Towards Elastic Edge Computing Environments: An Investigation of Adaptive Approaches

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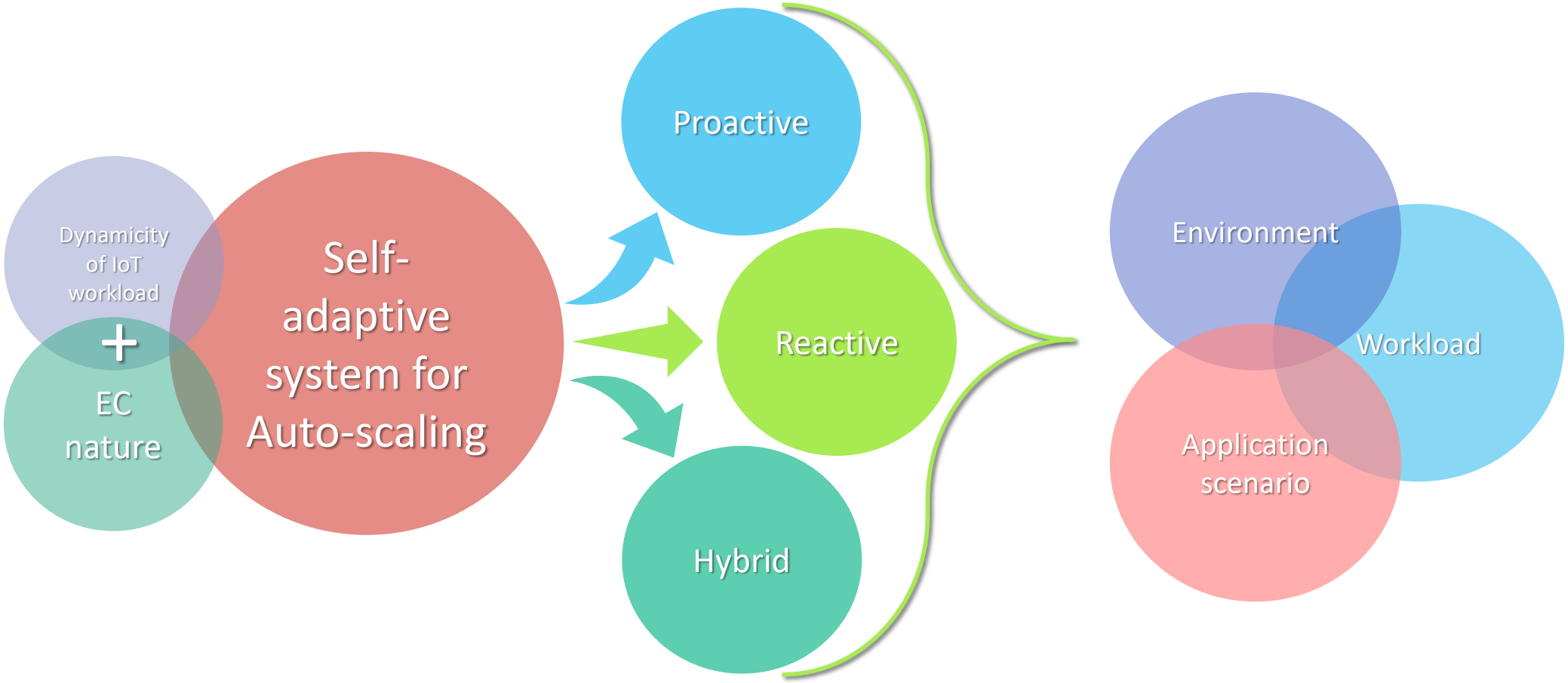
Presenter’s Bio

- BSc in Computer Science from Prince Sattam Bin Abdulaziz University.
- MSc in Advanced Computer Science (Cloud Computing) from the University of Leeds.
- Present: PhD student working on auto-scaling SAS for Edge Computing at the University of Leeds.
- A member of the Distributed Systems and Services Research Group at the School of Computing, University of Leeds.

