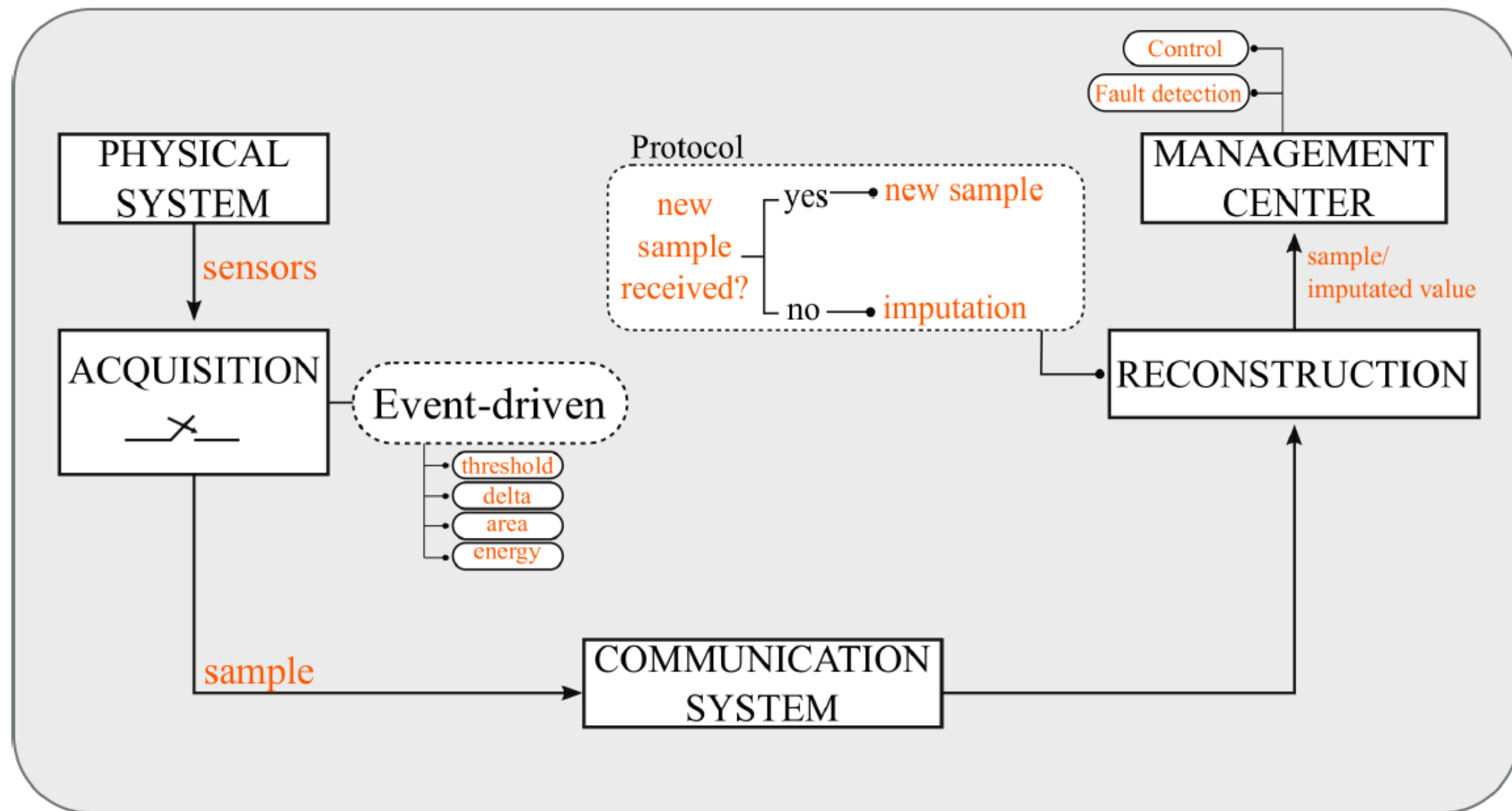


Fig. 1: Illustration of the three layers of CPSs and their physical deployment.

