**WRITTEN 2  
OPERATING/ DISTRIBUTIVE SYSTEMS   
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**1. Read Note 5.1 in the textbook. Write a 1-paragraph summary in your own words.**

Note 5.1 says that networking such as information-centric networking supports a principle that applications don’t worry about where an entity is stored, but to get a copy of it to access it locally. Researchers started designing an alternative to the host-based addressing schemas, where an entity can be accessed by an application by its name. The network takes the name input and routes a request to a location where the entity is stored, to return a copy to the requester. The key advantage of this approach is name-based routing so that it can skip the name-to-address conversion. The routing concept depends upon the naming organization, Flat names require solutions such as hash tables and structured names require hierarchical solutions.

**2. Read Note 5.11 in the textbook. Write a 1-paragraph summary in your own words.**

In Note 5.11, Figure 5.22 depicts a small portion of the file that houses most of the data for a prior administration of the cs.vu.nl domain to help the reader better understand these implementation issues. Please take note that we have selected an obsolete version for security reasons. For readability, the file has been altered. It displays the content of several nodes that make up the cs.vu.nl domain, each of which is recognized by its domain name.

The node cs.vu.nl represents the domain as well as the zone. Its 50A resource record contains specific information on the validity of this file, which will not concern us further. There are four name servers for this zone, referred to by their canonical host names in the NS records. The TXT record is used to give some additional information on this zone but cannot be automatically processed by any name server. Furthermore, there is a single mail server that can handle incoming mail addressed to users in this domain. The number preceding the name of a mail server specifies a selection priority. A sending mail server should always first attempt to contact the mail server with the lowest number.

The host star.cs.vu.nl operates as a name server for this zone. Name servers are critical to any naming service. What can be seen about this name server is that additional robustness has been created by giving two separate network interfaces, each represented by a separate A resource record. In this way, the effects of a broken network link can be somewhat alleviated as the server will remain accessible.

The next four lines (for zephyr cs.vu.nl) give the necessary information about one of the department's mail servers. Note that this mail server is also backed up by another mail server, whose path is tornado.cs.vu.nl.

**3. Read Note 5.12 in the textbook. Write a 1-paragraph summary in your own words.**

The implementation of DNS follows a hierarchy of servers with 13 well-known root nodes and large number of servers at the leaves. Higher-level nodes receive many more requests than lower-level ones and must be caching (by name-to-address bindings) to avoid swamping them with incoming requests.

In this article, we look at how a huge collection of (flat) names can be efficiently supported. What needs to be done is to maintain the mapping of identifier-to name information. Using identifiers can be made easier by letting users or organizations use a strict local name space.

The current, hierarchical design of DNS is not so bad for these two reasons, and there are many trade-offs to consider when considering the benefits and costs of replacing it with a non-downtime-based protocol such as OpenDNS or WebRTC. In a hierarchical design, not all nodes are equal and in the case of DNS, each of the higher-level nodes are engineered differently. For example, the root node provided by RIPE NCC is implemented at some 25 different sites (all using the same IP address), each implemented as a highly robust and replicated server cluster. We have already seen that top-level nodes in DNS are implemented as distributed and replicated server (clusters) but an associated server will not provide recursive name resolution. Such decisions are necessary also from a perspective of robustness, as they protect the more important parts of the system against abuse. DNS servers use caching to improve the efficiency of resolving domain names. The behavior of a DNS server is determined by the queries that are made at that server. An ISP's DNS server may be very effective in redirecting traffic to content that is localized in that ISP. Caching and replication in DHT-based systems generally does not show such principles of locality.

The above content discusses the pros and cons of using a decentralized DNS system. While it has some advantages, such as being more resistant to censorship, it also has some disadvantages, such as being less performant and less robust. In the end, it is up to the user to decide whether or not to use a decentralized DNS system.

**4. Read Note 5.14 in the textbook. Write a 1-paragraph summary in your own words.**

There are many decentralized implementations of attribute-based naming systems, each with its own advantages and disadvantages. Space-filling curves are relatively popular, but there are also other options available. The attribute-value tree (AVTree) is a data structure that is used to store and retrieve information in a DHT-based system. Each entity is described by a set of attributes, and each attribute has a corresponding value. The AVTree is used to store the attribute-value pairs in a DHT-based system.

The SWORD resource discovery system uses DHTs to partition the space of attributes and store specific (attribute, value) pairs. This system partitions the possible range of values for each attribute name into subranges and assigns a single server to each subrange. So, for example, if an entity has associated attribute values (a^1=7, a^2=175), server S^12 and server S^22 will maintain a copy of, or a reference to, that entity. The above scheme partitions data by ranges and distributes it across multiple servers. The advantage of this scheme is that range queries can be easily supported. However, updates need to be sent to multiple servers, and it is not clear how well the load is balanced between servers.

In computer networking, attribute-based naming is a system in which resources are named by their attributes, rather than by a name that is assigned to them. This system can be used to integrate naming with resource selection service, so that each resource only needs to have a fixed number of neighbors, while routing a query to the relevant subspace takes only a linear number of steps.