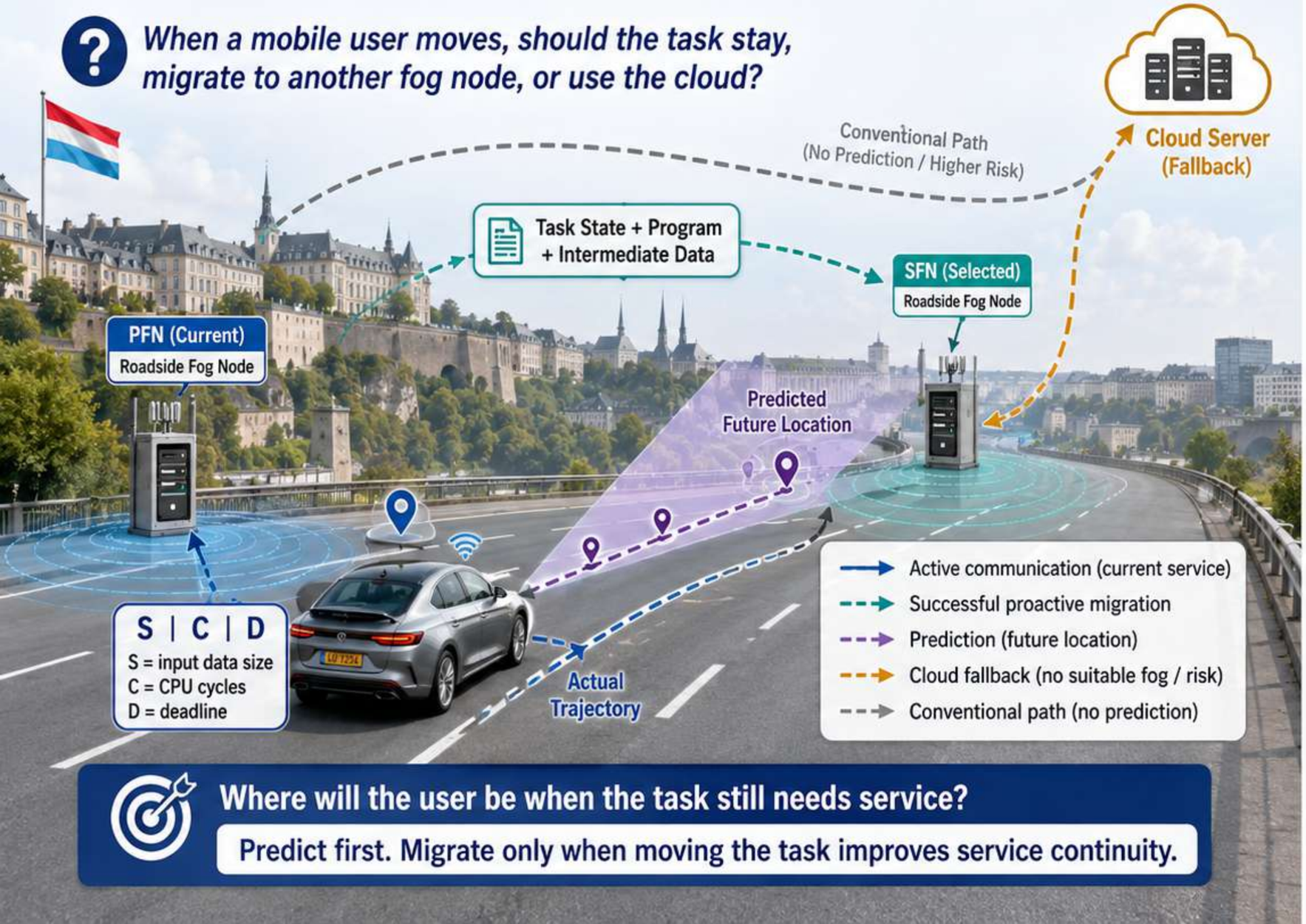
OptFog: Predict Mobility Before Migrating the Task

Optimized mobility-aware task offloading and migration for fog networks

When a mobile user moves, should the task stay, migrate to another fog node, or use the cloud?