TABLE I: Guiding questions to study and/or design CPSs

<i>Q#</i>	Topic	Related Question
<i>Q0</i>	Applications	What are the applications to be implemented and their relation to the CPS function?
<i>Q1</i>	Sensors	What kinds of sensors will be used? How many of each can be used? Where can they be located?
<i>Q2</i>	Samples	Which type of sampling (data acquisition) method will be used? How data are coded?
<i>Q3</i>	Communication	Which type of communication system (access, edge and core technologies) will be used?
<i>Q4</i>	Data storage	Where are the data from sensors stored and processed (locally, in the edge and/or in the cloud)?
<i>Q5</i>	Data fusion	Will the data be clustered, aggregated, structured, or suppressed? How?
<i>Q6</i>	Decisions	How will the (informative) data be used to make decisions?
<i>Q7</i>	Actions	Are there actuators and/or human interfaces? If yes, how many and where?



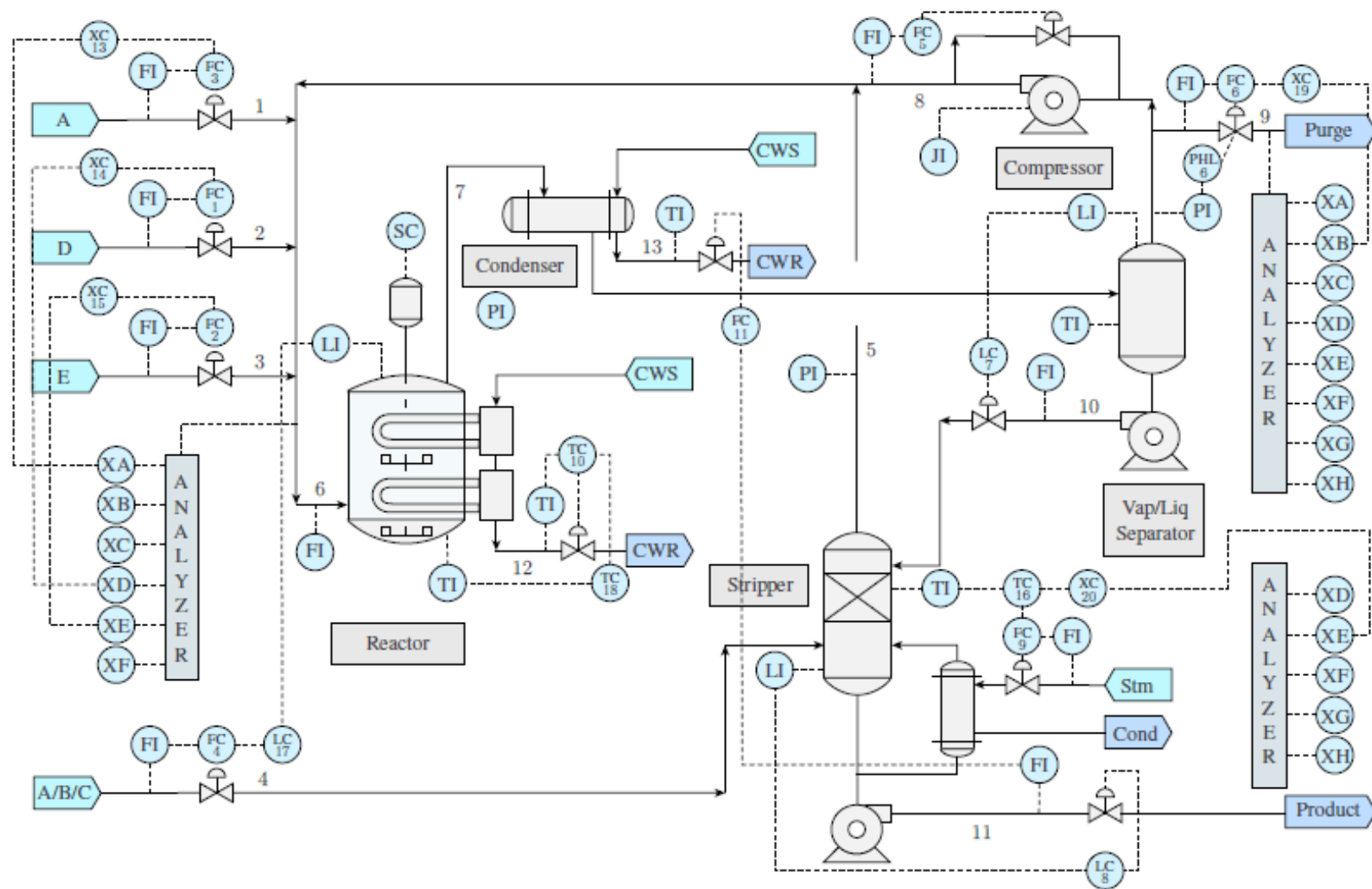
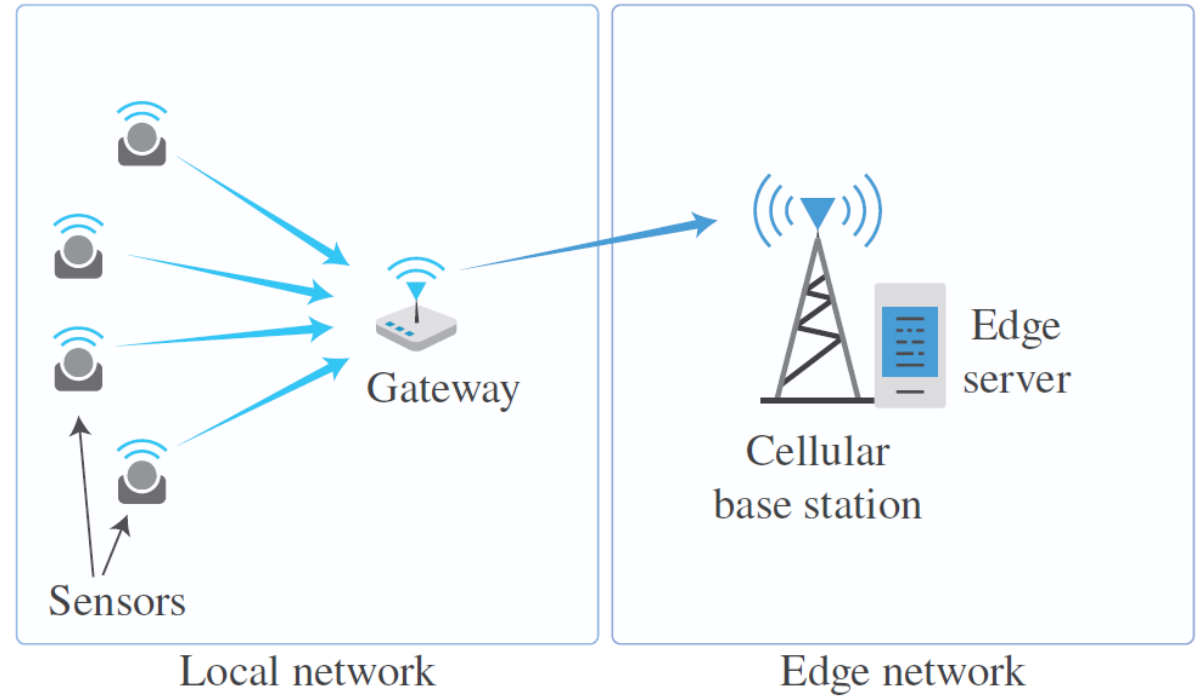


Fig. 2: Process flow diagram of the TEP. Adapted from [6].

