# Ipv6 Return On Investment (R.O.I) Analysis Framework At A Generic Level, And First Conclusions

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# IPv6 Return on investment (R.O.I) analysis framework at a generic level, and first conclusions

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**Abstract : This report puts the analysis of the overall profitability of IPv6 based products or services , in the context first of investment analysis ,and next of an evolutive technology adoption in phases . Whereas it cannot serve as an argumentation for a specific product or service ,or its migration, it encapsulates the key factors in a structured way ,and weighs them against each other .It also assesses the relative merits of IPv4 and IPv6 ,as a base for comparison ,and points at the role played in the investment analysis of the time bases for the IPv4 and IPv6 introductions . Using simplifications, some key overall conclusions can be made showing that over the technology cycle , IPv6 is bound to have both profit enhancing and profit risk reduction properties . A non exhaustive list is given in the incremental deployment phase for some incremental or new revenue sources . Any specific return on investment analysis for a specific product or service would mandate the fulfillment of a number of assumptions , and the availability of full data .**

**Keywords :IPv6 , IPv4 , profitability , return on investment, technology adoption , new services**

## PREAMBLE

This paper does NOT address specific technical issues , largely reported elsewhere, i.e. in IETF (Internet engineering task force) or in the IPv6 Forum .It is focussing solely on the profitability issues related to IPv6 deployment .

From the historical perspective, the reader is reminded that IPv4 and its forerunners required ,like IPv6 nowadays, research, product engineering, migration , deployment .!

Likewise, the implications on the business values and models of the IPv4 address exhaustion are not discussed there ,but the reader is referred to Ref 3 where this is explicitly affecting some of the operating costs analyzed here. Likewise routing address table growth , NAT operating costs , technical means for migration , security ,privacy implications are not addressed specifically here ,and are largely discussed elsewhere (Ref 1) .

# 0.The notion of return on investment (ROI)

The notion of return on investment (abbreviated herein as ROI) is well defined in finance and accounting standards ,and has more sloppy interpretations in research ,project management ,product management and general management .

The basic definition separates out :
-on “return” side , the net present value of real or expected cash flow generated by a specific activity or technology ;this means that operational revenues are offset by operational and related general contributions, but that the financing costs for this activity or technology are treated elsewhere
-on “investment” side , the net present value of real or expected resource ,material and immaterial flows of investments needed to reach a level of deployment for said project or technology .
If so , the ROI is normally defined as :

ROI = NPV(Cash-flow(t)) / NPV (Investment flow(t)) (Eq 1)

assuming :

- a discount factor or rate r
- a time horizon T for the discounting ,and time as well at which the residual flows Residual (T) beyond T are assessed
- NPV(f) = Sum (f(t)/(1+r)**t; t=1,...T) +Residual (f,T) (Eq 2)

Please note that NPV is explicitly dependent on T.
In this Report, the adjective “real” for a money quantity or flow , means the discounted value to time 0 , thus corrected largely for the effect of time and inflation .

However , an estimation of return on investment must be preceded by assumptions on :
(A) -the definition of the organizational and product /service context within which the cash flow and investment flow are assessed ; all others must be treated as externalities
(B) -the definition ,and the means for verifying milestones for evaluation ,that is milestones for the development, introduction ,deployment ,and phase-down ,of the activity or technology .

## 2.The confusion in the ROI debate,if any ..

These two last factors (A+B) are the root of a huge fuzziness ,and thus confusion, when discussing and thus estimating ROI for IPv6 . Almost no party engaging in the debate states these two essential assumptions as a base to their claims:
-equipment vendors talk ,or not ,about IPv6 ROI for their operator clients
-operators and ISP's talk ,or not ,about IPv6 ROI for their sourcing expenses ,but not for their private and enterprise customers
-IT suppliers talk ,or not , about IPv6 ROI for IPv6 functionality embedded as a small but essential part of larger IT software or solutions
-policy makers talk about IPv6 ROI , but in terms of opening up user bases to enhanced services ,but not in financial terms
-none of the above state for which phase of the technology adoption they make their remarks (research, trials, deployment,...)
-it is rare that estimates are given which cite explicitly relative terms to ,say basic IPv4 protocol suite, or to a given quantified number of users