Where will the user be when the task still needs service?

Predict first. Migrate only when moving the task improves service continuity.

HIGHLIGHTS OF THE PAPER

01 PREDICTIVE MIGRATION ASSISTANCE:
OptFog predicts a mobile device's future location before deciding whether a running task should migrate.

02 THREE ML MODELS EVALUATED:
Decision Tree, Random Forest and k-NN are compared using LuST mobility traces.

03 DEADLINE- AND UTILIZATION-AWARE DECISION:
Migration considers the predicted location, task deadline, candidate-node latency and fog-node utilization.

04 EXPERIMENTAL FINDINGS:
Random Forest achieves 97.47% accuracy. OptFog reports up to 45% fewer handoffs, 42% fewer migrations, 22% lower network usage and 44.5% lower migration latency.

Dataset: mobility traces from 262 vehicles in Luxembourg.

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When Should a Running Task Move?

Offloading starts the task remotely; migration moves an already running task

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1 Task Created

A connected vehicle / mobile end user creates a task.

Task: S | C | D

Data size · CPU demand · Deadline

Starting choices:

- Execute locally

OR

- Offload to nearest PFN

2 Task Running at PFN

The PFN is processing the task. The vehicle moves away from the PFN coverage zone.

A task may still be running when the user leaves the PFN coverage area.

3 Migration Cost

Moving a running task requires state **transfer** and causes temporary disruption.

Migration Payload

10110 01011 11010

Task State + Program + Intermediate Data

Migration Steps

Suspend → Capture state → Transfer state → Reconstruct → Resume

Costs Incurred

Downtime · Bandwidth · Energy · Migration delay

Migrating too early, too late or too often wastes resources.

4 Two Strategies

Reactive or unnecessary migration

Handoff occurs → Search begins late → Unsuitable destination → Added delay

OptFog proactive migration

Predict future location → Check deadline & utilization → Choose SFN in predicted region → Migrate only when necessary → Resume computation near the user

5 Application Trade-off

Vehicular or long-running service

Migration can preserve low-latency continuity.