Agenda

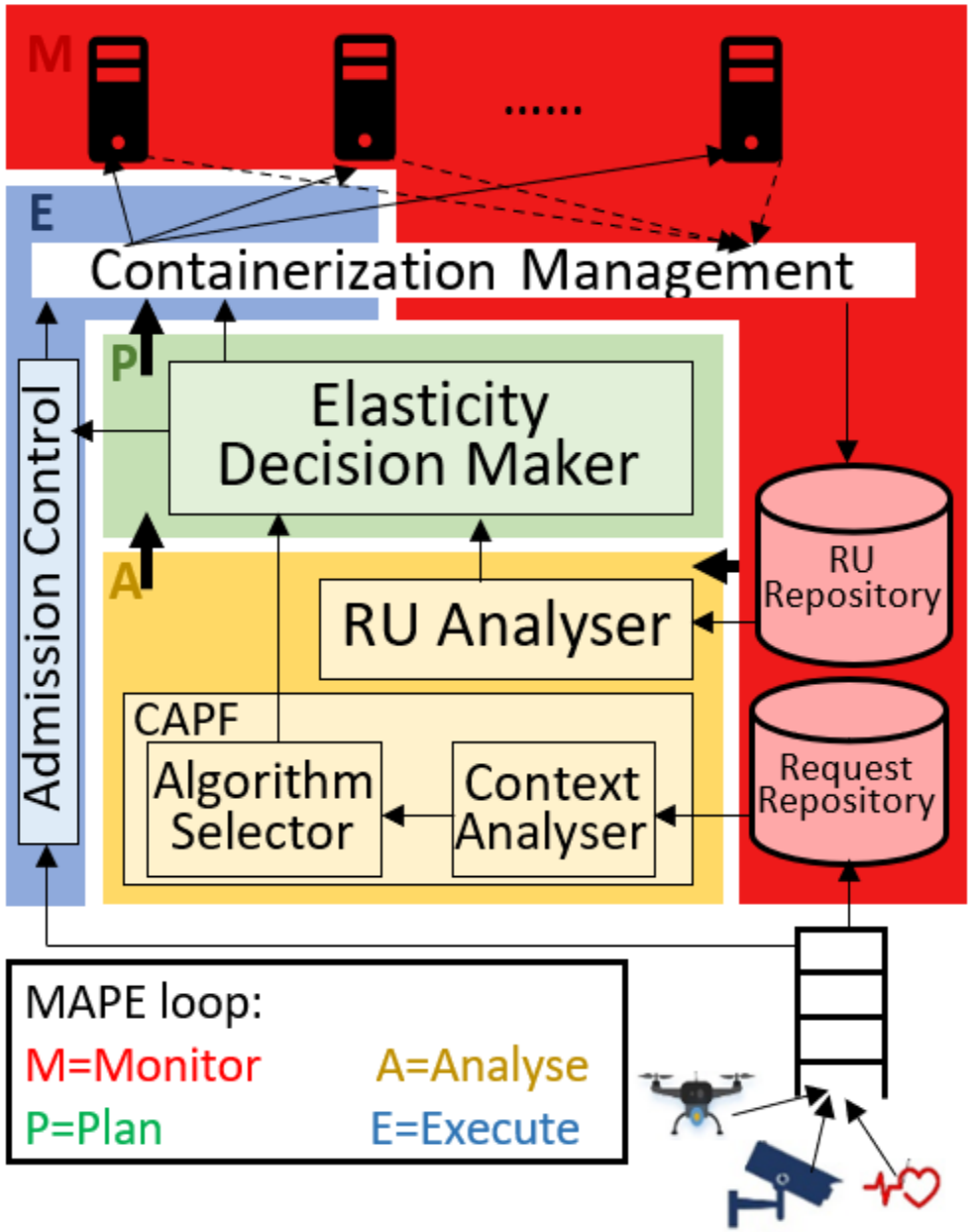
- Problem statement and motivations
- Auto-scaling self-adaptive system architecture
- Experimental design
- Results
- Hypothesis evaluation and take-away message.
- Conclusion and future work

