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Network Information Driven Cloud Computing

Harsha Narayan Jawale
Research Scholar, Pune, Maharashtra, India

Abstract:

Cloud computing is bringing about it achievable to alienate the approach of developing an infrastructure for service provisioning from the business of assisting end user supports. Now, such infrastructures are commonly ascribed in big information centers and the approaches are conducted remotely from the clients. One induct for this is that cloud computing needs an economically balanced infrastructure and networking circumstance, comprehensively due to business affirmations. Networking of Information (InfoNet) is a data centric networking archetype that can adjures cloud computing by assisting alpha probabilities for network transport and storage. It allows direct approach to data using a simple API, autonomous of their location in the network. This abstraction can camouflage much of the difficulty of storage and network transport mechanisms that cloud computing today has to deal with. In this paper we analyze how cloud computing and InfoNet can be co-acted to caste cloud computing infrastructures easier to control, as well as conceivably assent contribution in smaller and more assiduous networking environs. InfoNet should thus be accepted as an enrichment to the infrastructure for cloud computing rather than a change to cloud computing technology as such. To demonstrate the convergence accumulated by InfoNet, we also explain how it can be conducted by beginning a definite name determination and routing approach.
Keywords: Cloud computing; Networking of Information (InfoNet); network architecture; name resolution; routing.

1.Introduction

The concept of Cloud Computing is approaching more and more attentiveness in the service research culture. The core concept is to caste applications obtainable on alterable execution environs originally established in the Internet. Numerous flavours are known, and three autocratic ones are illustrated in the figure below.

Infrastructure as a service applies to the associating of hardware resources for comporting services, definitely applying virtualization technology. With this so-called Infrastructure as a Service (IaaS) imminence, conceivably many clients apply subsistent resources. The resources can efficiently be scaled up when constraint acquires, and are definitely charged for on a per-pay-use compulsion.

In the Platform as a Service (PaaS) case, the approaching also combines a software execution environs, like as an application server. In the Software as a Service convergence (SaaS), conclusive applications are conversed on the Internet so that e.g., your word processing software is not embedded locally on your PC anymore but runs on a server in the network and is converged via a web browser.

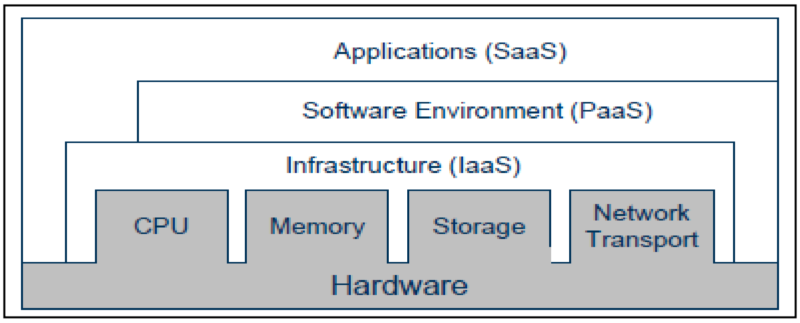

Figure 1: Cloud Computing Overview

At the same time, the networking research culture is operating on examining the merits emerging from the alpha bench mark of content-centric or information-centric networking. Accepted networking structures for the PSTN as well as the Internet determines the dilemma of adhering terminals or hosts to accept a discriminating application such as telephony or WWW. To this end, accepted authorizing and approaching approximates conduct box- or domain-oriented designations such as E.164 numbers for telephony, or IP and URLs for the Internet. Furthermore, the hindmost client is absolutely attentive in reaching an accomplishment object that sits behind or in the host, such as a human being or a file, rather than broadcasting with the host itself. As the accomplishment antagonizes comport to alpha hosts, the host- or network-dependent appellations of these objects must be updated. Information-centric networking allows a breakthrough to these consequences by clearly applying the data objects instead of applying the host-dependent or domain-dependent applying approximates.

