# Scalable Routing for Unstructured Networks of Low-Resource Devices

Thomas Fuhrmann,
IBDS System Architecture,
University of Karlsruhe, Germany

Routing has been studied for a long time. Still, new requirements create a need for new algorithms. In our work, we focus on networks of low-resource devices that are to be deployed by home users. Typical examples are embedded controllers in inexpensive appliances, building automation, or wearables. Today, such devices communicate either point-to-point, e.g. a remote control directly sending to the respectively controlled device, or they are based on hierarchically structured networks. In contrast, we aim at networks where devices can communicate multi-hop, but networks are not hierarchical. By combining wireless and wireline links, both energy consumption and radio interference are reduced when compared to the state of the art point-to-point radio controls.

Here, we present the scalable source routing protocol; an indirect routing mechanism that can provide both unicast routing and key based routing in large unstructured networks with moderately mobile nodes. Scalable source routing operates with arbitrary node addresses, including vendor assigned MAC addresses and random numbers, e.g. hashes of cryptographic keys. Its key idea is to view node addresses as forming a virtual ring. An iterative protocol provides each node with a source route to its respective neighbours in this virtual ring. A least-recently-used cache stores a small number of additional source routes that are learnt during operation. Thereby, nodes are able to always forward packets without the need to store packets and perform additional route discovery operations (as is the case with other ad-hoc routing protocols such as AODV).

With the help of extensive simulations, we show that scalable source routing is able to provide routing in large networks (10.000 – 100.000 nodes) with only very little per node state (~4-6 kB). Routes are slightly longer than globally optimal shortest paths (depending on the network topology and node mobility 20% or more). Especially in scenarios with frequently changing communication patterns scalable source routing outperforms reactive protocols such as AODV, since it does not need to explicitly discover routes. Thereby, despite of its source route overhead in the packets, scalable source routing generates less traffic overhead and is thus less prone to driving a network into congestion.