Evaluation of Fog Topologies in Fog Planning for IoT Task Scheduling

-- The 35th ACM/SIGAPP Symposium On Applied Computing(SAC 2020)

Zhiming He
School of Computer Science and Engineering
Kyungpook National University

Outlines

01 Motivation and Objective
02 Fog and IoT Task System Architecture
03 Fog Planning ILP Model (*OMITTED*)
04 Numerical Evaluation
05 Conclusion

1. Motivation and Objective

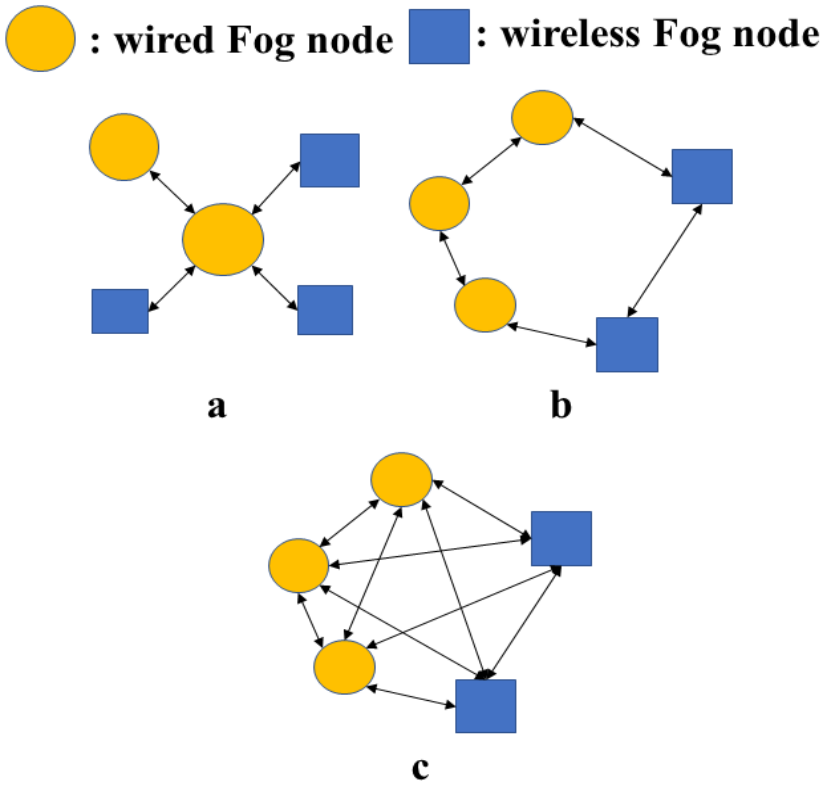
- features of Fog Computing

  Wireless Fog nodes
  Wired Fog nodes

  → **Wireless** Fog Networks (Fogs)
  Wired Fogs
  Hybrid Fogs

- Attention please, different fogs have different attributes!

- We investigate the impact of different fog topologies (fully-connected mesh[have addressed], star and ring topologies) in fog planning on provisioning diverse IoT tasks under an integrated cloud and fog framework (iCloudFog)



a: star topology; b: ring topology; c: fully-connected mesh;

1. Motivation and Objective (cont.)

- **Constructing Fog layer**
  - aims at classifying the fogs into three types, namely wireless fog (WLF), wired fog (WDF), and hybrid fog (HBF), respectively.