## 3.The technology adoption curve and resulting simplifying assumptions

It is here assumed that IPv6 represents an evolution of a preceding technology , product and competence base , with its users .
It is customary in technology management for an evolving technology to distinguish the following phases , sometimes overlapping :
0-innovation and research, with no commercial product/service revenues and operational costs , and essentially manpower-research costs
1-engineering , with no commercial product/service revenues ,no support costs , ,but only product/service development costs
2-substitution/replacement costs , where commercial revenues from products/services with the new technology are offset by equal costs for the phasing out of the preceding technology
3-incremental deployment of the new technology to usage not possible by the predecessor, with full commercial revenues from products/services "at value" , and sales ,support and customization costs
4-competitive deployment of new technology when exposed to volume increases , competing technologies ,etc ,with commercial/service revenues but at market driven rates ,and sales ,support and productivity re-engineering costs

5-phase out , with dwindling revenues from legacy users not willing to switch rapidly ,and only support and re-training costs

In the analysis below , following assumptions are made in line with Section 1:
(A) the cash flow and investment flows considered here are for all revenues, costs and investments at the level of such a large multi-vendor and diversified generic market ( communications services ,future use of IPv6 by default in third generation mobile services , gaming , home systems ,etc ...) that product or service differences are equalized .As stated above detailed analysis would mandate data from a specific product or service , which would offer variability over the averaged out considerations in this report
(B) the milestones in each of the phases defined above are for products and services to be fully tested, marketed, and with customer support ,and they have to have a functionality at least equivalent to the equivalent products or services built using IPv4 stacks .

## 4.The deployment horizon factor

Another fundamental confusion has been the discard of a fundamental difference between IPv6 and IPv4 , which is likely to be the deployment horizons

For IPv4 , for-revenue deployment can be estimated as starting 1988 ,and public IPv4 address saturation is estimated for 2005 , although behind NAT's services can and will still run thereafter ,although affected by end-to-end service constraints . Thus it is assumed here that the IPv4 deployment horizon T-4, is about 20 years

For IPv6 , for-revenue deployment start can timidly be set at year 2000 in Japan ,but no address saturation is in sight ,so the IPv6 deployment horizon cannot be estimated based on this indicator .The closest estimate is the life time of a basic back end or service infrastructure and of its players ; this it is assumed here that the IPv6 deployment horizon is about twice T-4, or 40 years .

## 5. The relative NPV calculation components

The Table 1 below gives the estimated and fundamental relative revenues ,operational costs ,and investment costs , to IPv4 at a similar Phase ,with the argumentation on each item ,at each of the above phases .Most arguments are not product or service specific, but represent an aggregate of views expressed e.g. at IPv6 Forum meetings ,or as the result of IPv6 Trial projects

| **Phase** | **Relative IPv6 revenues to IPv4 basic stack** | **Relative IPv6 operational costs to IPv4** | **Relative IPv6 investments to IPv4** |
|---|---|---|---|
| 0-Innovation | N/A | N/A | 0.2<br>The shear relative size in IETF and basic research of IPv6 innovation is much smaller for IPv6 at a similar stage of development ;especially,IPv6 benefited of much less public funding in proportion |
| 1-Engineering | N/A | N/A | 2<br>Because of Internet and network deployment, IPv6 benefited of larger product engineering investments |
| 2-Substitution | IPv6-addresses(ini)/IPv4 addresses (ini) at switching times ini-IPv4 and ini-IPv6 (see Figure 2) . IPv6 and IPv4 can coexist and overlap according to these two deployment dates .<br><br>To focus on services | 0.6*(IPv6-addresses(ini)/IPv4-adresses(ini))<br><br>Some of the key architectural ingredients of IPv6 ( autoconfiguration , security ,Mobile-IP) have a significant impact on this ratio (see (Ref 3 )(see also | 0.5<br><br>In relative terms, underlying technologies needed (semiconductor, software engineering) ,as well as IP competence learning curve , allow to migrate to IPv6 in products and services at far less |

| | | | |
|---|---|---|---|
| | ,devices and address usage, this ratio is taken assuming equivalent real-money service /device prices | Figure 1) | real-money costs than when IP was first introduced replacing at best X25 ,ATM and alike |
| 3-Incremental deployment | IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2)<br><br>To focus on new services, devices and address usage , this ratio is taken assuming incremental deployment to end at mid usage times T-6 and T-4 resp. .,and prices for value in real terms to be identical ( a very conservative assumption) | 0.4*(IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2))<br><br>Corresponds to ratio above, plus the effect of the vastly larger IPv6 usage base in relative terms due to Internet deployment in general ; see also the analytical model in Ref 3 | 0.3<br><br>Due to its wider adoption in operating systems and network processors, amongst others, complex incremental developments should be vastly cheaper in real costs |
| 4-Competitive deployment | X>> 5<br><br>It is very hard to estimate the relative real revenues fraction X from IPv6 in this phase, as today business models about IP service and value added services are so uncertain ;however , the lower bound is given in view of expected vastly more value-adding enterprise VPN services ;X is a fraction of address usage ratio at mid-deployment horizons | 0.6*( IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2))<br><br>In the similar phase, IPv4 deployment at ISP's with often "free" business model's thinking , has proven cost efficient ,and the complexity of IPv6 competitive services may prove a challenge | N/A; nevertheless for calculation reasons , in ROI ratio estimations , components to left are assumed scaled by NPV of investments in this phase |