Problem statement and motivation



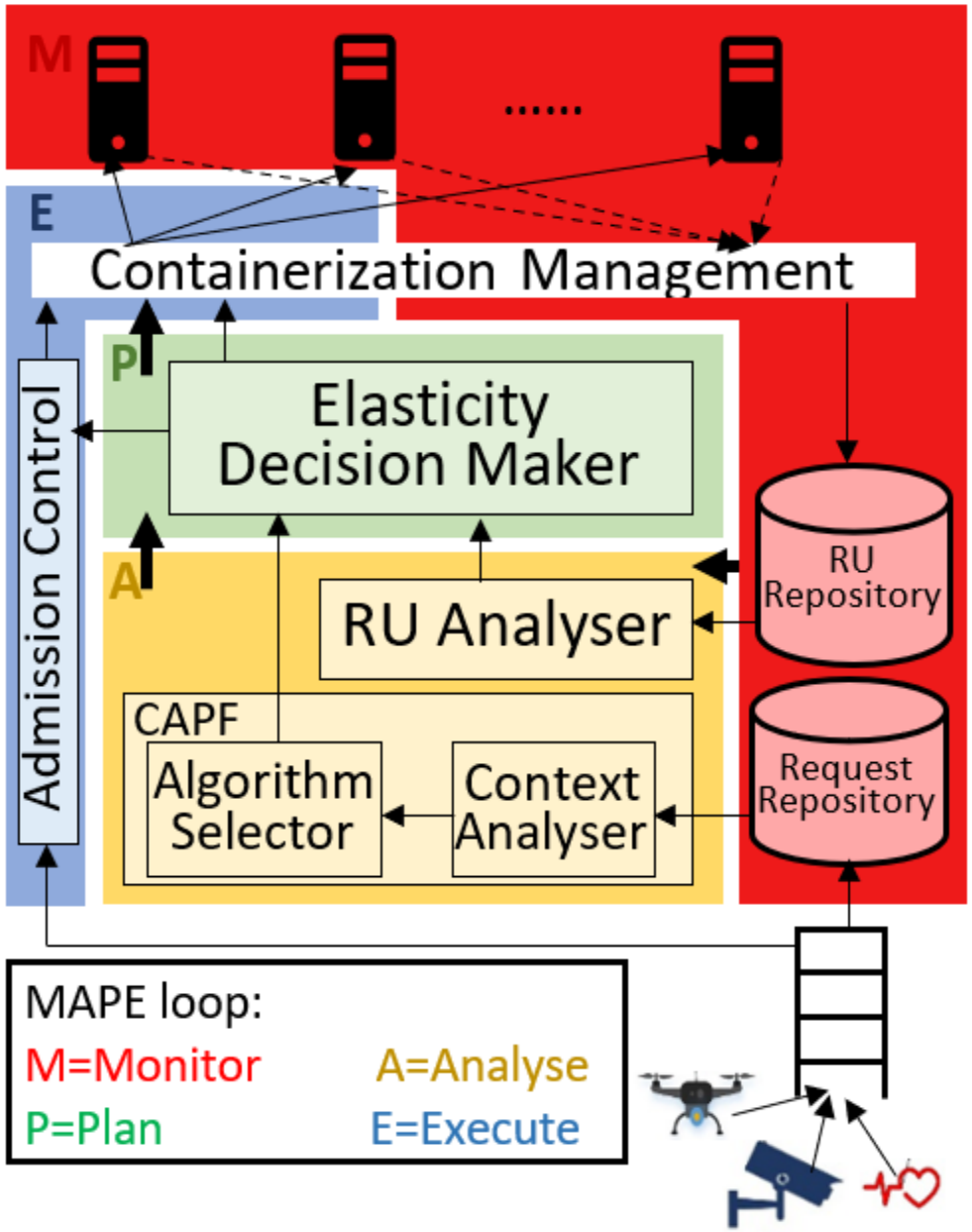
Auto-scaling self-adaptive system architecture

- **Control loop:** Monitor Analyse Plan Execute (MAPE).
  - **Monitor:** Resource Utilisation Repository and Request Repository.
  - **Analyse:** Resource Utilization Analyser and CAPF.
  - **Plan:** Elasticity Decision Maker.
  - **Execute:** Admission Control.



Auto-scaling self-adaptive system architecture (Cont.)

- **What is new?**
  - **Adaptation approaches:** Proactive, reactive, and hybrid.
  - **Admission control.**
  - **Algorithms support:** Proactive, reactive, hybrid, and admission control.
  - **SAS evaluation**: Edge Computing, three real IoT workloads, and application scenarios.