While URLs are also applied to detect data objects, there is an autocratic asymmetry to how InfoNet names data objects. URLs compose the domain name or locator of the host at which the destination object is accounted and are therefore based on the accepted location-oriented broadcasting bench mark. Posteriorly, bonds based on analogous to URLs break when the host of a destination object comports to a new direction, or when the address of the host of the object adjustments. In the current Internet, there are numerous amends to circumvent this dilemma, such as HTTP redirects and industrious DNS. The location-independent object labeling approximate of InfoNet declines this dilemma altogether, as the InfoNet object names continue the identical autonomous of any topology conditions, including site updates.

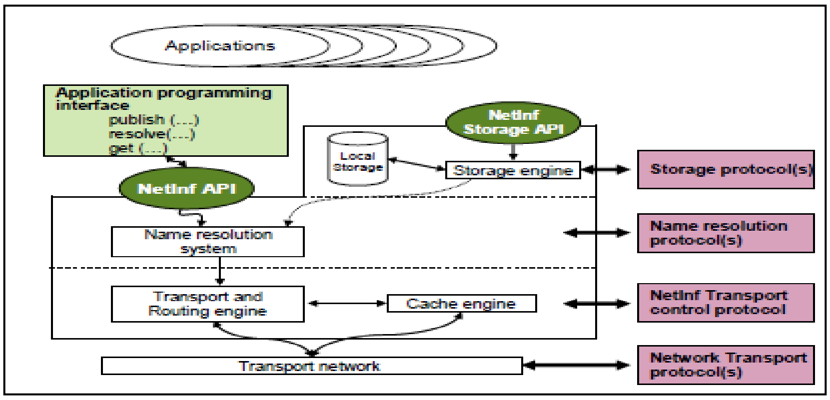

Figure 2: Networking of Information Overview

The fundamental object of Network of Information (InfoNet) is to shift from today's host centric networking paradigm to an information centric networking paradigm where the information items are the principal components of networking. One significant facet is that the information items are identified as independent of the hosts they are stored on. The fundamental design ideas of InfoNet are illustrated in [1]. In InfoNet, users demand the information by means of a well-defined API by stating the name of an information object using the get () primitive at the InfoNet API in Figure 2. The name can have cryptographic properties. The name of the information item can then be used to validate the genuineness of the file. How and from where the object is recovered is determined by the InfoNet Transport and Routing engine. This makes it likely to respond to modifications in the network, both in terms of topology and load situation, in a flexible way. Information can be amassed at random in the network and storage units. It can also be recovered from InfoNet hosts that have already obtained the information and have stored it in their local cache. The InfoNet Name Resolution System comprises an adaptable and scalable mechanism for processing the bindings between the object names and location, e.g. to support host, user and object mobility. From a cloud computing point of view, the network of information therefore proffers new technology for dealing with the "networking resources" and "storage" boxes in Figure 1.

In this paper, we posteriorly converse the cross-section between the cloud computing and the information centric axiom. The remainder of the paper is organized as follow. In section II we discuss how cloud computing can aid from Networking of Information (InfoNet). Then in section III we engender a first proposal for an architecture for putting cloud computing and

InfoNet together. We then go on to explicate, in some more detail, the mechanisms that make InfoNet adept to present the desired functionality. lastly we ascribe a conclusion and discuss further work.

2.Benefit From Infonet

Cloud computing, today, is presenting an effective environment for rapid operation of new services. In particular, it proffers unrivalled prospects for rapidly scaling up the capability for services that unexpectedly turn out to be popular. Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) approaches have substantiated to be effectual measures for separating the service deployment from the provisioning of the necessary service infrastructure. The latter apparently is a much slower procedure as it contains hardware installation and probably extensive physical facilities, as well as establishment of new communication infrastructure. One of the core obstacles with existing cloud computing is the costs required for management of the storage as well as networking facilities [3]. To make the management tractable, today's approach to cloud computing depends on the site infrastructure and the networking topology being moderately steady.