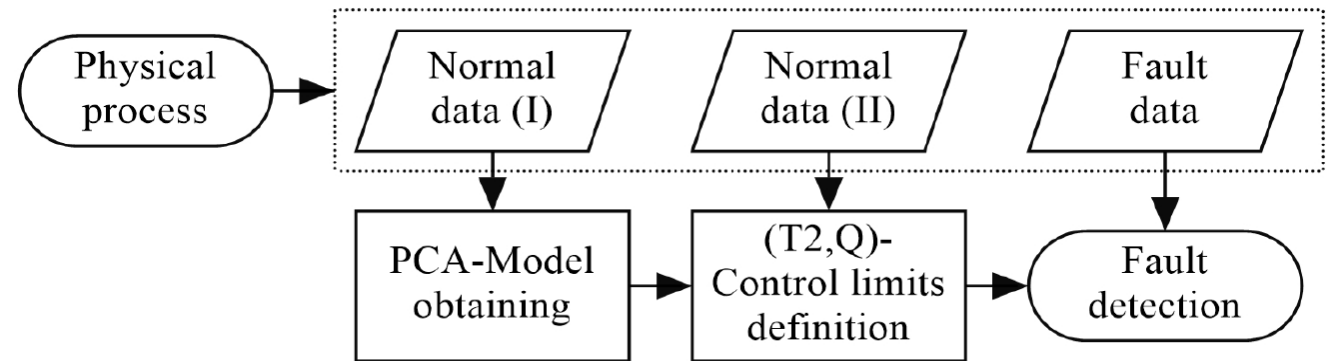
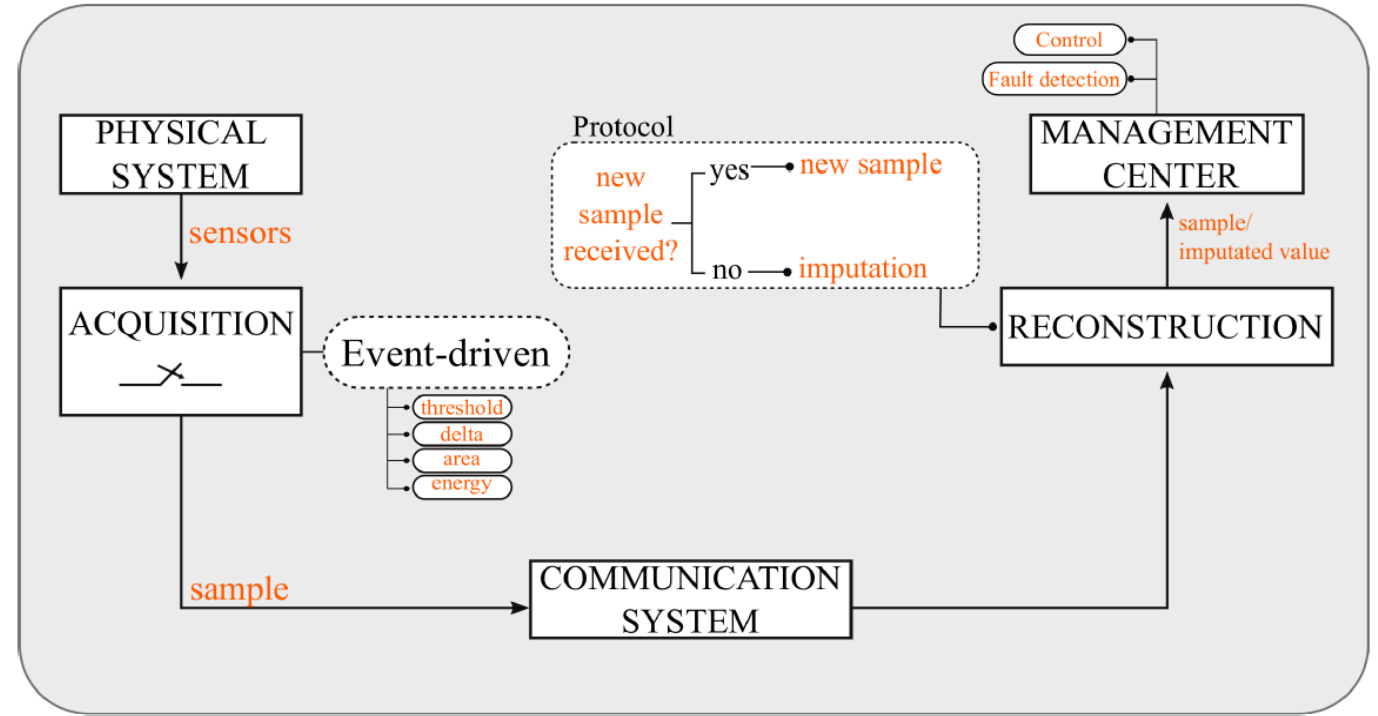
<i>Q#</i>	Topic	Related Question
<i>Q0</i>	Application	Detect faults.
<i>Q1</i>	Sensors	There are fifty-two measuring devices.
<i>Q2</i>	Samples	Periodic sampling with different granularities (3, 6, and 15 min); all variables are in sync (3 min).
<i>Q3</i>	Communication	Assumed perfect without explicit definition. Open for design.
<i>Q4</i>	Data storage	Assumed that the data of the sensors are recorded and available to be processed. Open for design.
<i>Q5</i>	Data fusion	(i) Principal component analysis (PCA), (ii) dynamic PCA, or (iii) canonical variate analysis (CVA).
<i>Q6</i>	Decisions	Q or T^2 statistical tests; details in [1].
<i>Q7</i>	Actions	Not defined; we may assume that the process stops whenever a fault is detected.

