

White Paper

OpenScape UC Suite IPv6 Transition Strategy

Siemens Enterprise Communications GmbH & Co. KG
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Germany

Executive Summary

IPv6 is finding its way into communication networks. This trend is mainly driven by the lack of public IPv4 addresses in the near future. We at Siemens Enterprise Communications GmbH & Co. KG (SEN) have recognized this challenge long before it really affects our customers. As a result with *OpenScape Unified Communications (UC)* SEN provides functionality for the transition from IPv4 to IPv6 which allows a smooth migration to the latest version of IP connectivity.

The devices and services of the *OpenScape UC Suite* are able to join an existing network in almost any transition state of the network, i.e. regardless of whether the customer is just planning the transition or has already started to make his network IPv6-ready.

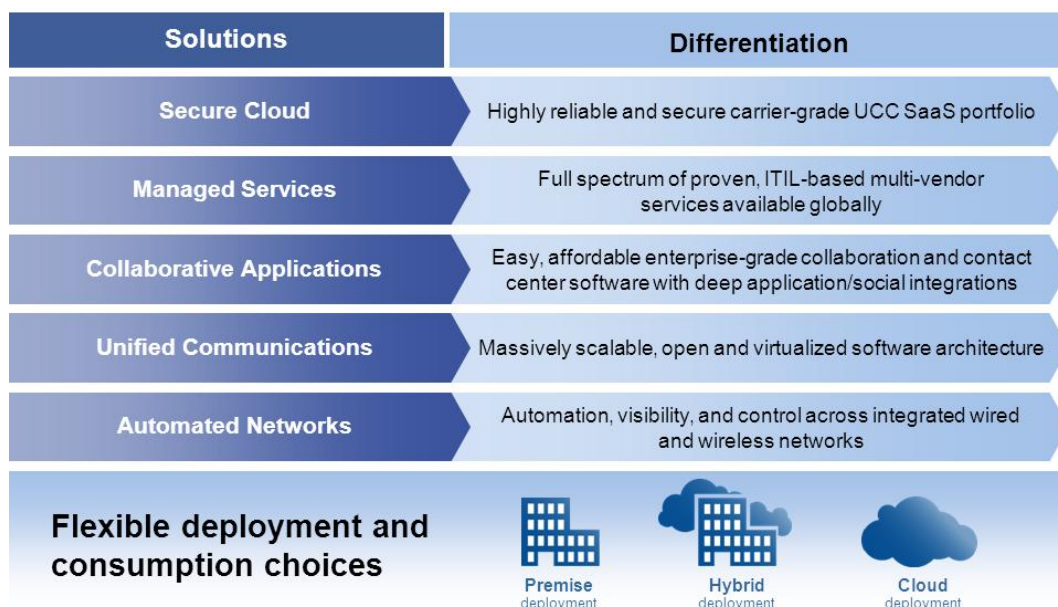
Each component of the *OpenScape UC Suite* comes with a Dual-Stack implementation and, therefore, supports IPv4-only, IPv6-only, and Dual-IP operation. The term "Dual-IP" indicates a mode of operation in which IPv4 and IPv6 are available in parallel; the selection of the appropriate IP version is done on demand, e.g. on a per-call basis.

In case even Dual-IP is not sufficient to solve all transition requirements, dedicated IPv4↔IPv6 translation devices will be deployed.

This White Paper describes the principles recommended by SEN for the deployment of the *OpenScape UC Suite* in order to allow a smooth migration from IPv4 to IPv6.

Finally, an example is presented to demonstrate the transition to IPv6 deploying the *OpenScape UC Suite* in a fictitious customer's network.

The award-winning **Open Communications Architecture** enables organizations to improve productivity and reduce costs through easy-to-deploy solutions that work within existing IT environments, delivering operational efficiencies.



Contents

- Executive Summary 2**
- Introduction 4**
- Technical Basics 5**
 - IPv4 ⇄ IPv6 Translation 6
 - IP-in-IP Tunneling 7
- Selecting the Transition Strategy 8**
- Implementation 10**
 - IT Infrastructure 10
 - OpenScape UC Suite 10
 - VoIP and UC Services* 11
 - Management Applications of the OpenScape UC Suite* 11
- Example 12**
- Further Reading 14**
- Abbreviations 15**

Introduction

Currently we can observe an increasing deployment of communication networks using IPv6. This evolution is mainly driven by the fact that the total pool of public IPv4 addresses is almost completely consumed.

