# Service Discovery and Session Initiation in a Highly Dynamic Swarm of Unmanned Vehicles

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## Context

This research project takes place in a **mobile and highly volatile network of unmanned vehicles**. Several nodes of this network can provide various services like *heat sensor*, *infrared camera*, *long range communications antenna*, etc. **Service discovery** is the capability for a node to locate a service hosted by another node.

For instance, in Figure 1, one UAV (Unmanned Aircraft Vehicle) is using the *camera service* of another UAV:

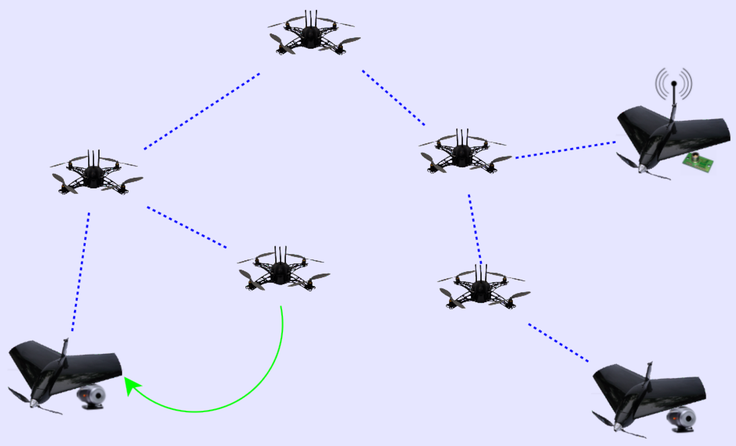

Figure 1: A UAV using a *camera service* of another one in the same network

## Goal

In this work, we propose a **hybrid and adaptable service discovery model** which combines a *semi-active method* (**DHT**) and a *semi-passive technique* (**Service Token**) in order to get an efficient solution for highly mobile and volatile networks.

## Service Token

A virtual element, the token [6], circulates through the whole network, gathering services information. Nodes update their local services localization table dynamically when the token passes through them. This services table stores only the adjoining node to be contacted to reach the service. We ensure, at each instant, that there is exactly one token per connected component. In case of the graph splits in separate parts, new tokens are generated. In the opposite case (i.e. components fusion), tokens have to be merged. This technique can be considered as **semi-passive** because even if services localization information are stored in the cache of the nodes, a multi-hop forward mechanism is used to reach services.

Figure 2 illustrates the service token system in action:

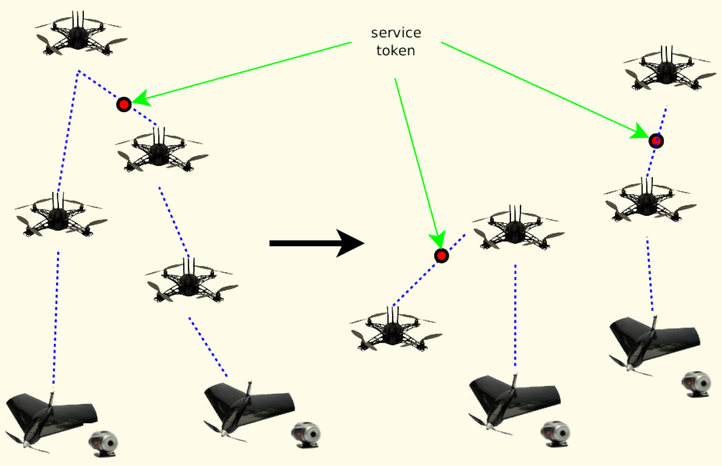


Figure 2: Service Token in action

## State of the Art

It is possible to divide **service discovery** techniques in two main categories [1, 2]:

1. **Passive methods** consist of a **proactive system** in which nodes continuously listen to broadcast messages which contain service localization information and store them in a local cache. The most important advantage of this technique is that only service messages pass through the network and that no service directory is needed. However, information contained in the local cache can be outdated and therefore invalid due to the important volatility of the network. Examples: *DEAPspace* [3] and *Allia* [4].
2. **Active methods** consist of a **reactive system** in which nodes send service requests in order to get localization information when they need it. Request messages are relayed by other nodes in order to reach the node which provides the service (or a service directory). This technique provides wise uptodate information but can be strongly invasive due to the quantity of relayed messages. Consequently, latency and nodes lifetime can be strongly altered especially in a large network. Example: *SANDMAN* [5].