ICTs

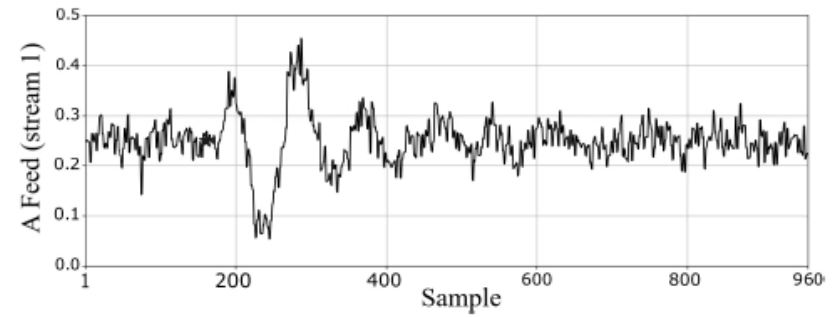
- How to communicate?
 - Wireless sensors
- Where to compute?
 - Edge computing



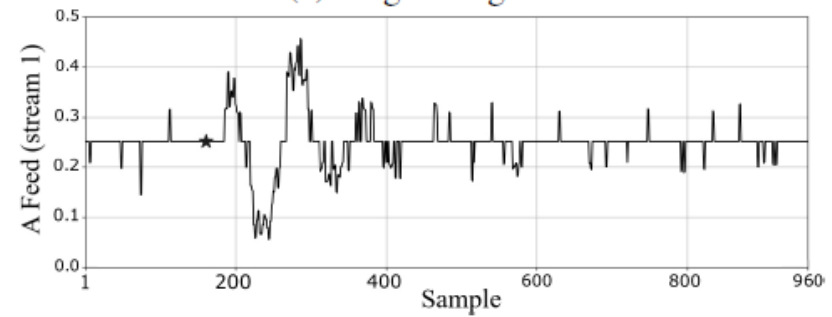
Data acquisition + fusion + analytics



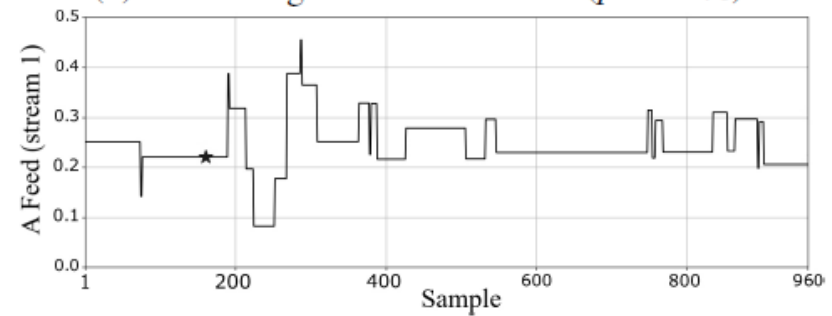
Acquisition based on events



(a) Original signal.