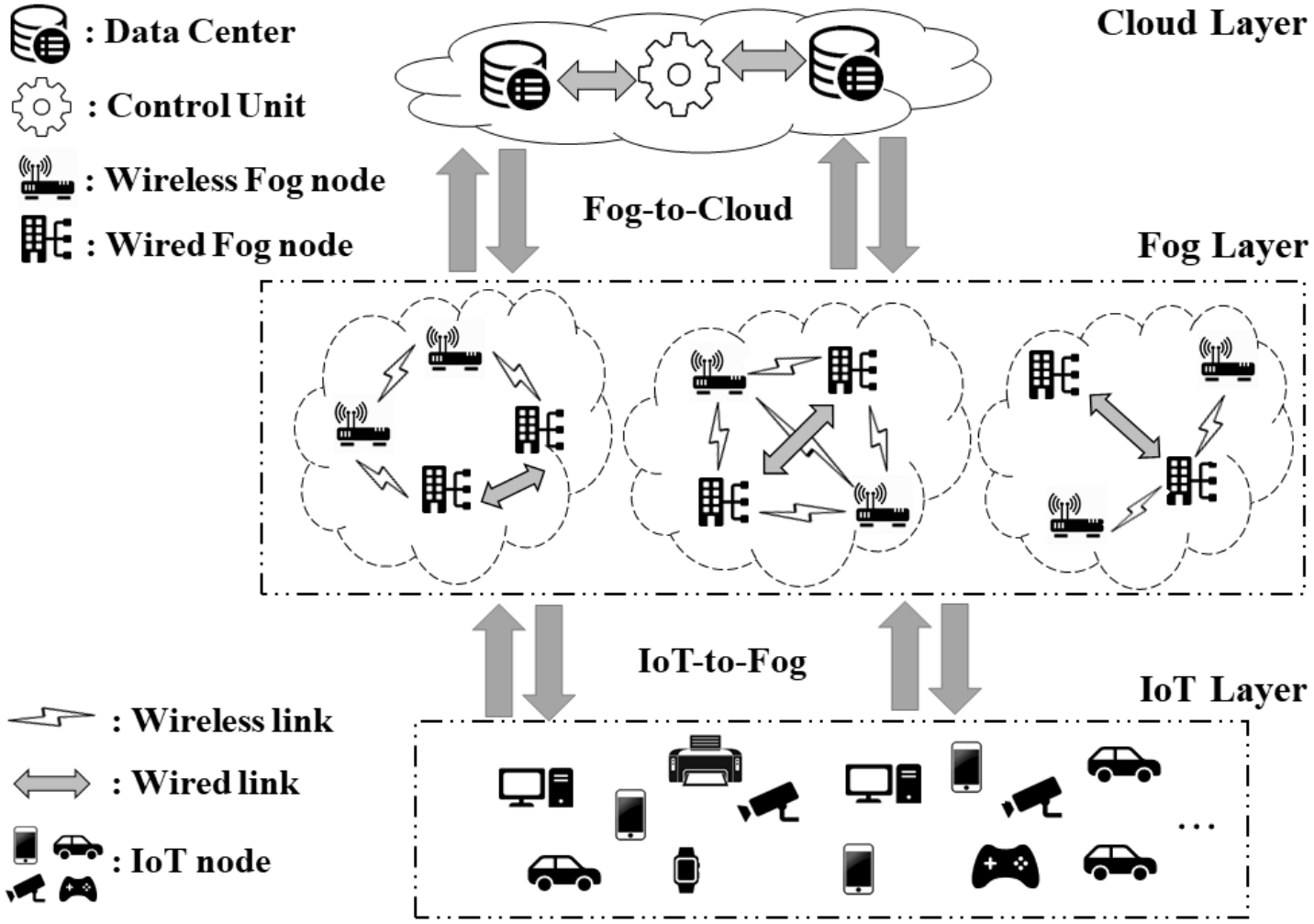
- **Objective 1**: Minimize (Total_Cost)
  - aims at minimizing the operating expenditure (OPEX) and capital expenditure (CAPEX) due to using Fog links and Cloud links.

- **Objective 2**: Minimize ($\boldsymbol{M} * $ average hops)
  - aims at minimizing the number of average hops required by a fog node to offload tasks to other fog nodes in the same planned fog.

- **Objective 3**: Minimize (Total_Cost + $\boldsymbol{\theta} * \boldsymbol{M} *$ average hops)
  - multi-weighted objective, where a weight value of $\boldsymbol{\theta}$ is used to integrate objective (1) and objective (2).