Deployment scenarios of hundreds or thousands of new IP devices will be among the first who will perceive the lack of free IPv4 addresses. Unified Communication (UC) is a good example: Both installing an entirely new system and replacing a legacy telephony system by IP based UC solutions, will require many, many new IP addresses and so UC will become one of the main drivers for IPv6 in the near future.

Transition to IPv6 typically starts with a network completely based on IPv4. The mission is to prepare the IT infrastructure for utilization with IPv6 and to upgrade the applications, one after another. Transition is finished if each application uses only IPv6 addresses and the entire data traffic throughout the whole network runs over IPv6 only.

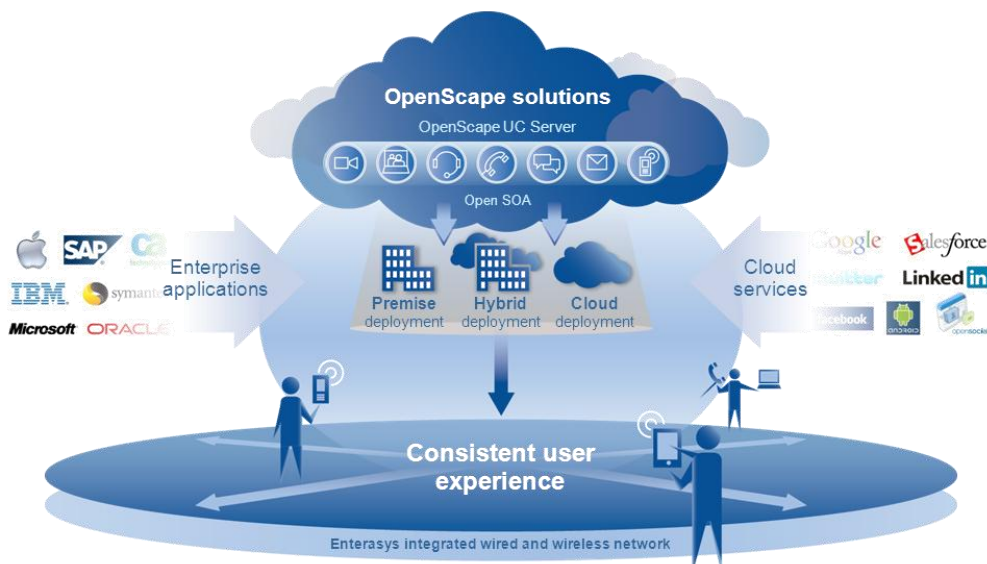
The transition period may take a long time especially if at least one legacy application must stay for whatever reason with IPv4 and can never be upgraded to IPv6. Such an application will have to co-exist for the rest of its life time with all the other applications using IPv6. Transition is - strictly spoken - not finished as long as this application is in operation.

After transition to IPv6 has begun, the network will usually no longer be a homogeneous IP network. It may contain devices having only an IPv4 address or only an IPv6 address or both. Consequently, a device will no longer be able to directly establish a connection to every other device in the network. To furthermore ensure overall connectivity requires deployment of additional techniques, e.g. IPv6-in-IPv4-tunneling and IPv6↔IPv4-translation. Devices offering such services play a key role in moving a network to IPv6.

Transition to IPv6 cannot be done "along the way"! In order to avoid negative impact on the operation of the existing IPv4 network it has to be done in several steps:

1. Detailed planning
2. Implementation of the planned activities
3. Extensive test phase

Even if all of the steps mentioned above are important, this White Paper only describes step 2 focusing on solutions based on the *OpenScape UC Suite* by Siemens Enterprise Communications GmbH & Co. KG (SEN).



Technical Basics

Before we have a look into a concrete example scenario, the technical basics shall be explained in brief. There are basically two concepts for transition to IPv6:

1. Dual-IP operation and
2. Single-IP operation.

In concrete customer scenarios usually a mixture of the two concepts will apply.

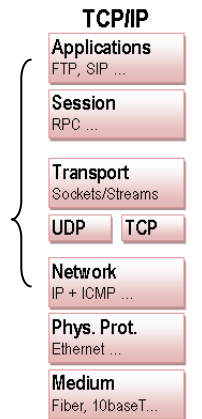
To enhance clarity we will consistently use the following definitions:

Dual-Stack / Single-Stack ... a SW implementation

“Dual-Stack” will be used as a synonym for “Dual-Stack – Implementation”, that means the capability of a device to interact with both IP versions – on all layers concerned – at the same time, independent of the way in which it is currently operated. Dual-Stack consequently includes the implementation up to the application layer. The Dual-Stack implementation typically allows operation in Single-IP or Dual-IP mode.

All SEN products that support IPv6 are implemented in Dual-Stack technology.