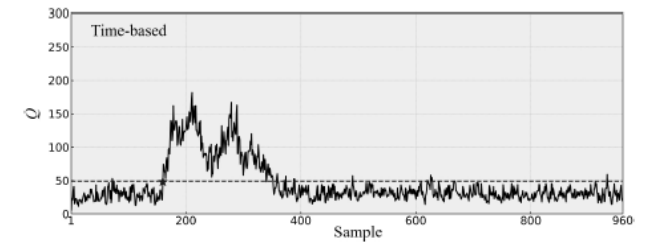
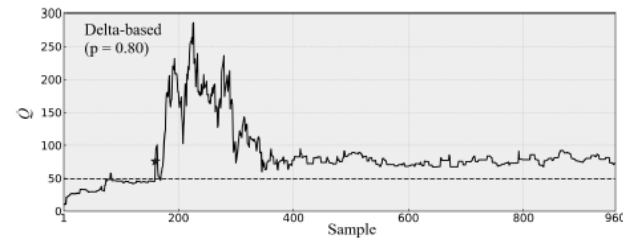


(b) Filtered signal: Threshold rule ($p = 50\%$).

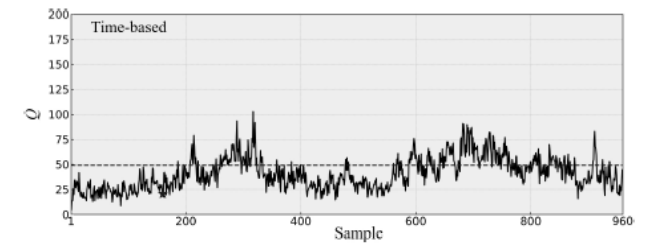
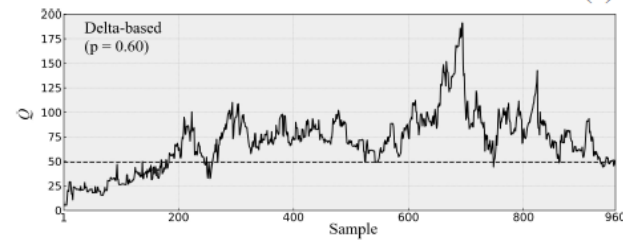


(c) Filtered signal: Delta rule ($p = 50\%$).

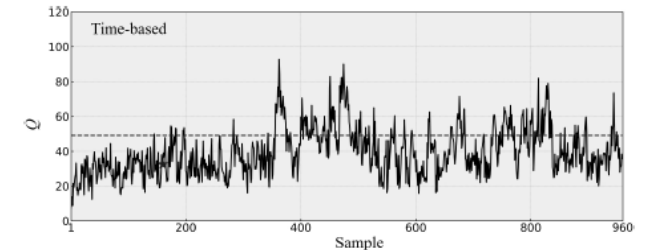
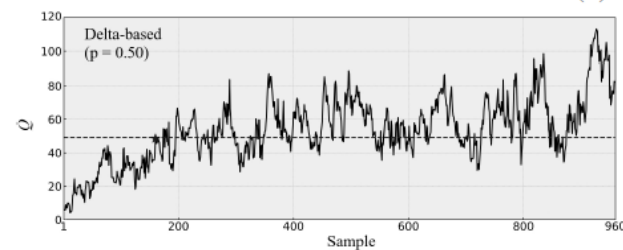
Modified
statistics to
better detect