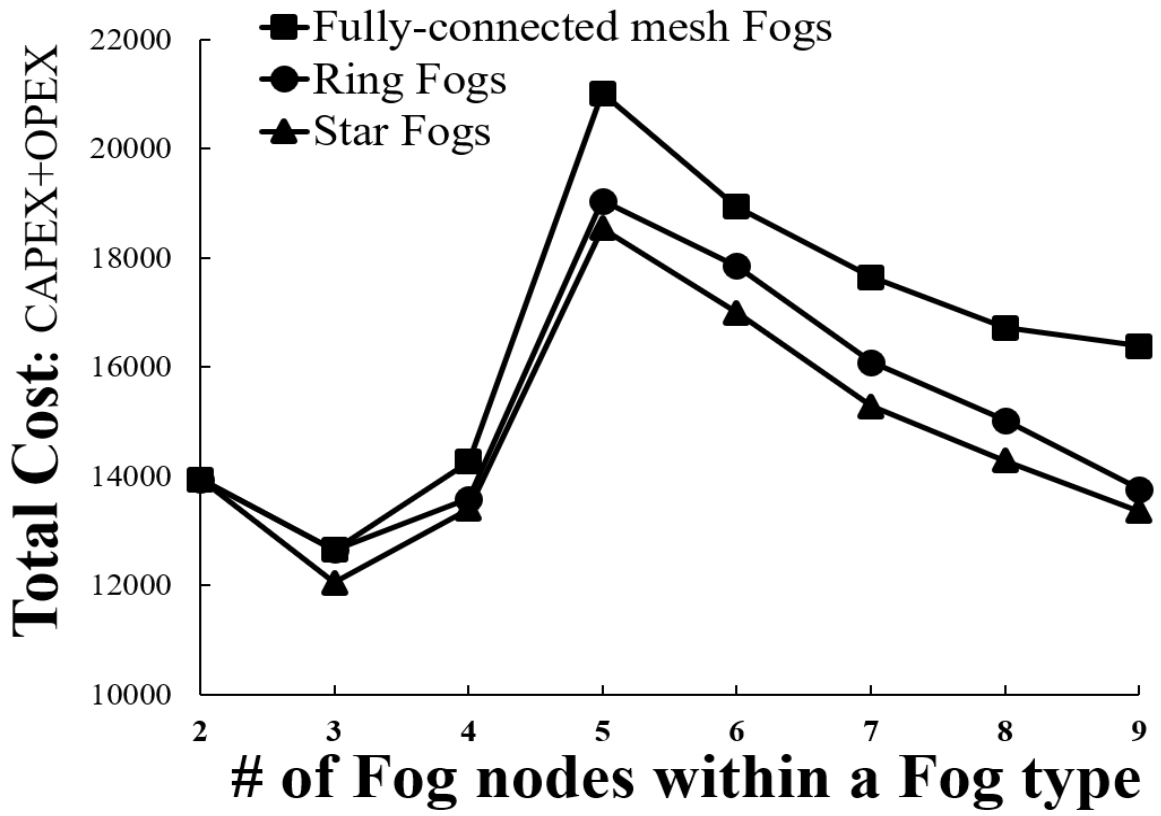
2. Fog and IoT Task System Architecture

- integrated Cloud-Fog (iCloudFog) framework



- Our research focuses on: Fog layers!