The major advantage of what is presented in this paper is not the means to enhance the cloud computing functionality as such by use of InfoNet. We rather argue that by basing the cloud computing infrastructure on InfoNet, many of today's issues with management of cloud computing infrastructures can be eased.

In this light, distributing cloud computing service across networking environment like virtual networks, is a very difficult with present technology. In addition, such cloud service need to be replicated between servers.

The following paragraphs exemplify how introducing InfoNet technology can facilitate addressing the above cloud computing challenges. We also recommend other potential benefits that InfoNet can bring to cloud computing.

The Network of Information paradigm permits for a new method to the challenge of dynamic network topologies. While cloud computing conveys revolutionary technology to resource sharing, the Network of Information is a new method in accessing information (in its widest sense) on a network. It brings a new concept to the networking layer: the conception of information objects. Contrasted to present networking paradigms, this new approach are designed for directly accessing the information, rather than addressing it indirectly through the host or network domain comprising the information. The addressing used in InfoNet completely relies on naming the information itself, and not the location or network domain in its retrieved from. For a cloud computing platform, thus considerably simplifies the way data is operated.

When the access of information objects is no longer done in an application-specific fashion, incorporation and organization of applications become effortless, since they all access information using the same naming scheme. Access control is a subject of its own right in the InfoNet work, but outside the scope of this paper.

The media distribution capabilities of InfoNet endow with a part of executing IaaS. A part of IaaS or PaaS offerings is regularly the potential to effectively disseminate large amounts of content, e.g. video files. This can be accomplished through content distribution overlays, such as the distinguished Akamai CDN [5]. Content distribution functionality is imparted natively in a InfoNet-enabled network, comprehended by the functions initiated in the earlier section. Information is purely requested by stating its name, while a InfoNet-enhanced networking layer takes precision of selecting the optimal distribution mechanism, incorporating caching and source selection. Similar to the prevalent peer-to-peer systems, clients can also operate as a new source for already downloaded information.

InfoNet functionality will also assist services and service composition. Without aspiring to become a service platform in itself, the notion is that services can be regarded as a type of information objects. Also a service needs to be unmistakably acknowledged, and can have manifold instances in the network. Meta-data can be used to depict the features of the service, and to aid the proper selection of a service. This pertains to both the cases where the selection takes place physically, e.g. by a user browsing a service registry, and to cases where this occurs in an automated fashion, e.g. in a service composition engine. In this way many mechanisms such as load balancing and mobility that are accessible through InfoNet can be reprocessed also for services.

Through a close assistance of cloud computing and networking of information, network nodes and network resources, comprising several storage systems, have the prospective of becoming accurately translucent to the applications and the users. The natural progression of networking is thus to move from networking of nodes to networking of information objects. But for users to feel comfortable with the, primarily appealing, idea of just dropping their information objects into the network, for storage, processing and dissemination, there are a number of issues that are required to be tackled and are presently being worked on in the WARD project [7]. These contain security issues like confidentiality, integrity, privacy and access rights. Also requirements on consistency and accessibility will pose challenges. While these all are first rank challenges we suppose that the primary impediment on the way to networking of information lies in the scalability issues related with changing the granularity of networking from, comparatively, few nodes to the particularly copious information objects themselves. In section IV we put forward a mechanism designed to meet this challenge.

3.Architecture Forcloud Computing : Infonet

In Figure 1 it is shown how the fundamental cloud computing service IaaS is organized of a set of virtualized resources, namely CPU, memory, storage and network transport. In the preceding section, we have already explicated how InfoNet can present an improved solution for network transport and storage. But let's take one step back and look at the two major motives to virtualize resources: one is security - to confine access to resources in order to present a 'virtual private' environment, the other is resource segregation in order to evade resource conflicts.

InfoNet can offer an substitute to the security facet of virtualization for two of the cloud computing resources, storage and network transport. The InfoNet networking architecture intrinsically acquires the access to information objects and network resources by cryptographic means. It is therefore no necessity to virtualize storage and network transport resources to guarantee the access rights. This stems from the fact that InfoNet abstracts away the boxes and links that is executing these resources and secures the resources themselves. Thus, there is no need to virtualize these boxes and links from a security perspective.