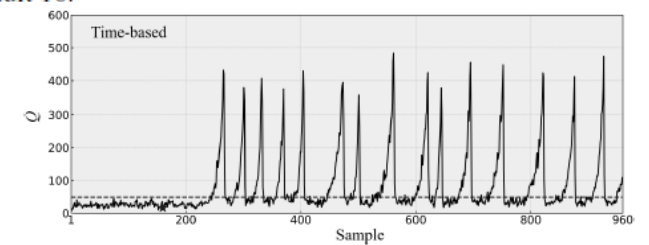
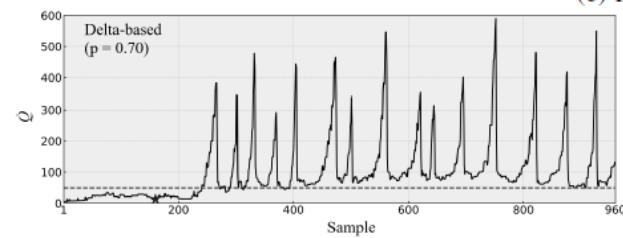
(a) Fault 5.



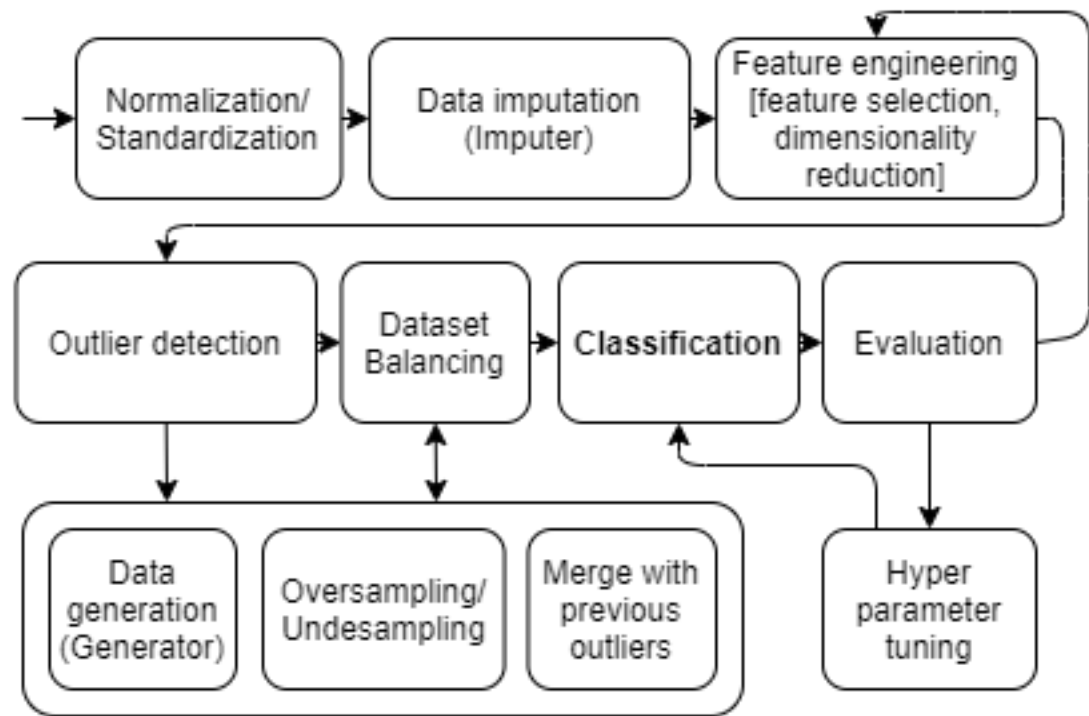
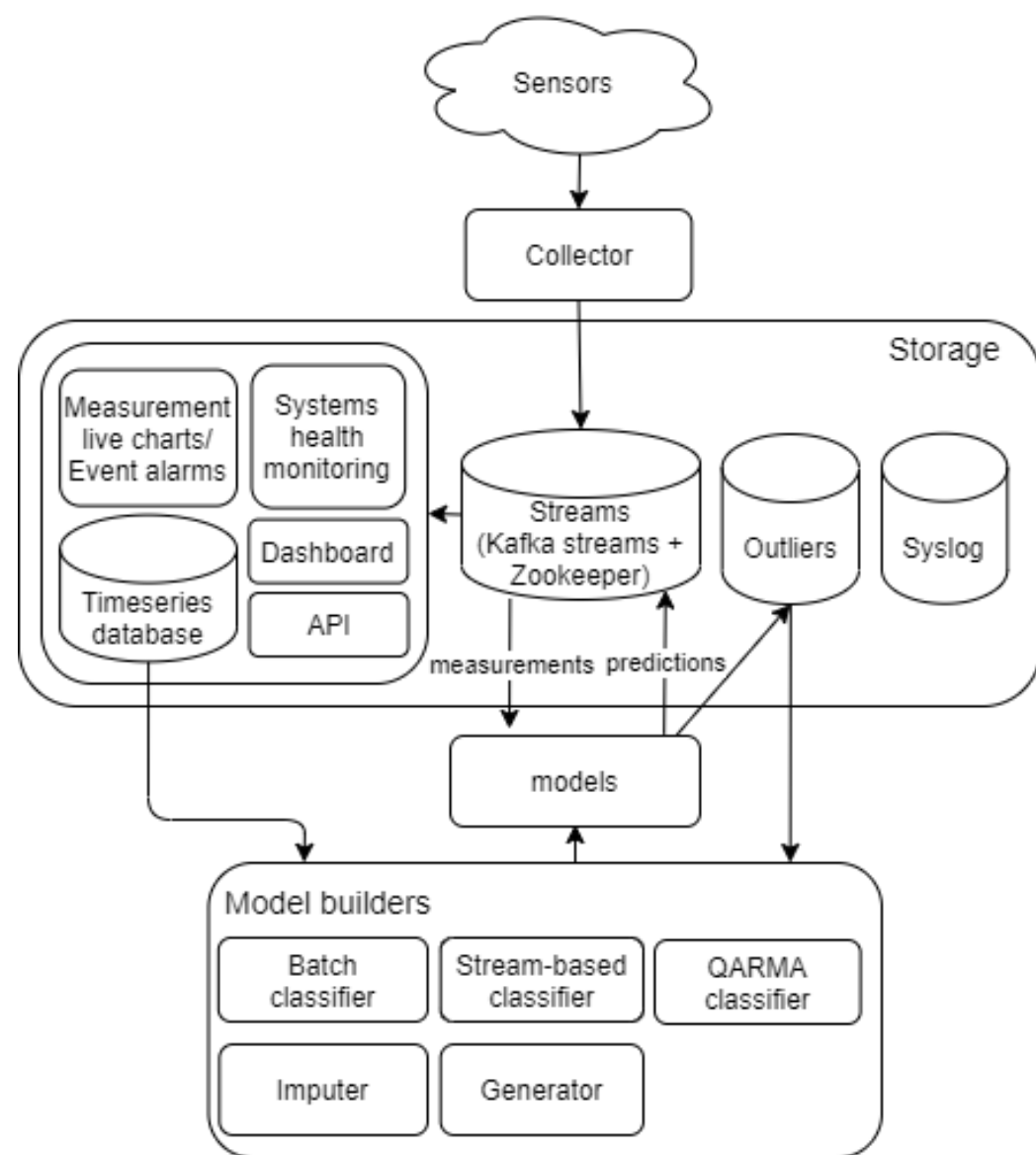
(b) Fault 10.



(c) Fault 16.



(d) Fault 20.



Generality of FIREMAN

- *Fault selection in power grids
- *Anomaly detection in power electronic based grid
- Anomaly detection in mechanical models
- Intrusion detection systems
- *SEAT manufactory process (installed, not faults yet)
- Ongoing:
 - *Microgrid operation (protection and cyber-security)
 - *Smart campus in University of Oulu
 - Diesel engine

All information is open...

- <https://fireman-project.eu/> >> *let's check*
- ... and we are open for new collaboration.
- Open workshops, also events with SOON
- Still one more year to go, and we are searching ways to follow up...
 - EIC Transition in Sept. 2022 (discussions started)
- Contact: Pedro.Nardelli@lut.fi