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pPath: Path Presumption in Wireless Sensor Networks

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ABSTRACT

Recent wireless sensor networks (WSNs) are becoming increasingly complex with the growing network scale and the dynamic nature of wireless communications. Many measurement and diagnostic approaches depend on per-packet routing paths for accurate and fine-grained analysis of the complex network behaviors. The basic idea of iPath is to exploit high path similarity to iteratively infer long paths from short ones. A novel path inference approach to reconstructing the routing path for each received packet. IPath exploits the path similarity and uses the iterative boosting algorithm to reconstruct the routing path effectively.

Keywords: Measurement, path reconstruction, wireless sensor networks.

I. INTRODUCTION

A novel path inference approach to reconstructing the per-packet routing paths in dynamic and large-scale networks. The basic idea of iPath is to exploit high path similarity to iteratively infer long paths from short ones. iPath starts with an initial known set of paths and performs path inference iteratively. IPath includes a novel design of a lightweight hash function for verification of the inferred paths. In order to further improve the inference capability as well as the execution efficiency, iPath includes a fast bootstrapping algorithm to reconstruct the initial set of paths. We also implement iPath and evaluate its performance using traces from large-scale WSN deployments as well as extensive simulations. Results show that iPath achieves much higher reconstruction ratios under different network settings compared to other state-of-the-art approaches.

A. Aim and objectives:

- ✓ To reconstruct path the per-packet routing path in dynamic and large scale networks on the sink side.
- ✓ Reconstruct the routing path effectively.
- ✓ Analyze performance of iPath and evaluate the performance using simulation.

II. ARCHITECTURE

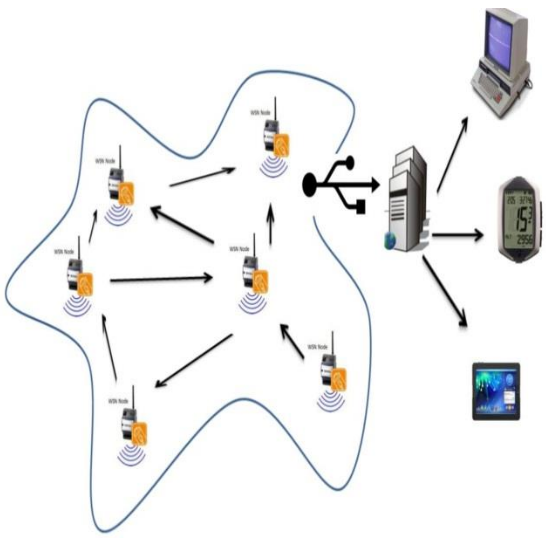

Figure 1. Wireless Sensor Network

A. Methodology:

Network Model: In the first module, we design the Network Model Module. We assume a multi-hop WSN with a number of sensor nodes.

- ✓ Each node generates and forwards data packets to a single sink. In multi-sink scenarios, there exist multiple routing topologies.
- ✓ The path reconstruction can be accomplished separately based on the packets collected at each sink. In each packet , there are several data fields related to iPath.
- ✓ The first two hops of the routing path, origin and parent. Including the parent information in each packet is common best practice in many real applications for different purposes like network topology generation or passive neighbor discovery.
- ✓ The path length. It is included in the packet header in many protocols like CTP. With the path length, iPath is able to filter out many irrelevant packets during the iterative boosting.

Iterative Boosting: iPath reconstructs unknown long paths from known short paths iteratively. By comparing the *recorded hash value* and the *calculated hash value*, the sink can verify whether a long path and a short path share the same path after the short path's original node.

- ✓ When the sink finds a match, the long path can be reconstructed by combining its original node and the short path.
- ✓ There are two procedures, the *Iterative-Boosting* procedure and the *Recover* procedure. The *Iterative-Boosting* procedure includes the main logic of the algorithm that tries to reconstruct as many as possible packets iteratively.
- ✓ The input is an initial set of packets whose paths have been reconstructed and a set of other packets. During each iteration, is a set of newly reconstructed packet paths. The algorithm tries to use each packet in to reconstruct each packet's path. The procedure ends when no new paths can be reconstructed.
- ✓ The *Recover* procedure tries to reconstruct a long path with the help of a short path. Based on the high path similarity observation, the following cases describe how to reconstruct a long path.

PSP- Hashing: The PSPHashing (i.e., path similarity preserving) plays a key role to make the sink be able to verify whether a short path is similar with another long path.

- ✓ The hash function should be lightweight and efficient enough since it needs to be run on resource-constrained sensor nodes.
- ✓ The hash function should be order-sensitive. That is, hash(A, B) and hash(B, A) should not be the same.
- ✓ The collision probability should be sufficiently low to increase the reconstruction accuracy.
- ✓ Traditional hash functions like SHA-1 are order-sensitive. However, they are not desirable due to their high computational and memory overhead. We propose PSP-Hashing, a lightweight path similarity preserving hash function to hash the routing path of each packet.

Performance Analysis: The fast bootstrapping algorithm reconstructs the routing path of a packet hop by hop. When the sink reconstructs the path of a packet to a forwarder, it can reconstruct the next-hop only when the packet is in one of stable periods.

The probability of a successful reconstruction by multiplying the probabilities there exists at least one shorter helper path at several hops.

III. CONCLUSIONS

a novel path inference approach to reconstructing the routing path for each received packet. iPath exploits the path similarity and uses the iterative boosting algorithm to reconstruct the routing path effectively. Furthermore, the fast bootstrapping algorithm provides an initial set of paths for the iterative algorithm. Formally analyze the reconstruction performance of iPath as well as two related approaches. The analysis results show that iPath achieves higher reconstruction ratio when the network setting varies. iPath implement and evaluate its performance by a trace-driven study and extensive simulations. Compared to states of the art, iPath achieves much higher reconstruction ratio under different network settings.

IV. ACKNOWLEDGEMENT

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