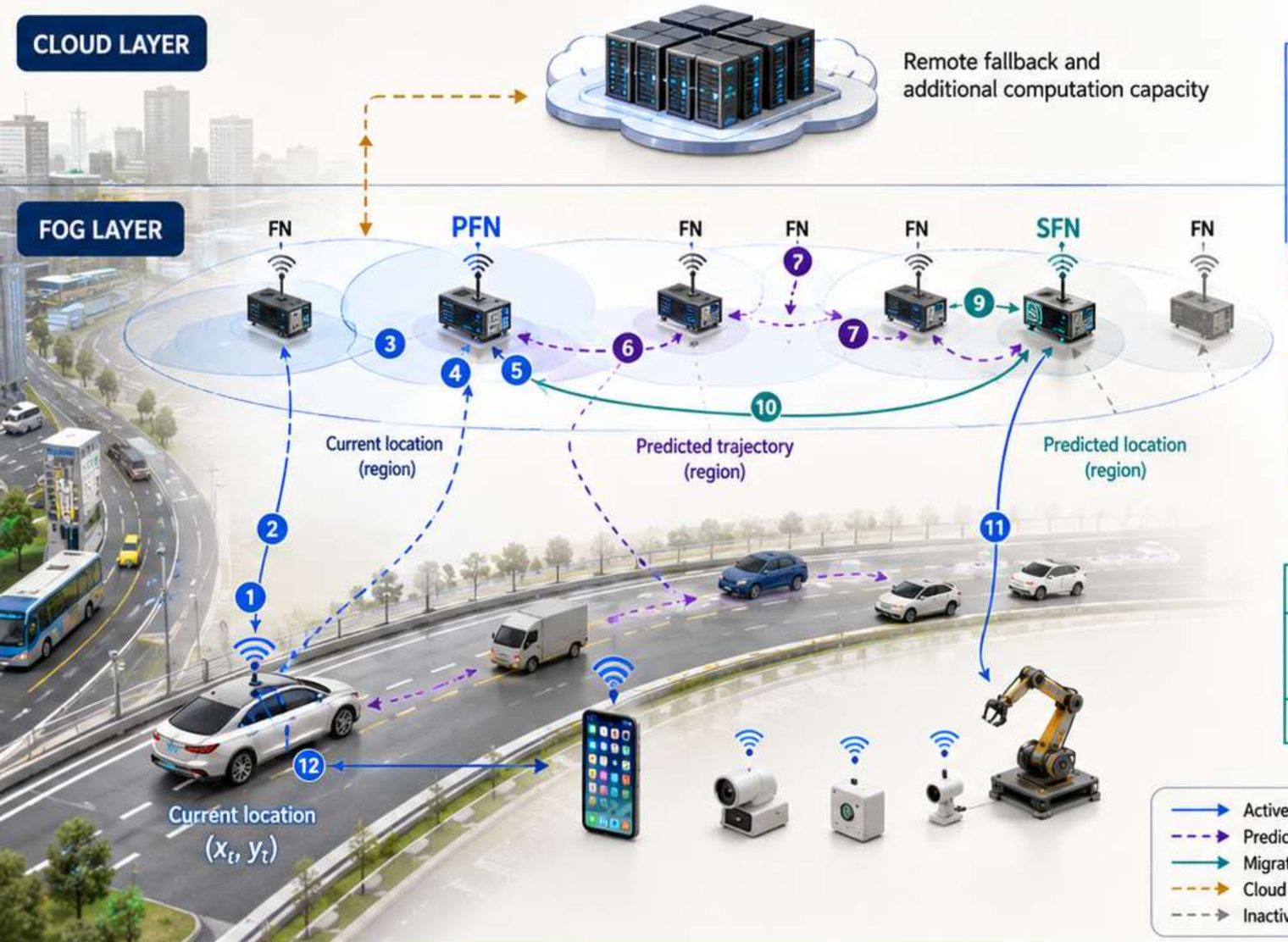
Healthcare-style short request

Direct task offloading may use fewer network resources.

Mobility alone should not trigger migration; the system must also consider task and network conditions.

Inside the OptFog Mobility-Aware Fog Network

Predict the next location, select the next fog node, resume the task



1. Mobile end user generates task (S, C, D).
2. User decides: local execution or PFN offloading.
3. Nearest fog node becomes the PFN.
4. PFN checks task demand, deadline and current execution time.
5. System determines whether migration is necessary.

6. ML model predicts the user's future location.
7. Candidate fog nodes in that region are evaluated.
8. Latency and fog-node utilization are checked.

9. Suitable SFN is selected.
10. Task State + Program + Intermediate Data transfers by live migration.
11. Computation resumes at the SFN.
12. Result is delivered to the mobile user.

- Active communication
- Prediction path
- Migration (live)
- Cloud fallback
- Inactive / not selected

RESEARCH PANEL 1
Migration Inputs

- Predicted location
- Deadline
- Node utilization
- Latency

RESEARCH PANEL 2
Task Information

- Task ID
- Size
- CPU cycles
- Deadline
- Current execution time

RESEARCH PANEL 3
Decision

- PFN can complete? → Continue at PFN
- Migration beneficial? → Move to SFN
- No suitable fog node? → Cloud fallback