Experimental design

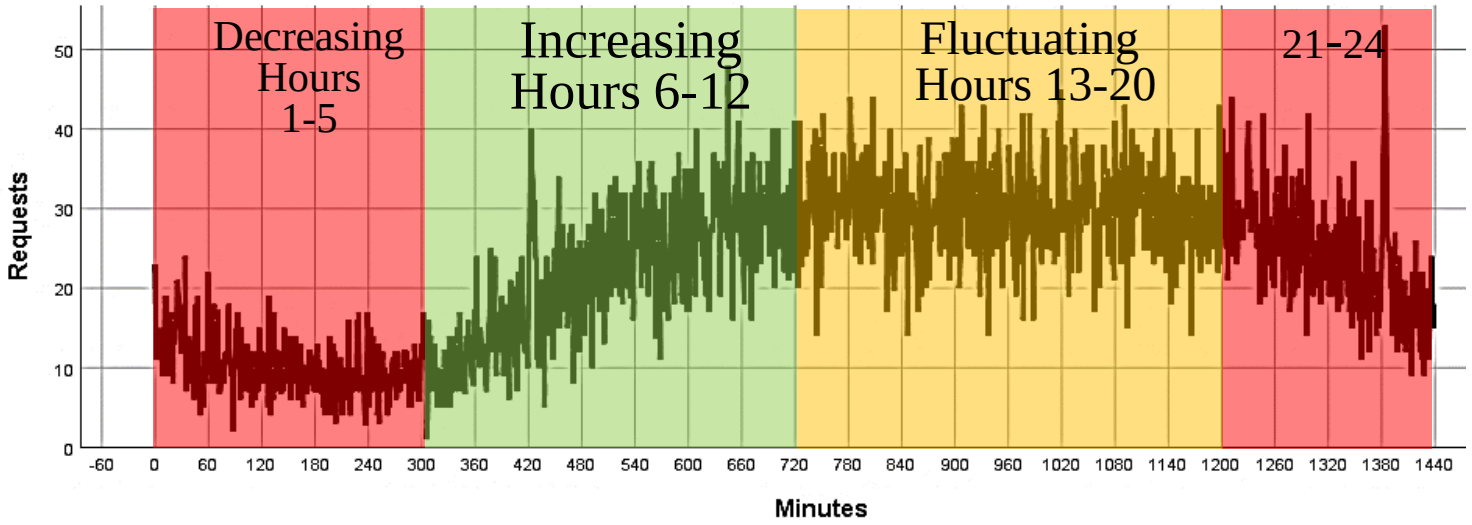
- **Implementation scenarios:**

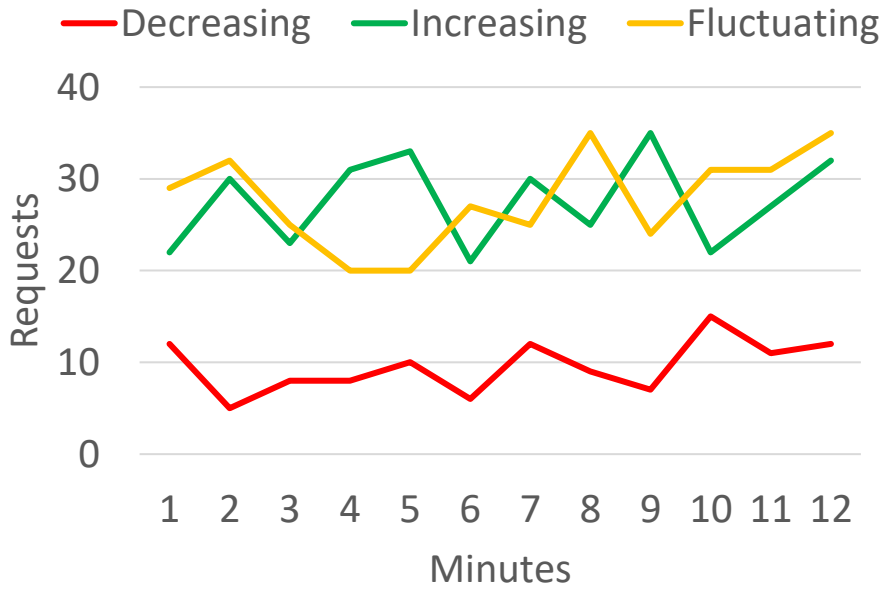
Scenarios		Adaptation approaches	Considered applications
1: Mixed applications		Proactive	All
		Reactive	All
		Hybrid	All
2: Single application	A	Proactive	FR
		Reactive	FR
		Hybrid	FR
	B	Proactive	AR
		Reactive	AR
		Hybrid	AR
	C	Proactive	IHM
		Reactive	IHM
		Hybrid	IHM