| | | | |
|---|---|---|---|
| 5-Phase out | X<br><br>It is assumed that legacy users of IPv6 will stick to IPv6 even longer as for IPv4, for the simple reasons of IPv6 enabling a wider coverage of their enterprise wide needs (broadband,fixed,wirel ess) than IPv4 at similar phase | N/A;”””” | N/A; “”” |

Table 1 : Relative IPv6 vs IPv4 NPV components

## 6.The relative IPv6 ROI estimate

From Equation (1) :

ROI(IPv4) = NPV(Cash-flow(t,IPv4)) / NPV (Investment flow(t,IPv4)) ,over T-4 (Eq 3)

ROI(IPv6) = NPV(Cash-flow(t,IPv6)) / NPV (Investment flow(t,IPv6)) ,over T-6 (Eq 4)

Thus we could define the relative IPv6 ROI (relative to IPv4) ,as :

Relative-ROI= ROI(IPv6)/ ROI(IP4) (Eq 5)

This cannot however be calculated or estimated as each time based component of costs ,revenues and investments would be needed.

We will make four simplifying assumptions:

-the residual values R(f,T) for IPv4 , as well as IPv6, both for revenues, operational costs ,and investments , will, be assumed equal to zero as it is best to assume that the services and products based on both with at terminal time , be non existent and replaced by newer solutions or usage
-the individual contributions ,from revenues and operational costs on one hand, and from investment components on the other hand , to the respective net present values of cash flows and investment flows , are additive
-the individual contributions to relative ROI estimation over time can be decomposed into the sum of the relative ROI per phase in the technology/service deployment horizons
-the same discount rate r applies over T-4 and T-6

, the sole purpose of which is to get an overall estimate and identify the key factors .

We then can estimate the simplified relative ROI in each phase from Table 1 :

| **Phase** | **Relative simplified ROI (unweighted)** | **Durations** |
|---|---|---|
| 0-Innovation | 5 | IPv4: 7 years, IPv6: 5 years |
| 1-Engineering | 0.5 | IPv4: 6 years , IPv6 : 4 years |
| 2-Substitution | 0.8*(IPv6-adresses(ini)/IPv4-adresses(ini) | IPv4 : 10 years , IPv6 : 10 years |
| 3-Incremental deployment | 2*( IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2)) | IPv4: 3 years , IPv6: 10 Years |
| 4-Competitive deployment | (X-0.6)* *( IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2)) | IPv4: 7 years , IPv6 : 10 years |
| 5-Phase out | X*( IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2)) | IPv4: 5 years , IPv6 : 5 years |

Table 2: Relative IPv6 vs IPv4 simplified ROI and durations for NPV calculation in each phase

If we make the normal assumption that full investments are made in Phases 0 and 1, and that revenue generating periods, and thus NPV's ,are proportional to their duration ,we get the weighted relative ROI's for each Phase :

| **Phase** | **Relative simplified ROI (weighted)** |
|---|---|
| 0-Innovation | 3.57 |
| 1-Engineering | 0.33 |
| 2-Substitution | 0.8*(IPv6-adresses(ini)/IPv4-adresses(ini) |
| 3-Incremental deployment | 6.66*( IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2)) |
| 4-Competitive deployment | 1.42*(X-0.6)* *( IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2)) |
| 5-Phase out | X*( IPv6-addresses(T-6/2)/IPv4-addresses(T-4/2)) |

Table 3: Relative IPv6 vs IPv4 simplified ROI (weighted)

# 7.Time dependent analysis of relative ROI

The analysis above shows that :

-IPv6 innovation and research were vastly more profitable than IPv4 research
-IPv4 engineering was by a comparable ration more profitable than IPv6 engineering ,and this is not surprising as IPv4 opened some markets owned by IPv4

-IPv6 substitution phase (or migration ) profitability is bound to be slightly les profitable ,but not much , than what it was for IPv4,IPv6 gains mostly because of the better operating cost structure ,and suffers from similar tariffing for similar services or products than IPv4

-IPv6 incremental deployment phase, where new products and services will be deployed and priced at value ,will offer vastly better profitability ,subject however on an aggressive timing of the switch-over to IPv6 addresses in services :although this is very crude , the calculated ratio that for that phase, break even ROI would be for 1/6 less IPv6 users than for IPv4 at a similar stage in its deployment .This should reduce risks for those service or product suppliers who can target 1/6 = approx. 16% of their captive markets with IPv6 enabled products and services