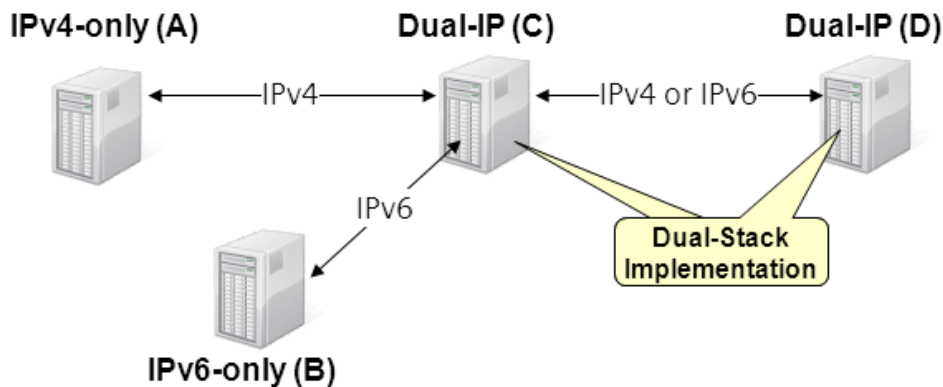
“Single-Stack” denotes a SW implementation supporting only one IP version. Particularly among old IPv4 devices the Single-Stack implementation is still widely-used.



Layering Model

Dual-IP / Single-IP ... an Operating Mode

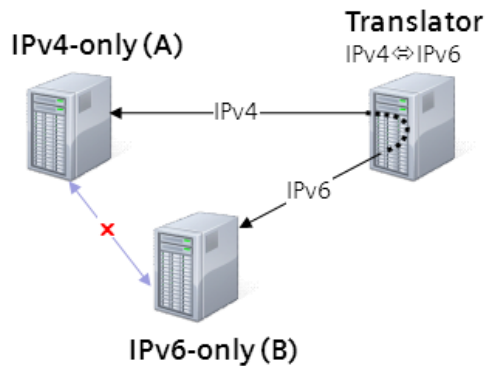
The operating mode of Dual-Stack nodes in which addresses of both IP versions were actually configured and made usable is termed “Dual-IP”. A node in Dual-IP will dynamically select the IP-version to be used for a specific connection.



In opposite to Dual-IP, a node in “Single-IP” mode can only use one IP-version (IPv4 or IPv6). In case of a node implemented in Dual-Stack technology, it's a matter of configuration which IP-version will be used. In case of a Single-Stack implementation, the implementation itself dictates the version.

IPv4↔IPv6 Translation

An IPv4-only and an IPv6-only device cannot directly communicate. Instead, both end devices have to use an IPv4↔IPv6 address translation service offered by an intermediate device relaying the transported data.



In general an IPv4↔IPv6 translation service:

- processes IP address information within the application's data,
- manages the mapping of the IPv4/IPv6 address pairs,
- replaces the transport addresses (IPv4 ↔ IPv6).

The particular implementation of an IPv4↔IPv6 translator depends on the protocol to be translated and may vary from simply translating IP addresses on IP level up to interpreting the application protocol data and modifying the contained IP addresses.

Example

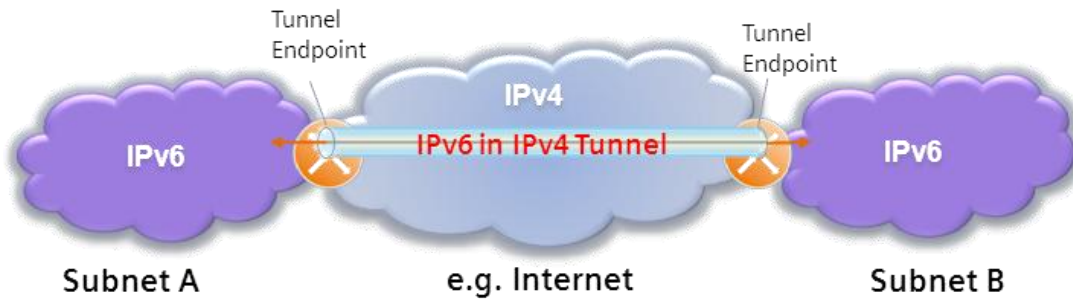
Media transport over RTP uses IP addresses only on IP level ("network"-layer¹), i.e. for giving the source and destination of the media data that are to be sent over the network. For this service plain IP address translation on IP level, similar to the well-known NAT, is sufficient. However, the data required for setup of the address mapping has to be derived from SIP signaling before.