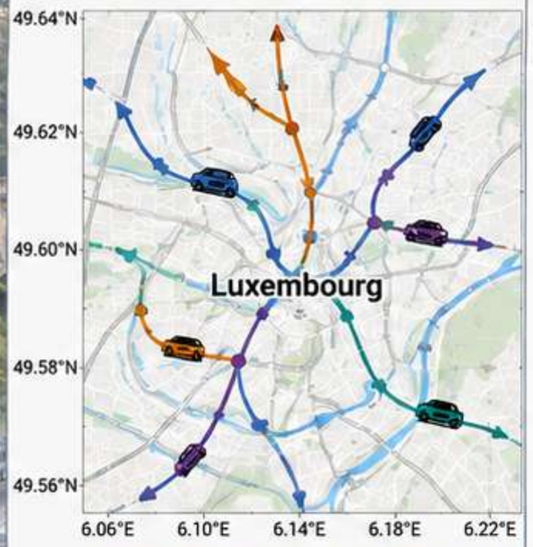
OptFog selects the migration destination before the user reaches the next fog-node region.

Slide 4

Predicting the User's Next Location

LuST mobility traces guide proactive migration

1 Mobility Data



Luxembourg SUMO Traffic, LuST

262 vehicles

2 Input Features

- Simulation time
- Direction
- Speed
- X coordinate
- Y coordinate
- Vehicle ID

3 Three Models

- Decision Tree — 96.48%
- Random Forest — 97.47%
  - Best overall accuracy
- k-NN — 86.96%

4 Prediction Output

- Current vehicle position
- Predicted X,Y coordinates (6.1521°E, 49.6042°N)
- Likely future road segment
- Fog nodes in that region
- Selected SFN candidate

5 Scientific Validation

Fig. 3: Accuracy comparison of different ML models

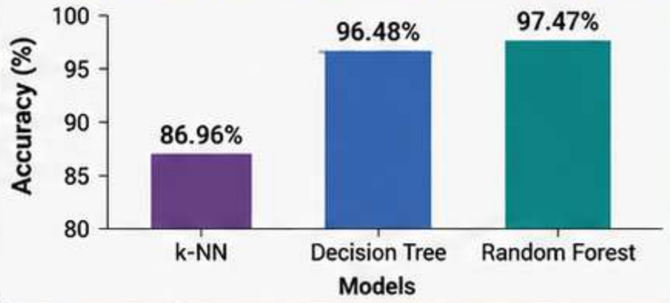
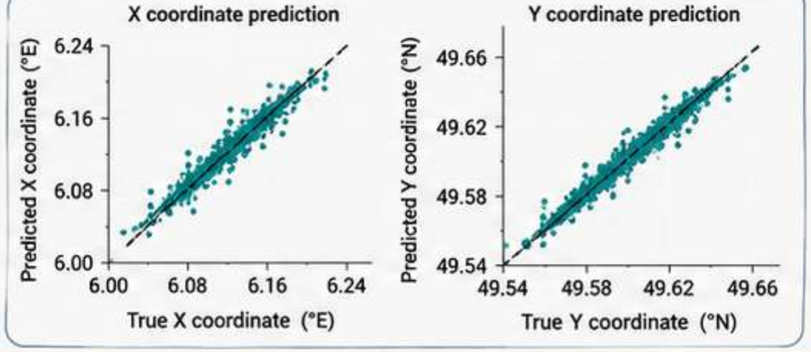


Fig. 6: Random Forest true vs predicted coordinates



The predicted location is used to search for an SFN before migration is triggered.

One-way ANOVA and t-tests reported *p-values* below 0.05.

More accurate location prediction enables earlier and more appropriate migration decisions.