-in the competitive deployment phase, and at mid-deployment term, the profitability of IPv6 will almost automatically be boosted by the availability of more IPv6 addresses, and that similar profitability may be achieved irrespective of address issue for a relative service/product revenue base mix gain of only 30 % over current day “free” IPv4 services (corresponds to 1.42(X-0.6)=1))

-in the phase out service ,legacy rich applications will provide tail revenues

## 8.The issue of revenue enhancing services

As shown above , the profitability in Phase 3 , hinges on the definition of services or products possible with IPv6 and generating relative better revenue streams .Based on presentations at IPv6 Forum (Ref ())), the following have been identified , as non-exhaustive examples. In each of those are identified the key IPv6 feature(s) allowing for the incremental revenue over IPv4 ,as well as entirely new IPv6 enabled revenues , and the nature thereof.

USE in MOBILE TERMINALS and CONSUMER DEVICES

- Technical dominant IPv6 features:
  -Neighbor discovery
- Incremental revenue :
  -reduced costs in customer support from much stronger auto-configuration at installation time (compare e.g. WAP 1.3 terminal configuration via SMS with Mobile Internet service configuration with IPv6)
- New revenues :
  -video streaming onto mobile terminals with flow control
  -personalized services obtained by user profiles (on server or on host) by XML tags in IPv6 packets

NEW OPERATOR CAPABILITIES

- Differentiated business /traffic/infrastructure/service business models for IPv6/IPv4 mobile traffic and services ,e.g with service based billing
- Business concepts and technical DNS solutions allowing for efficient management by operators of IPv6 addresses in relation to subscriber profiles
- Billing solutions with bundled IP/ non-IP IPDR and CDR tracking

USE In HIGH SPEED INTERNET ACCESS SERVICES

- Technical dominant IPv6 features:
  -increased IPv6 address space
  -IPSECv6 with both data encryption and user authentification
- Incremental revenue :
  -price multiple addresses and flows managed at same cost (e.g Japanese 180 Mbit/s IPv6 ISP's)
- New revenue :
  -price enhanced security features

USE in STORAGE AREA NETWORKING

- Technical dominant IPv6 features:
  -IPv6 address hierarchy
- Incremental revenue :
  -more reliable management of large data stores
- New revenue :
  - content provisioning into 3G enabled mobile services without NAT handling

USE in ENTERPRISE VPN's and ASP's

- Technical dominant IPv6 features:
  -existence of IPv6 "flow label" field
  -MobileIPv6 integration
  -IPSECv6 integration
  -IPv6 address space breaking 4096 VLAN address limitation
  -combination with 802.1p/q/r/s QoS (quality of service) and extended addressing features
- Incremental revenue :
  -"transparent LAN" services with reduced configuration costs
  -reduced need to map VLAN ID's at network-to-network transition points
- New revenue :
  - enterprise specific tariffing characteristics encapsulated into "flow label" field
  -services from supplying enterprises with AAA servers for their VPN's

-premium service revenue from mobile workers which take their virtual office with them with full security

-M-Business services which can only be deployed with IPv6 features from financial risk points of view

-CRM and logistics services where case/object labels and tags are linked to IPv6 addresses in applications

USE in HOME ENTERTAINMENT

- Technical dominant IPv6 features:
  -SIPv6
  -Neighbor discovery
  -enhanced multi-cast support
- Incremental revenue :
  -maybe VoIP revenue ,but business case is doubtfull for lack of differentiation of voice quality and costs
- New revenue :
  -all multimedia SIP supported services
  -business models around fee based support ,provisioning or billing made by operators for content providers , using aggregation of services

## 9. Conclusions and overall estimation

The above Sections do not , and could hardly ,provide any absolute or aggregate IPv6 return on investment analysis , as component quantities would be needed for any correct calculation ,and thus the full estimation of the ROI according to Equation (1 ) .