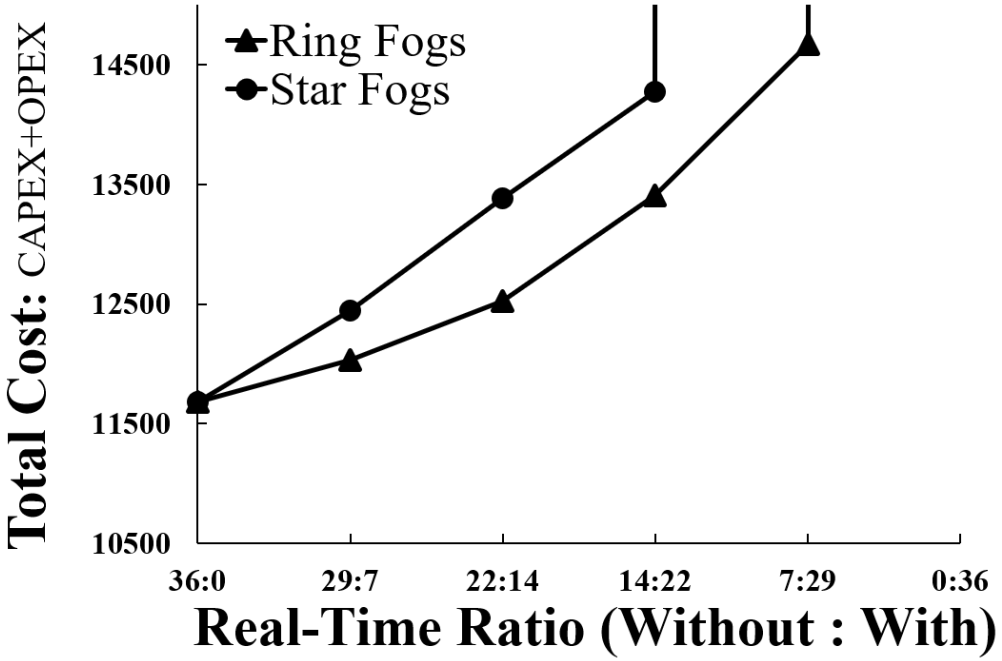
4. Numerical Evaluation

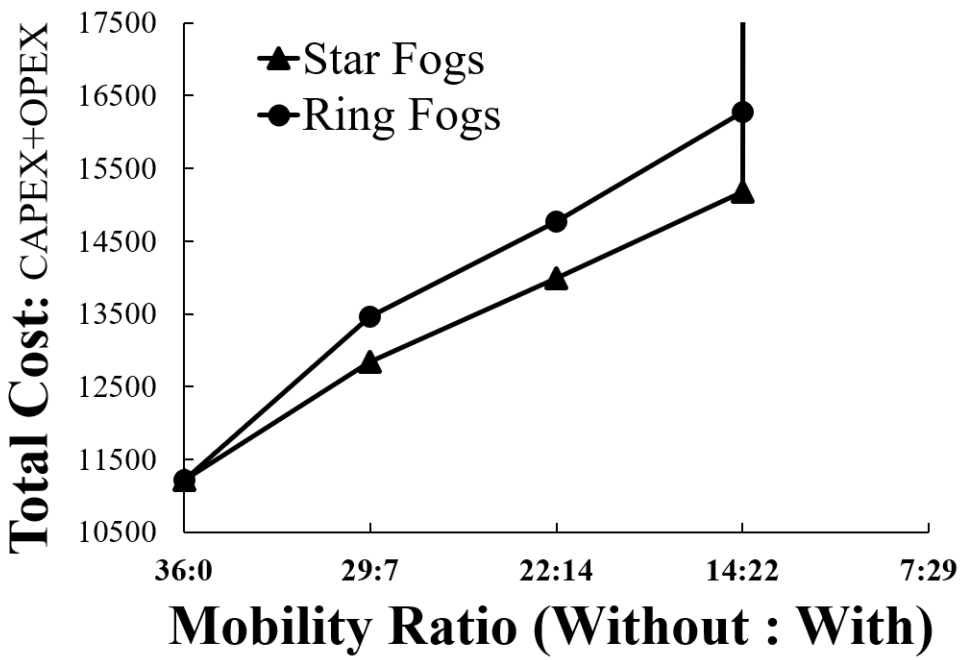


◆ Result analyses

- From this figure, we can see that the total cost under different numbers of candidate fog nodes for fully-connected mesh, ring and star fogs.
- Among all the three topologies, star performs the best in terms of the total cost, followed by ring, and fully-connected mesh.