Slide 5

What the OptFog Experiments Show

Prediction-based migration reduces unnecessary mobility overhead

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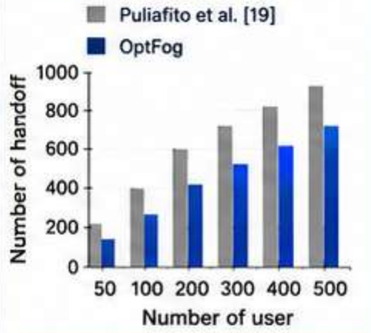
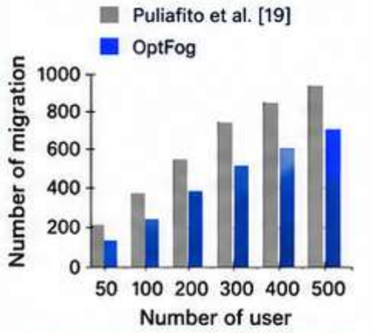
1 HANDOFFS



Up to 45% fewer handoffs

Prediction reduces unnecessary connection changes.

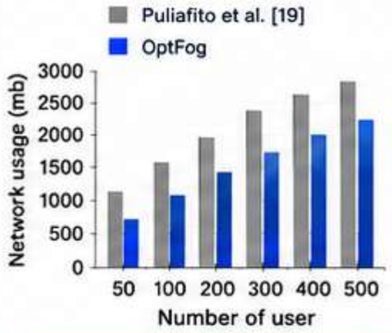
2 MIGRATIONS



42% fewer migrations

OptFog avoids moving tasks when migration is not beneficial.

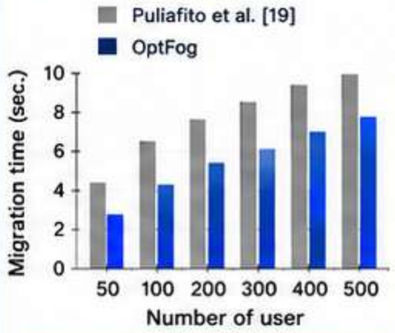
3 NETWORK USAGE



Up to 22% lower network usage

Fewer task-state transfers lower network consumption.

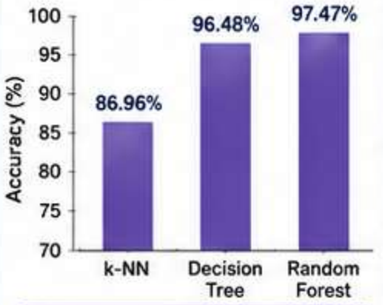
4 MIGRATION LATENCY



44.5% lower migration latency

Predicted mobility helps select the destination earlier.

5 MODEL ACCURACY



Random Forest performs best.

High accuracy in predicting the next fog node location.

EXPERIMENTAL SETUP

iFogSim2 | 1 cloud node | 50 fog nodes | 50–500 end devices | 262 vehicle mobility traces | LuST dataset | Fog node: 2800 MIPS | End device: 500 MIPS | Fog RAM: 4000 MB

RESEARCH CONCLUSION CHAIN

Mobility traces → predict future location → check deadline and utilization → select SFN → Task State + Program + Intermediate Data (PFN (current) → SFN (next)) → migrate only when useful → lower mobility overhead

EVALUATION SCOPE

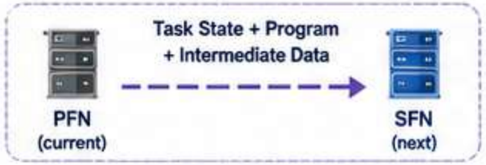
Simulation-based using iFogSim2 and LuST mobility traces. Effectiveness is demonstrated for the evaluated vehicular mobility scenarios.

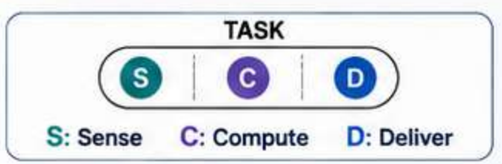
FINAL CONCLUSION

OptFog uses predicted mobility to make proactive task-migration decisions and improve mobility support in fog-assisted networks.

APPLICATION INTERPRETATION

Migration is most useful when a running service must remain close to a moving user for an extended period.





Predict the movement. Choose the next fog node. Migrate only when it helps.