- **Profiled applications:**
  - Heavy load:
    - Face Recognition (FR).
    - Emergency Traffic Management (ETM).
  - Medium load:
    - Augmented Reality (AR).
    - Health Monitoring (HM).
  - Low load:
    - Industrial Health Monitoring (IHM).
    - Intelligent Parking (IP).

Experimental design (cont.)

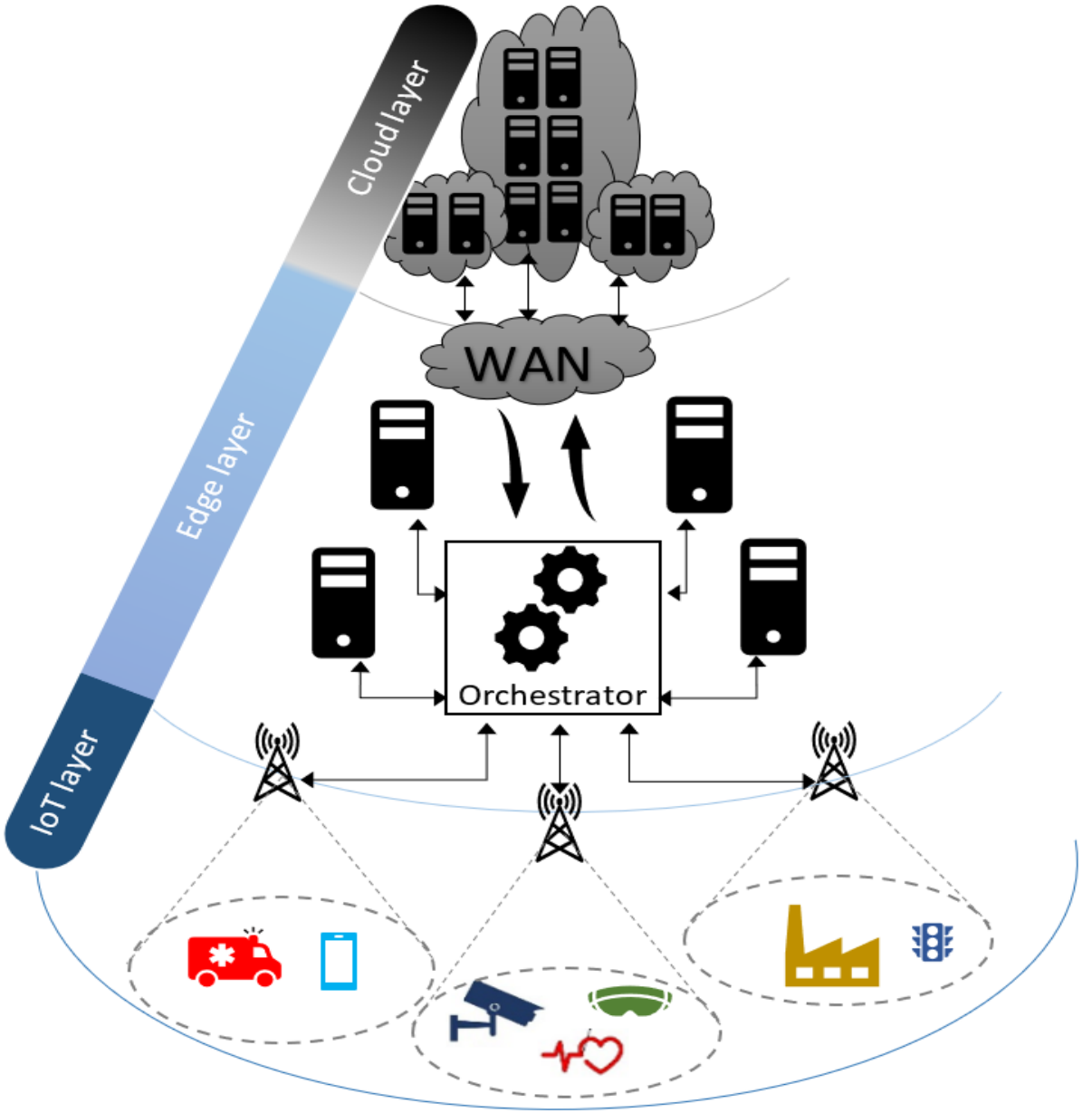
- **Workload dataset:**
  - **Provided** by Shanghai Telecom.
  - **Contains** 6 Months, 6,952,921 records, 9739 mobile devices, and 3042 BSs.
  - **Select:** 2nd as a decreasing, 12th as an increasing, and 14th as a fluctuating.





