



Considerations on the Endpoint for Future Internet

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Outline

- Background
- Endpoint in the Internet
- Endpoint for FI
- Conclusions

Future Internet Research

- Future Internet researches are very popular worldwide
 - Overcome the limitations of the Internet
- FI allows the introduction of revolutionary network concepts
 - Some fundamental things of the Internet are being revisited
 - A typical and important one is what should be the communication endpoint of Future Internet

Endpoint

- Endpoints of the Internet
 - Network interface



- Allocates a unique identifier (ID) to the interface in the form of an IP address
 - The ID, which identifies the communicating object, and the address, which indicates the location of the object, are exactly the same
 - Has worked very well and contributed to the surprising success of the Internet, especially from the scalability perspective

New Network Environment-(1)

- New network environments have emerged
 - E.g. Host/site multi-homing and mobility
- Multi-homing
 - A host, which has multiple interfaces, has multiple IDs, and thus, multiple connections because connections are typically identified using the associated IDs
 - Since each connection has different IDs, it is hard to identify that all of them belongs to the same host
- Mobile environment
 - The location of a mobile host, i.e. IP address, is very likely to change
 - Since the Internet connections are typically identified by the associated IP address, it is hard to maintain the connections in the Internet

New Network Environment-(2)

- New network paradigm
 - For instance, Content Centric Networking (CCN)
 - Trying to put the endpoint at the content itself and may aggravate scalability problem
- The problem of defining the location of the endpoint is a key issue in Future Internet that deserves a thorough and comprehensive research
- The purpose of this paper
 - Briefly reviews related works regarding the endpoint issue
 - Proposes a suitable endpoint for Future Internet

Related Works-(1)

- N. Chippa [1]
 - Generally reviewed the endpoint issue
 - Pointed out the problem of the Internet: IP address identifies two things, host and interface
 - Argued that, instead of the interface, host should be used as ID for communication
 - Also suggested the use of the term, endpoint, to replace the existing term, host
 - And defined it as the participant or fundamental agent of end-to-end communication
 - On the contrary, the interface is differentiated from the endpoint under the name of address

Related Works-(2)

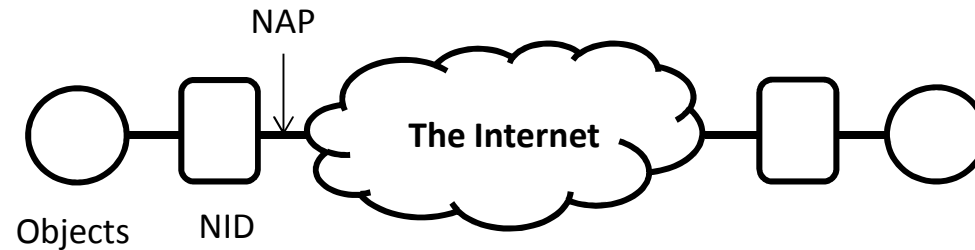
- LISP
 - Also uses the term, endpoint, separates it from locator
 - However, the endpoint still indicates the network interface rather than the host
- HIP
 - Proposes a new namespace, host identifier (HID) to indicate host itself, for effective support of multi-homing, mobility and security
 - HID is used as the endpoint
 - However it stays as a host-to-host approach rather than an architectural solution
- HID-based architectural approaches
 - Node Identity Architecture of Ambient Networks
 - MOFI (Mobile Oriented Future Internet)

Related Works-(3)

- CCN/NDN
 - A typical new networking paradigm for Future Internet
 - Content itself is used as the endpoint
 - Such approach to extend the endpoint towards user-side is becoming more common
 - E.g. many other Future Internet proposals, such as XIA, MobilityFirst, and SAIL
- Observation
 - There is no consensus on where to put the endpoint in the network
 - And it is a very controversial issue

Generic Network Model

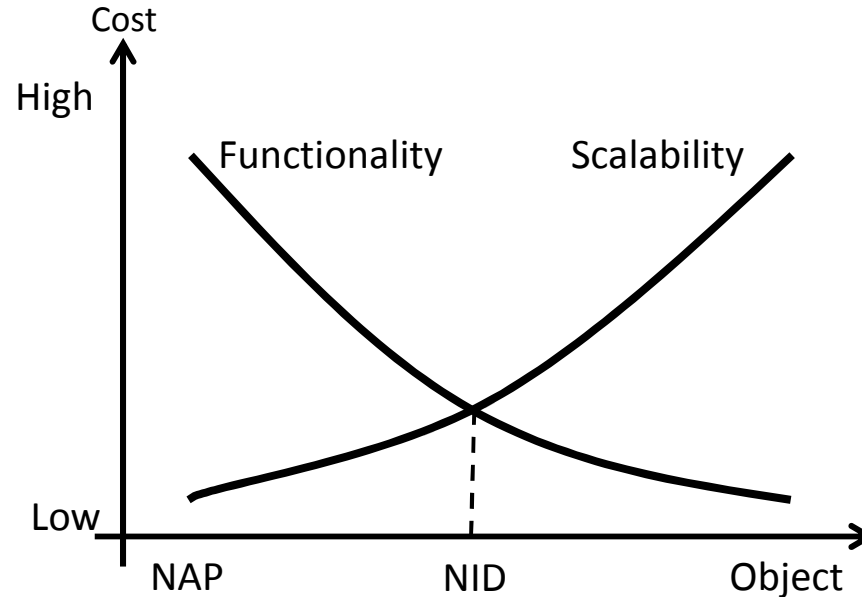
Referred [3] IETF RFC 1498



NAP: Network Attachment Point
NID: Network Interface Device

- The Internet delivers objects, e.g. contents, applications and services, with various delivery mechanisms such as unicast, multicast, and anycast
- Network Interface Device (NID), e.g. host, plays a role of interfacing them with the Internet through Network Attachment Point (NAP)