SIP signaling messages ("application"-layer¹) carry among other things the IP addresses of the media streams within their message body. In this case an IPv4↔IPv6 translator has to find and translate IP addresses within the application data in addition to the address translation on IP level. The retrieved address information will also be used to control the translator for the media streams (see above).

¹ See „Layering Model“ on page 5

IP-in-IP Tunneling

Data traffic between two IPv6-only subnets cannot directly reach its destination if it has to be forwarded via an IPv4-only network segment. The same is true for IPv4-only subnets and an IPv6-only network segment. IP-in-IP tunneling allows routing of IP packets using one IP version over a network segment using the other IP version.



An IP-in-IP tunnel endpoint

- encapsulates packets received at the tunnel entrance side into IP packets of the IP version of the tunneled network,
- forwards the encapsulated packets,
- decapsulates the packets received at the tunnel exit side.

This way, an IP-in-IP tunnel achieves direct data transport transparently between the subnets.

In the context of this White Paper we focus on tunnels that are configured on IP router devices. Tunnels created by the endpoints themselves (e.g. Teredo) are not considered here.

Selecting the Transition Strategy

A customer's network may be in any state of transition from IPv4 to IPv6. We will focus our considerations on how to find a strategy for the deployment of the *OpenScape UC Suite* in such a network. Components of the IP infrastructure, e.g. routers or DHCP and DNS servers, will be considered only to the extent to which they are important for the operation of the *OpenScape UC Suite*. A description of a complete transition including all IT applications and the complete infrastructure goes beyond the scope of this White Paper.

A network being in transition from IPv4 to IPv6 is subject to dramatic changes. Even so the network should remain fully functional. Therefore, a detailed planning is one of the most important steps of the transition process. Care is necessary to keep negative impacts temporary and as low as possible.

Trying to do the transition to IPv6 along the way bears a high risk of ending up in a dead end road; escaping from there may cost a lot of time and money as well as cause unnecessary network downtime.

Starting point for the planning is the analysis of the status quo: the existing network at the customer site and the existing VoIP/UC environment. Important topics of that analysis will be

- the network topology (e.g. the distribution of the network all over the world, redundancy features),
- the deployment of VoIP/UC services and devices within that network, and
- what network infrastructure components (e.g. DHCP or DNS servers) they access.

In the next step the customer's plans for the VoIP/UC environment will be included into the analysis. Examples are the transition of VoIP users or of a UC service from IPv4 to IPv6, the deployment of a new UC service for Dual-IP operation, or the deployment of a large number of new VoIP users for IPv6-only operation which may be the result of moving legacy telephones into the VoIP/UC network.

The transition strategy will then be worked out based on the analysis done so far. Important influencing factors for the transition strategy will be:

1. available IPv4 address pool size
If there are no more IP addresses available from the IPv4 address pool - which may be the triggering event for the transition to IPv6 - then the new devices can only get IPv6 addresses. They join the network as IPv6-only devices right from the start.
2. existing legacy equipment (VoIP/UC)
For some of these devices an upgrade to IPv6 might not be cost-effective or even impossible. If they are not scheduled for replacement, these devices keep on being operated as IPv4-only devices.
3. special devices needed only for transition to IPv6
Especially a large network may be split up into many sub-networks. If only portions of that network are intended for transition to IPv6, the result will be a mixture of IPv4-only, IPv6-only and Dual-IP sub-networks. In this case, usually IP-in-IP Tunneling and/or IPv4↔IPv6 Translation devices will be required.

In detail the transition strategy plan shall determine

- the devices and portions of the network that will go in Dual-IP- or IPv6-only operation, and those that will remain in IPv4-only operation,
- the network infrastructure services that will go to IPv6, and those that won't,
- if IPv4↔IPv6 translation is required and where to place the corresponding devices,
- if IP-in-IP tunneling is required and where to place the corresponding devices.

Decision Guidelines

Considering the VoIP/UC servers, where many protocols are used in parallel, Dual-IP operation has the following advantages:

- There is no need for IPv4↔IPv6 translation
- Direct connectivity to both old (IPv4) and new (IPv6) endpoint devices and servers
- Only the (relatively small number of) servers continue to need IPv4 addresses
- The double effort for network management of Dual-IP has to be spent only for the (relatively few) servers

For these reasons, we recommend to operate server components (OSV, OS UC ...) preferably in Dual-IP mode.

However, considering VoIP endpoint devices, there are strong arguments against Dual-IP operation:

- Dual-IP operation requires protocol extensions which are problematic with respect to some advanced VoIP features [13].
- The network management for a large number of Dual-IP devices creates a considerable additional effort.
- Due to the lack of public IPv4 addresses it frequently is not possible to deploy a large number of devices in Dual-IP.