Experimental design (cont.)

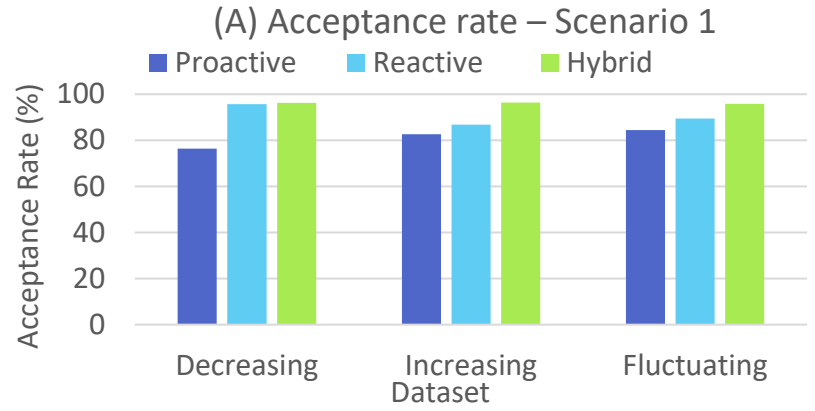
- **Simulation:**
  - EdgeCloudSim.
- **Hypothesis:**
  - *hypothesis 1:* The use of the hybrid adaptation in an elasticity framework will provide the highest acceptance rate as compared to both proactive and reactive adaptations.
  - *Hypothesis 2:* The proactive adaptation will perform better than the reactive adaptation due to the prediction ability that helps acting prior events happen.

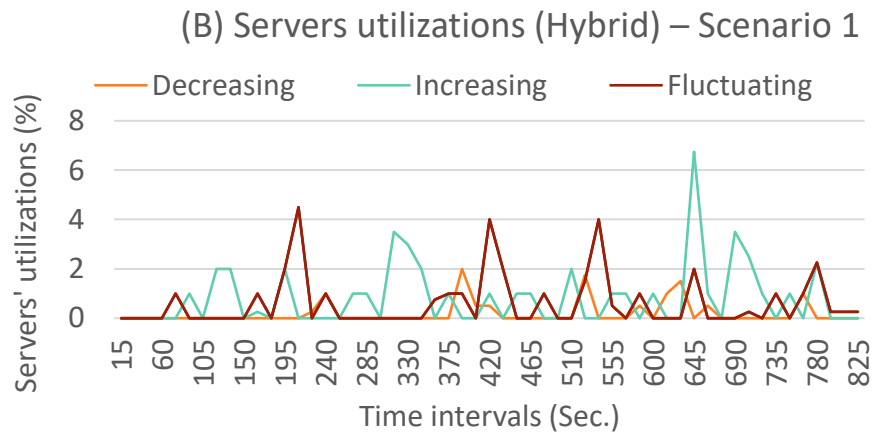


C. Sonmez, A. Ozgovde, and C. Ersoy, "EdgeCloudSim : An environment for performance evaluation of edge computing systems", Trans. Emerg. Telecommun. Technol., vol. 29, no. 11, pp. 1–17, 2018