## DHT (Distributed Hash Table)

A DHT [7] is an information directory which is distributed and replicated upon each node of the network. When a node joins the network, it sends a DHT request to a neighbor in order to share its services and to store a part of the DHT. During the network lifetime, some regular messages are sent and received by all of the nodes in order to update their hash tables. To localize a service, a node can ask the DHT which node stores this information and then, ask this node where the service is hosted. Of course in case the graph splits in separate parts, a partial rebuild of the DHT may be necessary. This technique can be considered as **semi-active** because a node has to ask the DHT where a service is located when needed, and also because DHT update messages cross the whole network during its lifetime.

Figure 3 illustrates a DHT request failure in case the node which stores a service localization information is unreachable:

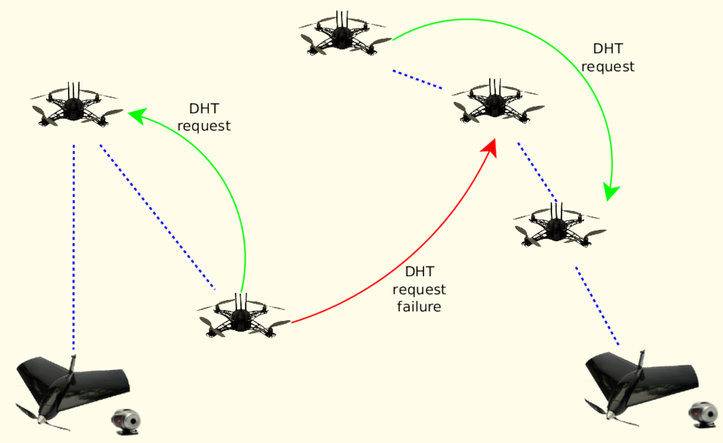


Figure 3: DHT in action

## Hybrid Model

Our hybrid model consists in combining the two previous techniques depending on the volatility, the mobility and the size of the network. DHT will be more suitable for a large network with lots of services, and a token based approach will be more efficient if the volatility of the network is important.

## Test Platforms

In order to evaluate our system, we will use two different testbeds.

### NEmu : a Virtual Testbed

**NEmu** [8] is a distributed virtual testbed which emulates a virtual dynamic network in order to perform experimentation on real application code. Figure 4 provides an illustration of such a virtual network:

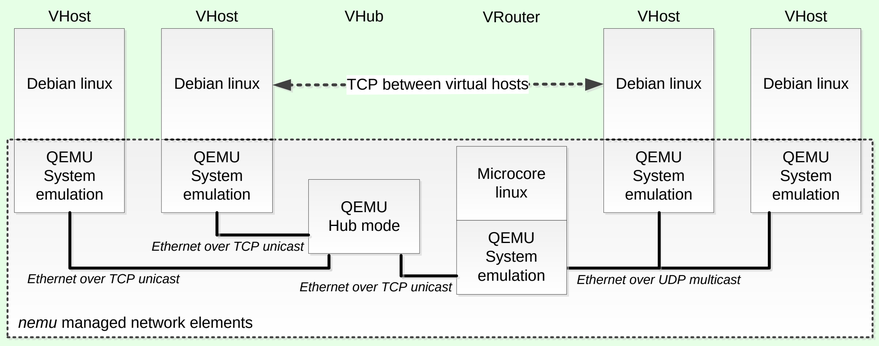


Figure 4: A virtual network generated by NEmu

We will use this tool to evaluate our system before launching it on a real swarm of UAVs.

### SCUAL : a Physical Testbed

**SCUAL** [9] is a swarm of nano quadrotors UAVs acquired from the *Fly-n-Sense* company (Merignac). Figure 5 is a picture of this swarm of UAVs.

Figure 5: UAVs of SCUAL

We will use this swarm in order to evaluate our system on a real physical mobile and volatile *ad-hoc* network.

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