For these reasons, we recommend to operate endpoint devices in Single-IP mode.

Conclusion:

- Usually a mixture of Single-IP and Dual-IP operation will result in a cost-efficient transition to IPv6.
- Use IPv6 right from the start whenever possible.

Implementation

When putting the transition strategy into action, we should alter the network from the bottom up. Usually, the following sequence of steps is reasonable:

1. obtain an IPv6 address band (e.g. from your Internet Service Provider, ISP), in order to be able to plan e.g. firewall settings at an early stage
2. upgrade the IT infrastructure components
3. upgrade the hosts (servers, clients resp. endpoint devices) and applications.

IT Infrastructure

The IT infrastructure provides the data transport service across the network as well as the supporting basic network services. Components of the *OpenScape UC Suite* rely on following services (examples, list may be incomplete):

- **Routing Infrastructure:** Routers must have an IPv6- or a Dual-Stack implementation. If Dual-IP operation is required but the new routers only provide IPv6, they can be installed in parallel to the existing IPv4 routers. If tunnels are part of the transition strategy, the routers must be capable of providing the tunnel endpoints.
- **Firewalls:** A new security policy for the IPv6 network must be implemented in addition to the existing security policy for IPv4.
- **DHCP:** DHCPv6 and DHCPv4 are totally separate protocols, exclusively processing IP address information of their own IP version. This means that two different servers are required: a new DHCPv6 server in parallel to the existing DHCPv4 server.
Please note that both DHCP servers must support vendor specific options in order to be able to supply e.g. SEN's *OpenStage* endpoints with the address information of the device management server.
- **DNS:** An up-to-date DNS server can issue IPv4 or IPv6 addresses or both together within the same answer. This is independent of whether the answer will be transported via IPv4 or IPv6. Even an answer containing only IPv6 addresses can be transported via IPv4 and vice versa. Therefore, it makes sense to upgrade the DNS server for Dual-IP operation.
- **NTP:** Since the NTP server may also have to serve both, IPv4-only and IPv6-only devices, at the same time, it makes sense to upgrade it for Dual-IP operation as well.

OpenScape UC Suite

The components of the *OpenScape UC Suite* run on different types of hosts:

- Server Machines (Windows, Linux) hosting server applications, such as *OpenScape Voice*
- Client Machines (Windows, Linux) hosting client applications, such as *OpenScape Desktop Clients*
- Network Appliances (embedded systems) hosting the phone application such as *OpenStage VoIP Endpoints*

Most components of the *OpenScape UC Suite* come with complete SW packages, i.e. including operating system and application layer SW. These components can be upgraded to IPv6 in one single step. However, certain components, e.g. the *OpenScape Desktop Clients*, consist only of application layer SW. In this case, the operating system of the host machine has to be upgraded to IPv6 first, before the application layer SW can be upgraded.

VoIP and UC Services

All components of the *OpenScope UC Suite* that support IPv6 are implemented in Dual-Stack technology. This gives an administrator the flexibility to configure any device for IPv4-, IPv6- or Dual-IP operation just as desired.

Firstly, the icons used in the example schematics shall be introduced:

Server Components



The *OpenScope UC Suite* offers the VoIP/UC functionality by means of a number of different server components, including

OSV Softswitch , OS Media Server , OS UC Server , and Gateways .

Server components typically have connections to many client devices at the same time. During transition to IPv6 the client devices may run in different operational modes, some in IPv4-only or IPv6-only mode, others in Dual-IP mode. Therefore, it is usually a good choice to operate server components in Dual-IP mode.


Client Components


There are a lot of endpoint types that can be operated with the *OpenScope UC Suite*. Important examples are

OpenStage IP Phones  and OpenScope Desktop Clients .

Due to their large number, it is recommended to operate endpoint devices in IPv6-only mode, especially if the lack of IPv4 addresses was the triggering event for transition to IPv6.

IPv4↔IPv6 Translation Devices

In several components of the *OpenScope UC Suite* an IPv4↔IPv6 translator  is implemented. The translation functionality differs on each of these components:

- A softswitch translates the SIP/SDP signaling only, and controls the media server.
- A media server translates RTP media streams only. Since a media server does not get any signaling information on its own, it needs to be controlled by the softswitch.
- A Session Border Controller (SBC)  translates both, the signaling and the media streams. Usually, the signaling as well as the media streams pass through an SBC. Therefore, it has full knowledge of the necessary information and acts independently; it does not need to be controlled by the softswitch.