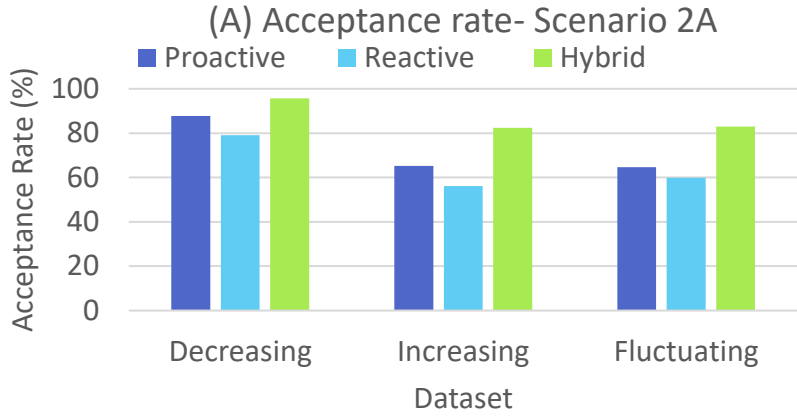
Results

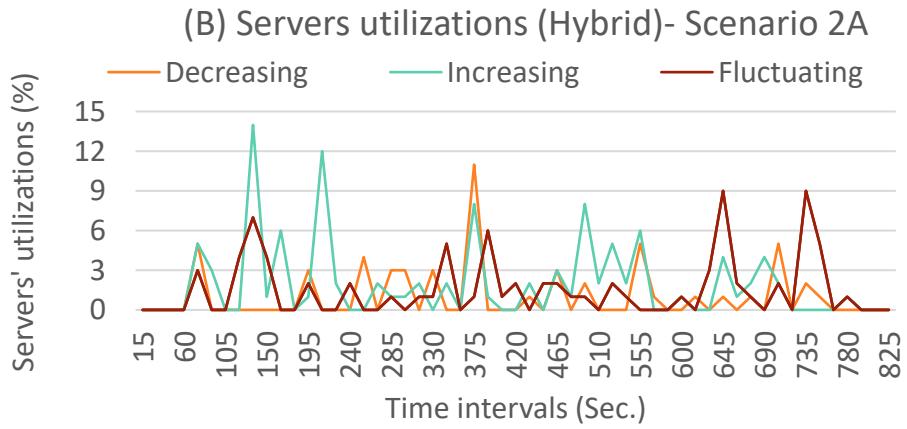
- **Scenario 1 (mixed applications):**





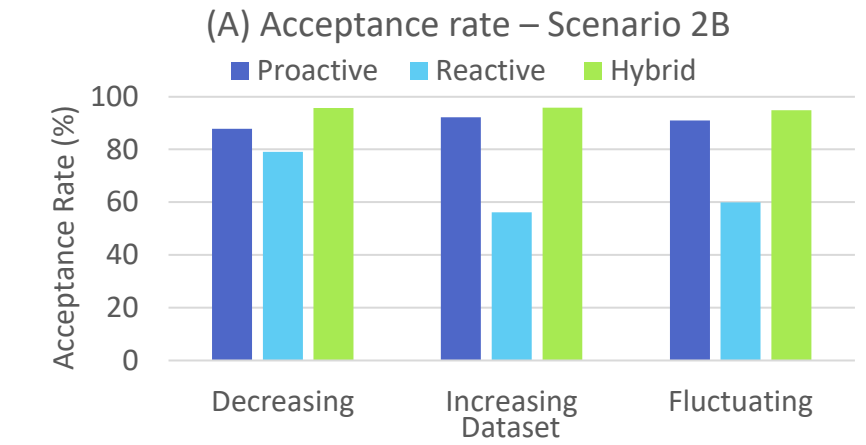
- **Scenario 2A (Single application- Face Recognition):**