The requirement to virtualize for resource separation may or may not be a problem depending on the network configuration. With the current trend of reduced prices, particularly on storage but also on transmission links, this might be dealt with by conventional over provisioning, which can be coalesced with active network management in order to guarantee that new (real) resources are supplemented before resource conflicts surface. InfoNet in combination with advanced virtualization techniques like Vnet proposed in 4WARD can impart a simpler solution to this problem by virtualizing both storage and network transport resources [6]. One key benefit with Vnet compared to other virtualization techniques is that it also tackles the problem of virtualizing wireless network resources.

The InfoNet architecture endows with an API for communication between arbitrary types of information objects, autonomously of which hosts they are appended to, and of how they move between hosts. By arbitrary information object we indicate any information object which holds to the InfoNet naming scheme, and which is registered with the InfoNet name resolution system. Examples of such objects are data files, service objects, or digital representations of physical objects, such as RFID tags.

The InfoNet API assists a mode of communication, which is object-centric in the sense that only the object identity or sets of characteristics are desired to access an object. The object-naming scheme lets users and applications to build object names based on cryptographic hashes of the owner's public key. This circumvents the requirement for initiating a novel naming authority. Such object names are completely sovereign of the location of the object. Using this naming scheme, the API hides the location of an object, as well as the dynamics of the fundamental transport network. In addition, if numerous identical copies of an object subsist in the network, the InfoNet name resolution and routing system finds the "best"1 copy in an anycast fashion. getObject(objID) getObject(str1, str2, str3) API.

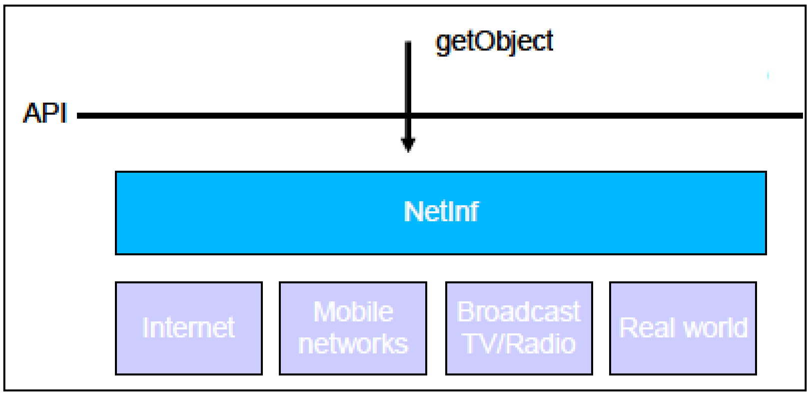

Figure 3: InfoNet API

The API comprises methods such as publish (objectName), resolve(objectName), and get(ObjectName). These methods allow for registrations of objects in the name resolutions system, determining the location of an object, and ascertaining connectivity with the object. The API also incorporates methods for object storage and recovery.

Figure 4 shows how InfoNet can corroborate a set of different cloud computing services. The cloud computing service uses InfoNet objects, which connect over a dynamic infrastructure network, such as a global network, using the InfoNet API. The service uses object names to recover and interrelate with other objects over the API, and has no idea of object locators. The dynamic infrastructure network on the other hand uses traditional addresses (locators), and has no notion of service layer objects.