Management Applications of the OpenScope UC Suite

The management applications of the *OpenScope UC Suite* are implemented in Dual-Stack technology as well. This allows an administrator to use IPv4 or IPv6 on demand in order to

- operate the management servers and to
- access the managed devices.

The management interfaces of many of the managed devices (e.g. VoIP/UC server components) can be configured completely independently of the VoIP/UC interfaces. For example, a softswitch may already run the SIP signaling over IPv6 while the management application may still access that same softswitch via IPv4. This means that VoIP/UC services and management services need not always be ported to IPv6 at the same time. During the transition period it will often be possible to continue using management applications that support data transport only via IPv4.

Example

This example demonstrates the basic ideas for transition to IPv6. It is kept simple by intention and focuses on the company internal voice traffic. Internet teleworkers and SIP service provider access are out of scope here.

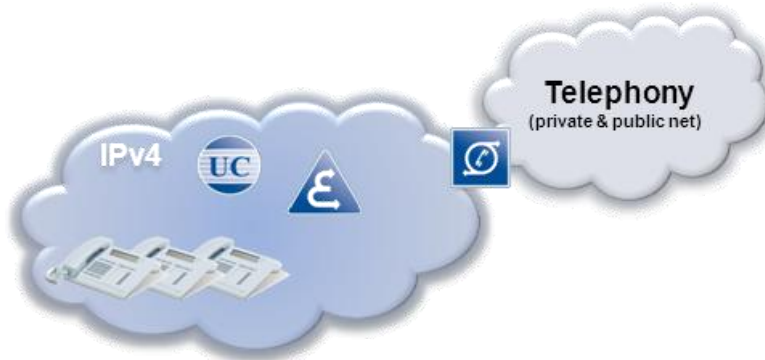
We consider a IPv4 network with a group of VoIP subscribers, and a legacy telephone network with a major number of ISDN subscriber lines, and access to the public telephone network. The first goal is to replace the ISDN subscriber lines by VoIP subscriber lines. The new VoIP subscribers will only get IPv6 addresses. Reasons for this decision:

- Due to their large number there are not enough public IPv4 addresses available.
- The deployment of IPv6 devices now will save costs for an upgrade to IPv6 later.

In a second step the transition to IPv6 is planned for the whole VoIP system.

Initial Situation:

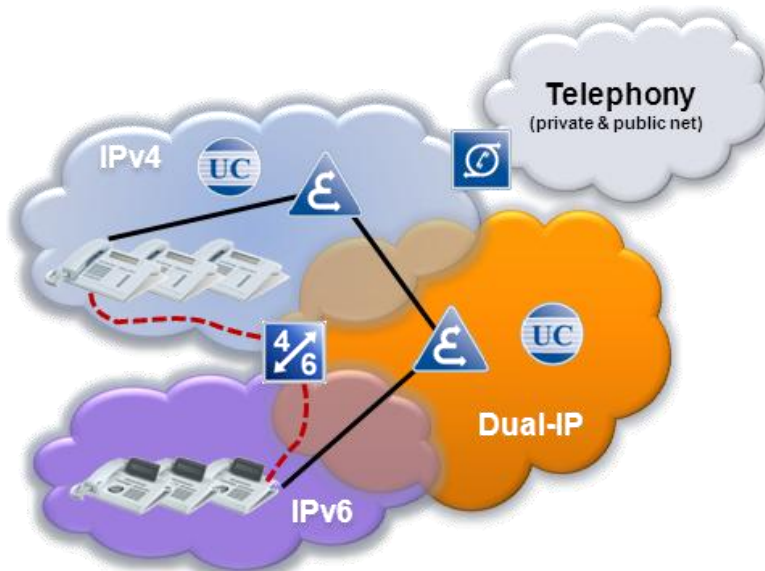
The existing VoIP/UC system is completely based on IPv4. It consists of a softswitch, an UC server, a certain number of endpoint devices and a gateway into the telephone network. For simplicity, both the private and the public telephone networks are represented with the same cloud.



First Step:

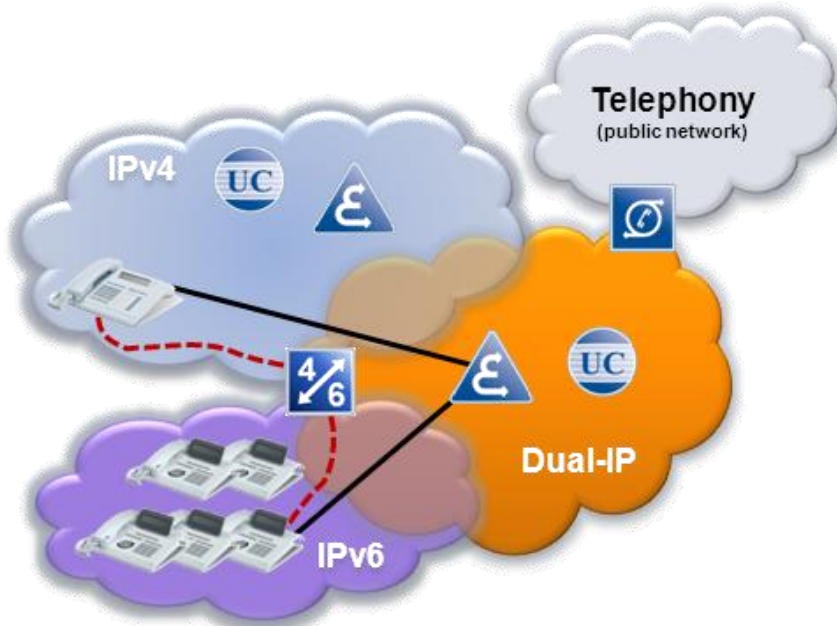
Install a new OSV softswitch and a new OS UC server, both serving the new VoIP subscribers. The new endpoint devices will run in IPv6 mode. OSV softswitch and OS UC server will run in Dual-IP mode:

- The signaling traffic towards the new endpoint devices goes over IPv6; the signaling towards the legacy softswitch over IPv4. The same is true for the new UC server.
- Additionally, an IPv4↔IPv6 translator will convert the media traffic between the legacy IPv4 endpoints and the new IPv6 endpoints.
- As long as the gateway to the telephone network supports IPv4 only, media traffic between IPv6 endpoints and the gateway also needs to pass the IPv4↔IPv6 translator.



Second Step:

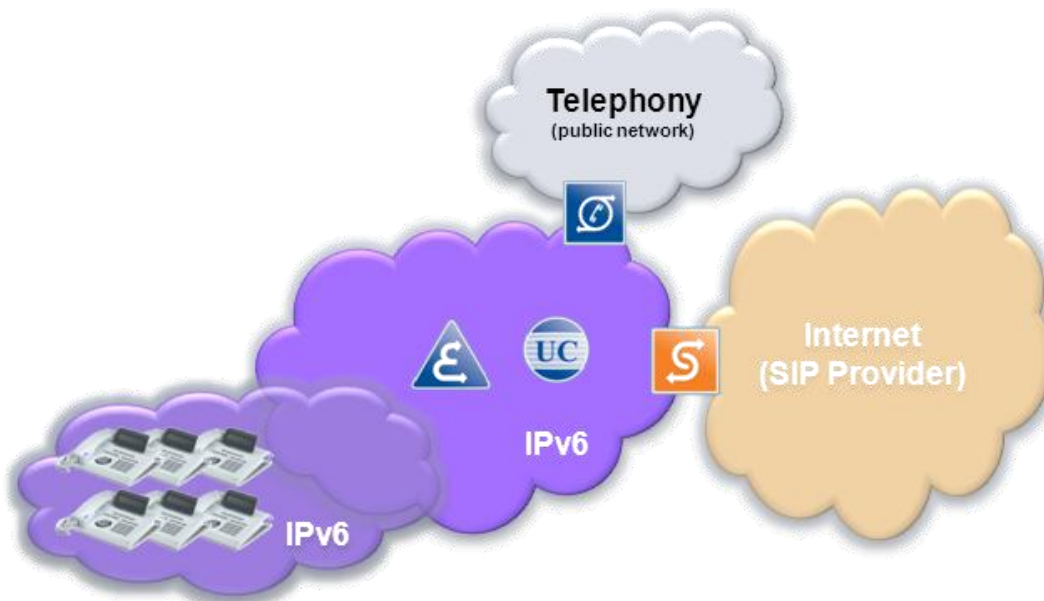
Now, perform the transition to IPv6 for the existing IPv4 subscribers and move control for them to the new central components OSV and OS UC server. Optionally, the new central components may also take over control of the remaining legacy IPv4 endpoints during the transition period. This would allow the shutdown of the old central components. At least by now provide a gateway in Dual-IP operation. From now on the IPv6 endpoints will directly access the gateway, and the load on the IPv4↔IPv6 translator will decrease correspondingly.



One by one replace the legacy IPv4 endpoints by new IPv6 equipment. When the last legacy device has gone out of service, transition to IPv6 is almost completed.

Clean-up:

IPv4↔IPv6 translator, legacy IPv4 softswitch and legacy IPv4 UC server are no longer in usage; they can be removed from the network. Finally, the Dual-IP components may be configured for IPv6-only mode.