First, it must be highlighted in conclusion , that any such actual ROI analysis can only be done once three conditions are met:
-the definition of a business model for the specific IPv6 service or product
-the specification of the full assumptions on scope (A) for the specific IPv6 service or product
-the specification of the full assumptions on milestones (B) for the specific IPv6 service or product

Next ,as in today's debate , the specific analyses above are hindered by superficial judgments on IPv6 as a whole, the analysis above yields some useful constructive learnings ,which are :
-considering all phases , most ( 5 out of 6) are fundamentally favorable to IPv6 relative to IPv4 from the phase-baed return on investment analysis

-product or service managers adopting IPv6, run much smaller risks than what superficial judgments usually express ,due to the profitability safety margins on the upside in most phases
-the timing of the commercial launch of IPv6 services or products with a targeted penetration ratio of approx. 16 % into the equivalent IPv4 markets is essential for early ROI positive outcomes already from the incremental deployment phase (no 3)
-migration costs can hardly be the deciding factor ,as these are bound to happen for any evolutive technology ; firthermore , from the historical perspective , IPv4 also had such migration and replacement costs, which are no less than for IPv6 .Some would therefore like to use the dual words " integration & coexistence" instead of “migration” ,to point at the possibility of keeping and making money from current investment while investing in new IPv6-based technology to create new revenue streams.

## FOR FURTHER READING


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Figure 1 : Migration costs in Phase 3, from Ref (2)

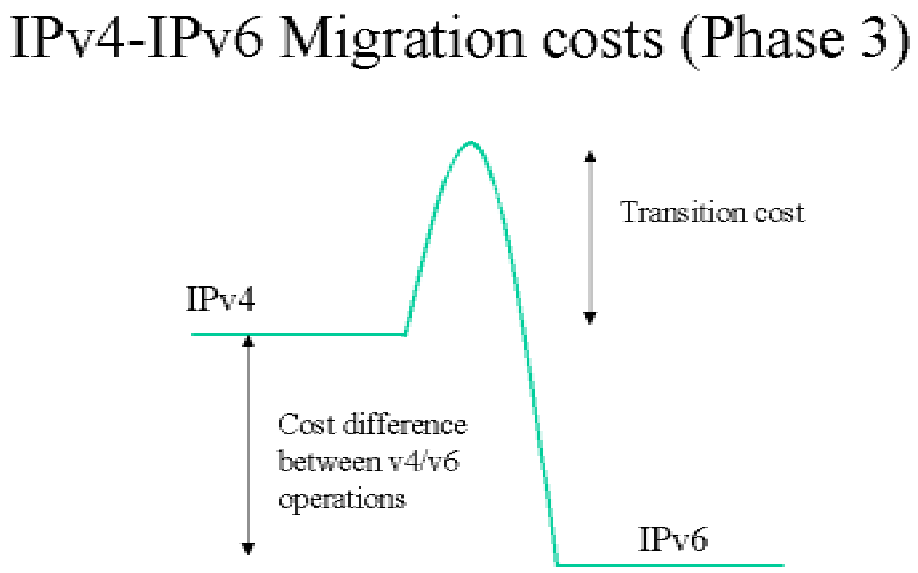
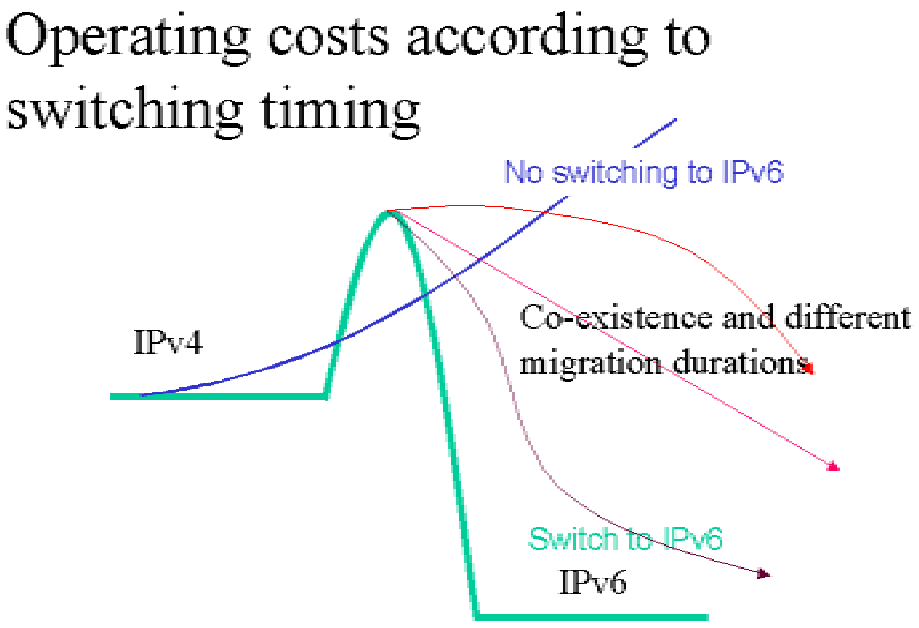


Figure 2 : Operating costs according to switching timing IPv4(ini), IPv6 (ini) , dapated from Ref (1)



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