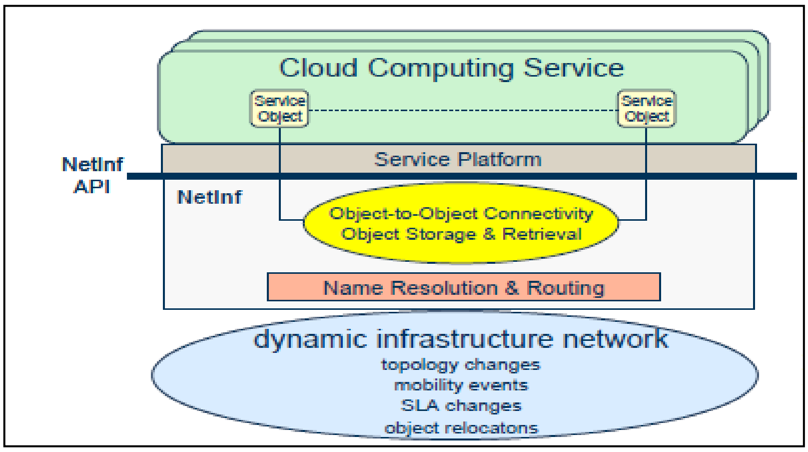

Figure 4: Architecture overview

A keystone of the InfoNet architecture is the name resolution and routing system, which determines the name of an object to a set of current network locators. The resolution mechanism is intended to deal with exceedingly dynamic network topologies in a scalable fashion, and offers an updated locator for a digital object that is moved between hosts, or for digital objects that are amassed on mobile hosts, which in turn may be attached to moving networks. Also, the resolution mechanism is competent of operating multihoming of objects, hosts, and networks. Note that the competence of handling these rather general mobility and multihoming scenarios also presents a source for the handling of dynamic events in fixed networks as described in section 2.1.
The name resolution and routing system is planned to scale to large networks and to a large number of objects (~1015). Similarly, the routing system must allow short convergence times also in a dynamic network topology. The concentration of the next section is on the name resolution and routing system and its interoperation with the dynamic network infrastructure. A novel mechanism is described that allows for a strict separation between the object-centric view of the API on the one hand, and a highly dynamic network topology on the other hand.

5.Object Routing Based On Locator

Customary routing imparts a network path between source and destination boxes that have locators such as IPv4 or E.164 addresses. The InfoNet name resolution and routing system uses an object-to-object routing mechanism that provides a network path between any set of objects that can register with a network node. A crucial characteristic of the mechanism is that it can deal with routing for a very large number of objects across a network that has a dynamic topology.
Below we illustrate an execution of the InfoNet name resolution and routing system based on the Late Locator Construction (LLC) mechanism. An outline of the locator construction process is shown in Figure 5.
The end-to-end routing problem is divided into three parts:
(i) detecting a path from the source object to the source core edge router at one edge of the core, (ii) determining a path form the source core edge router through the core to the destination core edge router at another edge of the core, and
(iii) Determining a path from the destination edge router to the destination object.
LLC accosts the first and the third of these routing problems. To route through the core network, traditional routing can be applied, since one constraint on the core network is that it is cogently static. As most of the nodes will reside in the edge parts of the network, also a future core network should consist of much less nodes than today's internet and there should not be a problem to reuse today's routing for the foreseeable future.
With the LLC mechanism, the locator of an object is developed (encoded) when packets are to be sent to or from the object to take fresh topology information into account. The object locator is thus developed at the last juncture before sending packets, which entices the term late locator construction. By using fresh topology information when encoding a forwarding path in the locator, topology changes due to mobility or re-homing events can be taken into account.
To quickly construct locators that represent the current topology, LLC uses Attachment Registers (AR). Each node in the network is represented by an AR in the routing system. The routing system, which resides in a fixed core network, consists of the ARs and a set of routing protocols. In the ARs, the nodes register their current connectivity, i.e. to which other nodes they have direct links, and the characteristics of each link. Note that the ARs only need to store information about immediately attached nodes. When an AR is requested to return a current locator for the node it is representing, a path fulfilling the requested link characteristics towards the core is constructed by traversing the ARs that lead to the core. This path is recorded in thelocator that is returned to the requesting host. To make this possible there is a simple routing protocol that announces the path towards the core, so each AR always knows through which attached nodes the core can be reached. When a node moves or when the topology changes forother reasons, e.g. re-homing events or changing link characteristics, only the directly attached nodes need to update their attachment registers. Thus even when a large network moves there will not be any update storm as most of the nodes in the moving network will not experience any change in their immediate environment.
When the resolve() method of the InfoNet API is invoked, a global name resolution system based on a distributed hash table resolves the cryptographic ID of the target object into a locator of the AR that is associated with the object. Starting from this AR, the current locator of the object is constructed and returned.
Steps 1-7 in Figure 5 represent the locator construction procedure described above. The figure illustrates an object locator that depicts a path from the core network to the object using a syntax with a series of attachments between adjacent network entities. The attachments are represented by the @ symbol. In a real implementation, the locator syntax would be more small to decrease the overhead.
It should be noted that there subsist numerous aggregation schemes that reduce the amount of mobility update signalling required for mobile hosts and networks, for example the IETF Nemo protocol [2]. However, such schemes are not promptly pertinent to the problem of arbitrary types of moving objects which is addressed by the InfoNet architecture. Moreover, Nemo suffers from the wellknown pin-ball routing problem, i.e. the user data path traverses all the mobility agents of the moving networks involved in an end-to-end flow.
A more extensive description of the LLC approach for object-to-object routing can be found in a report [4] from the EU FP7 project 4WARD where there is also ongoing work to further assess the scalability and performance of the LLC mechanism.