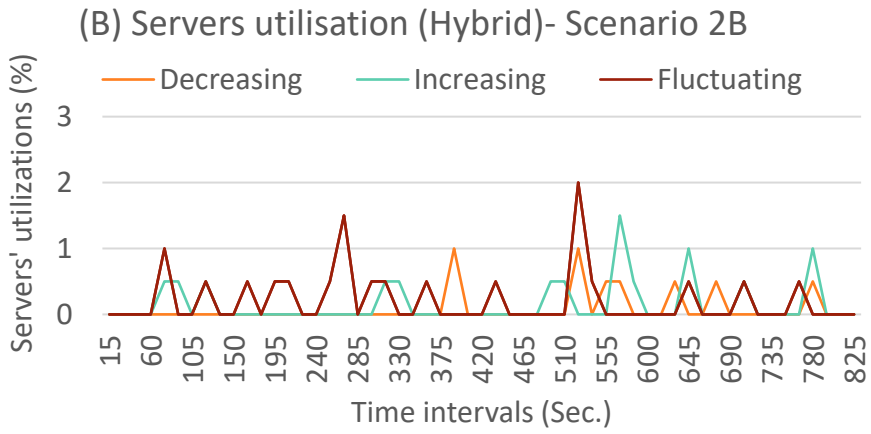




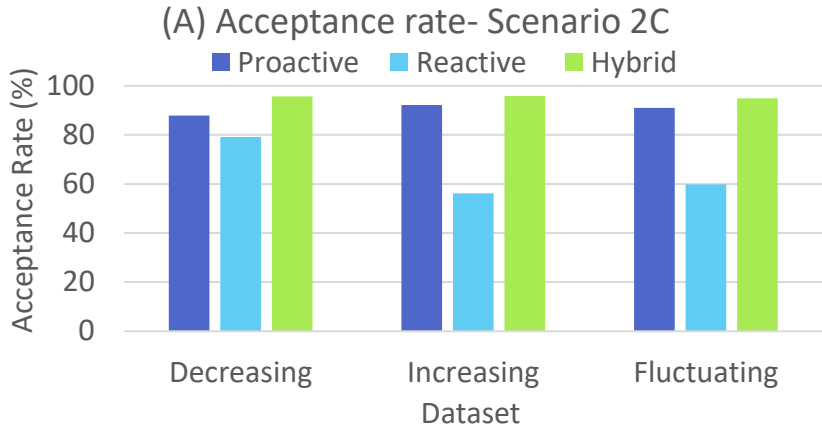
Results (Cont.)

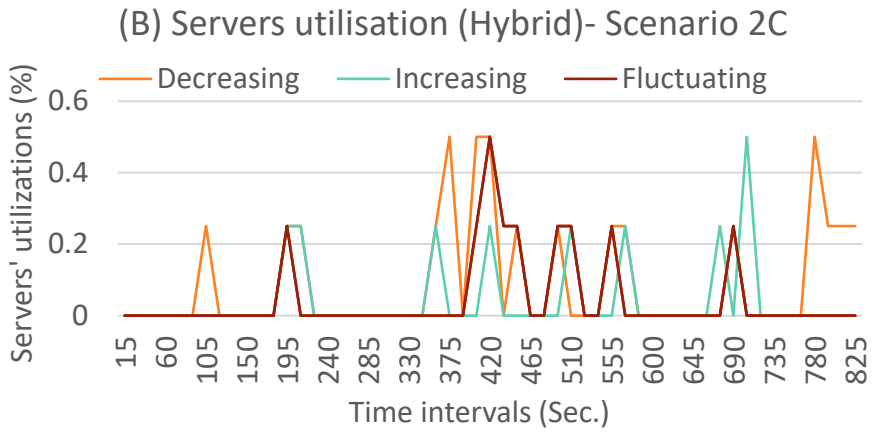
- **Scenario 2B (single application- Augmented Reality):**





- **Scenario 2C (single application- Industrial Health Monitoring):**





Hypothesis evaluation and Take-aways message

- **Hypothesis evaluation:**
  - *Hypothesis 1:* The use of the hybrid adaptation in an elasticity framework will provide the highest acceptance rate as compared to both proactive and reactive adaptations.
    - It is true in all scenarios.
  - *Hypothesis 2:* The proactive adaptation will perform better than reactive adaptation due to prediction ability that helps acting prior events happen.
    - It is true for scenarios 2A, 2B, and 2C (single application scenario).
    - It is disproved for scenario 1 (mixed applications scenario).
- **Take-away message:**
  - It is important to use the hybrid adaptation SAS in highly fluctuating environments such as Edge Computing.
  - It is important to evaluate the adaptation approaches according to the considered scenario, workload, and environment.
  - Lack of data about the nature of the submitted requests can have a significant impact.

Conclusion and future work

- Conclusion:
  - The SAS for Edge Computing environment is designed and evaluated considering the adaptation approaches.
  - Several scenarios are considered to investigate the effect of the workload and applications on the Edge Computing environment.
  - A set of take-aways messages are made.
- Future work:
  - Evaluate the SAS adaptation approaches using a higher workload.
  - Consider QoS.
  - Cloud layer offloading policy.

Questions