Transition to IPv6 is now completed.

In order to complete the picture, this final figure shows in addition the access to the Internet or a SIP service provider. Usually, an SBC is deployed for that purpose.

Further Reading

- [1] **Siemens Enterprise Communications**
<http://www.siemens-enterprise.com> → Products
- [2] **Enterasys Networks**
<http://www.enterasys.com> → Products & Services
- [3] **RFC 2460**
Internet Protocol, Version 6 (IPv6), Specification
IETF, The Internet Engineering Task Force, December 1998
<http://www.ietf.org/rfc/rfc2460.txt>
- [4] **RFC 3261**
SIP: Session Initiation Protocol
IETF, The Internet Engineering Task Force, June 2002
<http://www.ietf.org/rfc/rfc3261.txt>
- [5] **RFC 3550**
RTP: A Transport Protocol for Real-Time Applications
IETF, The Internet Engineering Task Force, July 2003
<http://www.ietf.org/rfc/rfc3550.txt>
- [6] **RFC 4057**
IPv6 Enterprise Network Scenarios
IETF, The Internet Engineering Task Force, June 2005
<http://www.ietf.org/rfc/rfc4057.txt>
- [7] **RFC 4213**
Basic Transition Mechanisms for IPv6 Hosts and Routers
IETF, The Internet Engineering Task Force, October 2005
<http://www.ietf.org/rfc/rfc4213.txt>
- [8] **RFC 4566**
SDP: Session Description Protocol
IETF, The Internet Engineering Task Force, July 2006
<http://www.ietf.org/rfc/rfc4566.txt>
- [9] **RFC 5211**
An Internet Transition Plan
IETF, The Internet Engineering Task Force, July 2008
<http://www.ietf.org/rfc/rfc5211.txt>
- [10] **RFC 5245**
Interactive Connectivity Establishment (ICE)
IETF, The Internet Engineering Task Force, April 2010
<http://www.ietf.org/rfc/rfc5245.txt>
- [11] **RFC 6157**
IPv6 Transition in the Session Initiation Protocol (SIP)
IETF, The Internet Engineering Task Force, April 2011
<http://www.ietf.org/rfc/rfc6157.txt>
- [12] **RFC 6180**
Guidelines for Using IPv6 Transition Mechanisms during IPv6 Deployment
IETF, The Internet Engineering Task Force, April 2011
<http://tools.ietf.org/html/draft-arkko-ipv6-transition-guidelines>
- [13] **draft-elwell-mmusic-ice-updated-offer**
ICE Updated Offer Problematic
IETF, The Internet Engineering Task Force, February 4, 2011
<http://tools.ietf.org/html/draft-elwell-mmusic-ice-updated-offer>
- [14] **Acme Packet Inc.**
<http://www.acmepacket.com> (Session Border Controllers)

Abbreviations

ALG	Application Layer Gateway	SBC	Session Border Controller
DHCP	Dynamic Host Configuration Protocol	SDP	Session Description Protocol
DHCPv6	DHCP for IPv6	SEN	Siemens Enterprise Communications GmbH & Co. KG
DNS	Domain Name System	SIP	Session Initiation Protocol
FTP	File Transfer Protocol	SNMP	Simple Network Management Protocol
IP	Internet Protocol	SNTP	Simple Network Time Protocol
IT	Information Technology	SW	Software
LAN	Local Area Network	TCP	Transmission Control Protocol
NAC	Network Access Control	TDM	Time Division Multiplexing
NTP	Network Time Protocol	UC	Unified Communications
OS	OpenScape	UDP	User Datagram Protocol
OSI	Open System Interconnection	UI	User Interface
OSV	OpenScape Voice (softswitch)	VoIP	Voice over IP
POTS	Plain Old Telephony System	WAN	Wide Area Network
PSTN	Public Switched Telephony Network		

About Siemens Enterprise Communications

Siemens Enterprise Communications is a premier provider of end-to-end enterprise communications solutions that use open, standards-based architectures to unify communications and business applications for a seamless collaboration experience. This award-winning "Open Communications" approach enables organizations to improve productivity and reduce costs through easy-to-deploy solutions that work within existing IT environments, delivering operational efficiencies. It is the foundation for the company's OpenPath commitment that enables customers to mitigate risk and cost-effectively adopt unified communications. This promise is underwritten through our OpenScale service portfolio, which includes international, managed and outsource capability. Siemens Enterprise Communications is owned by a joint venture of The Gores Group and Siemens AG. The joint venture also encompasses Enterasys Networks, which provides network infrastructure and security systems, delivering a perfect basis for joint communications solutions.

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