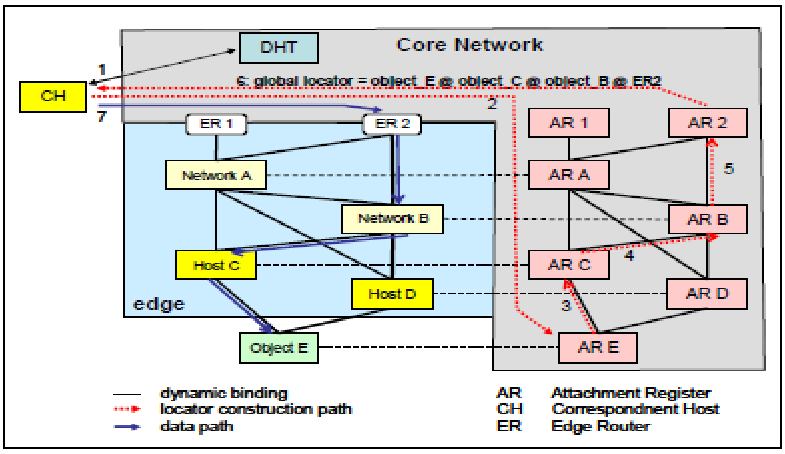

Figure 5: Overview of the Locator Buildup procedure

5.Conclusion

The chief intent of this paper is to explore what advantages the Networks of Information (InfoNet) technology can beget to the infrastructure that is the base for cloud computing. In particular, the management of a cloud computing infrastructure can be simplified, as it does not have to deal with the particulars of storing and transporting information objects. In this paper we have offered the InfoNet architecture,and portrayed how it can assist cloud computing services by presenting an API that conceals the dynamics of object locations and network topologies. One single name resolution and routing mechanism is used, despite of whether the dynamics depend on network reconfigurations, change of service level agreements, mobility events, rehoming events, or any other type of network event. The task of designing cloud computing services that are forceful against object re-locations or changes in the topology of the fundamental infrastructure network can thereby be considerably simplified.

To exemplify the InfoNet approach, a novel routing mechanism based on late locator construction has been xplained that executes object-to-object routing rather than traditional host-to-host routing. This mechanism can function over an extremely dynamic network topology and allows for scalable handling of a very large number of objects.

Future work comprises more comprehensive investigations on how InfoNet can handle services, including the use of InfoNet as a service directory for Web Services. Apart from the characteristics described in this paper, also automated and distributed processing of information objects shall be scrutinized, e.g. to offer a delay-sensitive service as close as possible to the end-user. As both InfoNet and virtualization (Vnet) of network resources are part of a common architecture being developed in the 4WARD project, we are also investigating which supplementary benefits their grouping can fetch to cloud computing.

6.References

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