4. Numerical Evaluation (cont.)

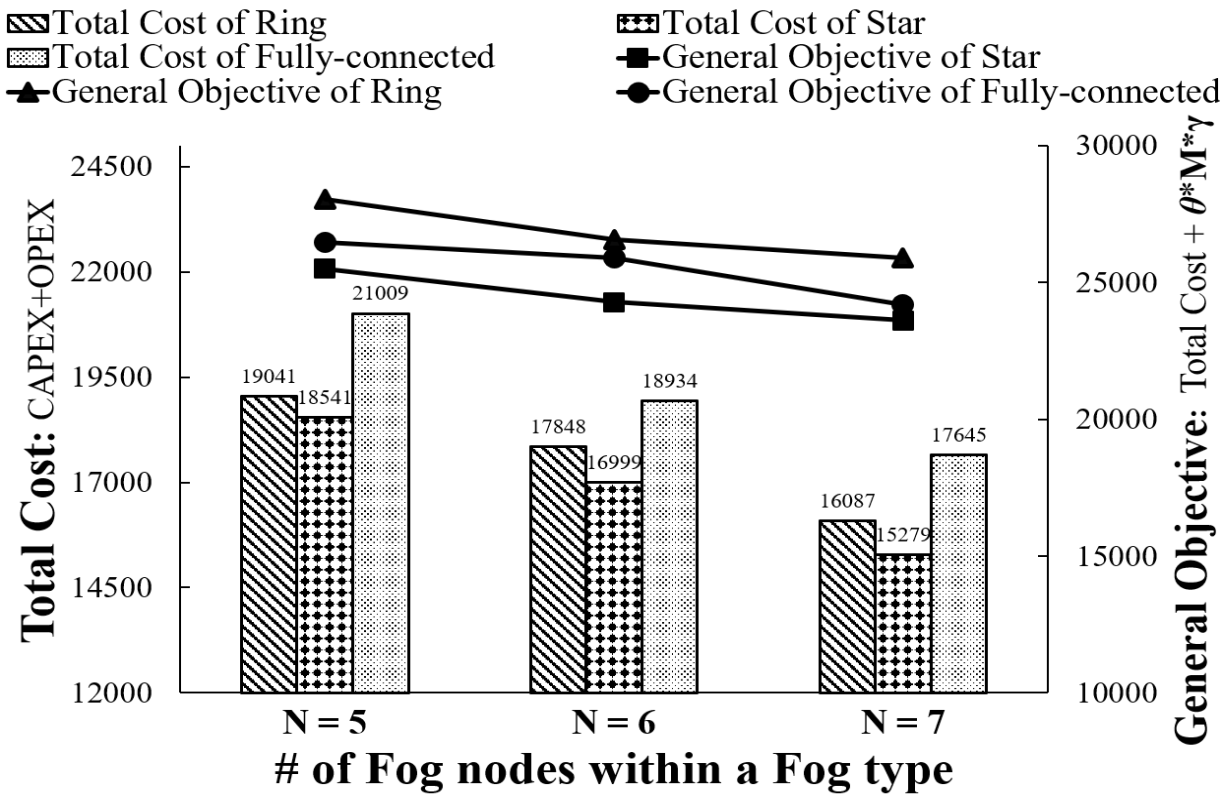




◆ Result analyses

- This two figures show the impact of real-time and mobility requirements of IoT tasks on the performance of total cost for star and ring topologies.
- From the results we can see that the star topology performs slightly better in serving both of real-time and mobility IoT tasks since it requires less total cost.

4. Numerical Evaluation (cont.)



◆ Result analyses

- **This figure** shows the performance for the total cost and the multi-weighted general objective.
- For the general objective, star performs the best, followed by fully-connected mesh and ring.
- Although fully-connected mesh fogs have the largest number of links in planning a fog, it is superior to ring, because the number of average hops in a ring increases more dynamically with increasing N than fully-connected mesh.

5. Conclusion

- **Conclusion**

  - In this paper, we investigated the impact of different fog topologies, i.e., fully-connected mesh, star, and ring, in fog planning on the performance of CAPEX and OPEX cost under the framework of iCloudFog.

  - We proposed two ILP models, with the objective of minimizing the total cost by considering the average hop count.

  - Numerical simulations were carried out and the results were compared with the fully-connected mesh in our previous work.

  - Results showed that fully-connected mesh topology had the highest cost and star topology performed the best in serving real-time and mobile IoT tasks.

Related Works

[1] Faisal Haider. 2018. On the planning and design problem of fog networks. Ph.D. Dissertation. Carleton University.

[2] Zhiming He, Limei Peng, Yin Zhang, and Byungchul Tak. 2019. Green Fog Planning for Optimal Internet-of-Thing Task Scheduling. IEEE Access (Early Access) (Dec. 2019). **(PREVIOUS WORK)**

[3] Limei Peng, Ahmad R Dhaini, and Pin-Han Ho. 2018. Toward integrated Cloud–Fog networks for efficient IoT provisioning: Key challenges and solutions. Future Generation Computer Systems 88 (2018), 606–613.

[4] Ashkan Yousefpour, Ashish Patil, Genya Ishigaki, Inwoong Kim, Xi Wang, Hakki C Cankaya, Qiong Zhang, Weisheng Xie, and Jason P Jue. 2019. FogPlan: A Light-weight QoS-aware Dynamic Fog Service Provisioning Framework. IEEE Internet of Things Journal (2019).

[5] Decheng Zhang, Faisal Haider, Marc St-Hilaire, and Christian Makaya. 2019. Model and algorithms for the planning of fog computing networks. IEEE Internet of Things Journal 6, 2 (2019), 3873–3884.

Q & A

Email : hezhimingabc@knu.ac.kr

Thank You !