Expected Cost according to the Place of the EP-(1)

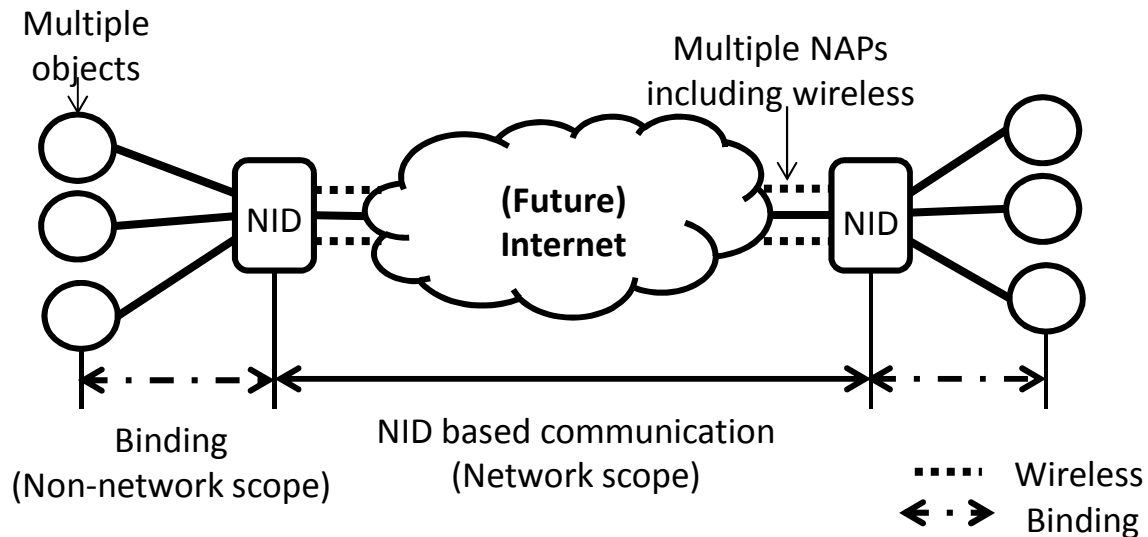


- NAP endpoint
 - Scalability issue can be minimized because the number of NAP is smaller than the number of objects
 - But it would inherit the same difficulties of the Internet, such as inefficient supporting multi-homing and mobility

Expected Cost according to the Place of the EP-(2)

- Object (content or service) endpoint
 - Enable better functionalities to the network (such as efficient data dissemination and multi-screen service)
 - Cost of scalability since the number of content is expected to be more than 10^5 times the number of hosts
 - The scalability is already one of the biggest problems in the Internet that uses the interface as the endpoint
- Two tradeoffs, scalability and functionality
 - Conflicting yet essential requirements for Future Internet
- This paper proposes NID as the end-point
 - Allows better network functionalities without sacrificing too much in terms scalability

NID-based Network Model



- Overview

- Objects, such as content and service, connected to the NID are exchanged through the FI via NAP
- From the perspective of network, the endpoints are NIDs, i.e. NID-based communication
- Binding of multiple objects to the NID could be supported by non-network functions, e.g. enhanced-DNS or search applications

Features

- NID basically provides the interface between objects and Future Internet
 - A typical example of NID is the host but includes virtual devices such as Virtual Machine (VM) in cloud network
- NID can have multiple interfaces (NAPs) including wireless as well as wired interfaces
 - Addresses are statically assigned to the NAPs
- For the mapping between NID and NAP, global mapping system should be provided
 - With the mapping system, intrinsic multi-homing and mobility support can be achieved in built-in manner

Scalability & Functionality

- From the scalability perspective,
 - Since the number of NIDs is much smaller than the number of objects, the scalability issue is more manageable
 - In addition, since the assigned addresses are unlikely to be changed, the routing scalability can be relieved
 - The scalability issue on objects is more easily addressed by non-network functions
- From functionality aspect,
 - Since the endpoint is NID, not interface, multi-homing and mobility can be supported in more efficient manner.
 - Moreover the flexible binding using non-network functions can efficiently support futuristic services.

Conclusions

- Future Internet will be a new network for future social infrastructure that overcomes the limits of the current Internet
 - Where to put the endpoint is an important issue in Future internet because many problems of the current Internet stem from it
- This paper briefly reviewed related works and proposed NID as the appropriate endpoint
 - With respect to two essential aspects, scalability and functionality
 - Also, this paper described a basic model for the NID-based communication
- How to design NID-based identification system (e.g. Name-NID-Address) is left as further study

Thank you!

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