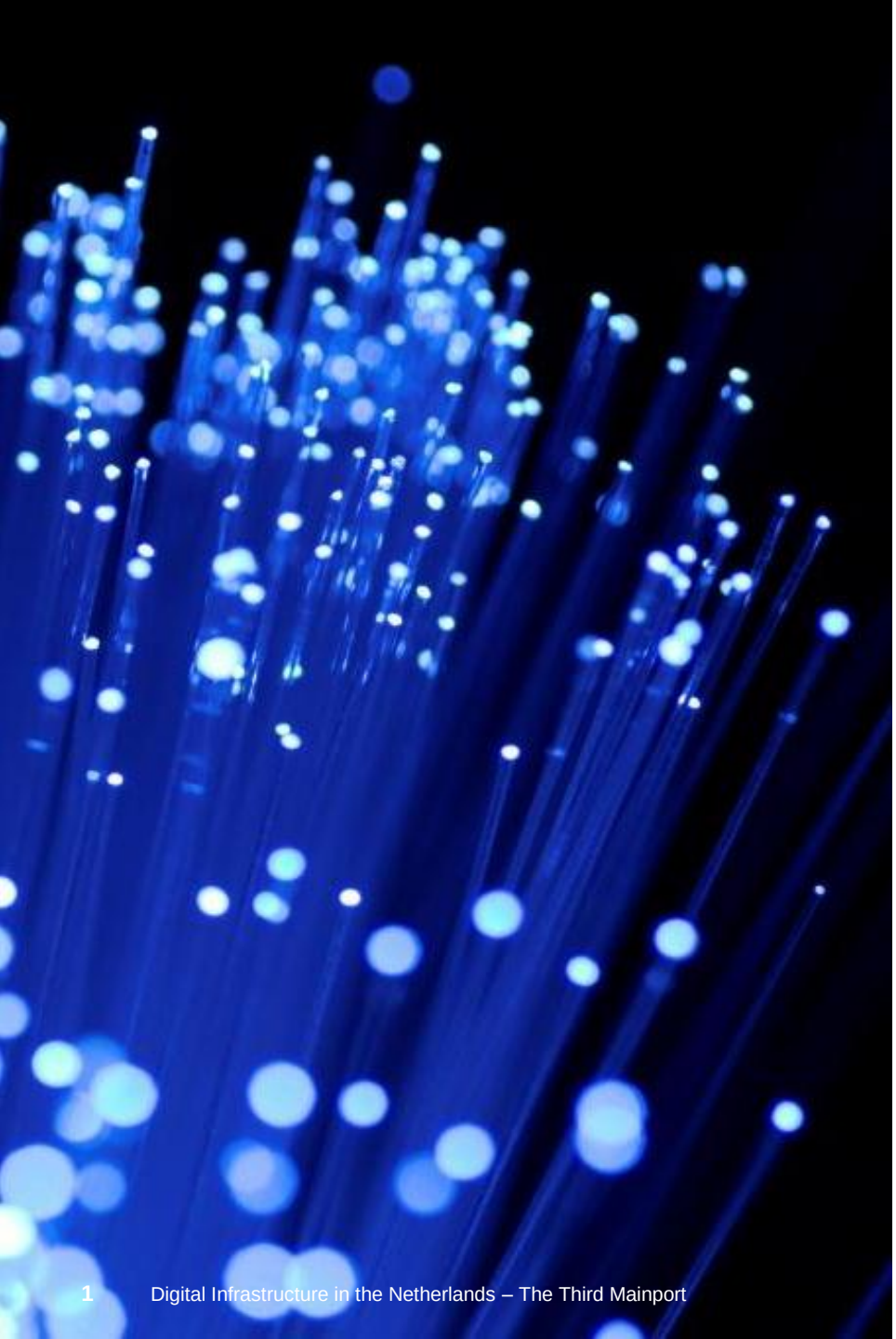
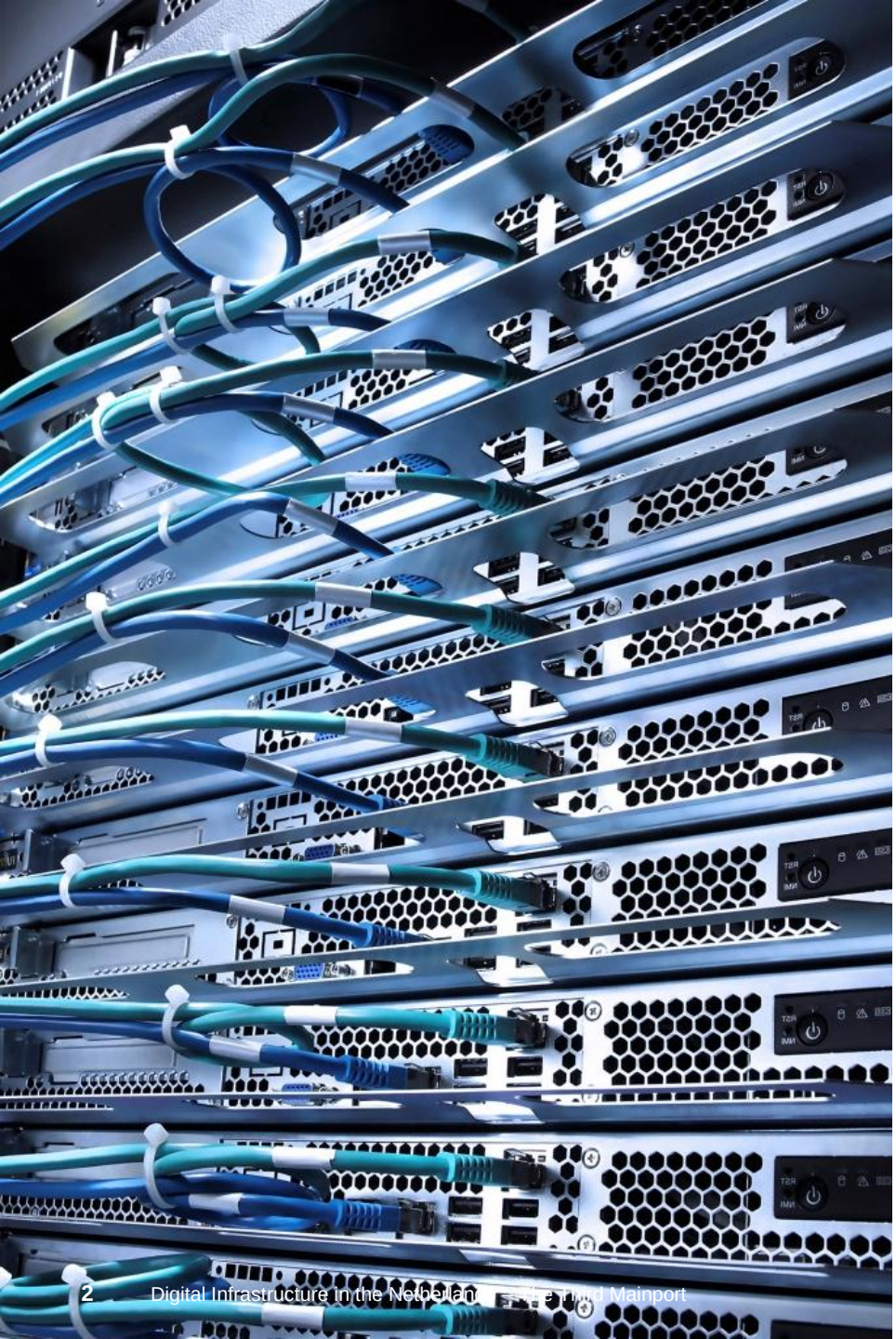
Digital Infrastructure in the Netherlands

The Third Mainport

November 14, 2013



Content



1. A technology backbone: The third mainport

The Digital Infrastructure, our third mainport, is mainly invisible yet the arteries for economic lifeblood of the digital economy

The Rotterdam harbour and Schiphol airport are two major assets of the Dutch economy. They both have the position as ‘mainport’; an international gateway for physical products and passengers.

This importance of these mainports for the Dutch economy is on two levels. First, they have a *direct* impact on the economy, for instance through employment of people working at the container terminals in Rotterdam or at Schiphol airport. In addition, there is also an *indirect* effect as these mainports attract various economic activities for which the presence of the mainport is conditional. The ecosystem of economic activities related to a mainport is a source of entrepreneurship and creativity.

All mainports rely on massive infrastructures. In the case of Rotterdam harbour: quays suited for the largest container vessels in the world, navigation technology to guide ships to their destination safely, container terminals with enormous cranes and automated vehicles that put containers in stacks, railroads and inland waterways for transportation, etc. Each successful mainport is a combination of unique aspects like the geographical position with continuous investments to keep the infrastructure on a competitive level.

The two mainports Rotterdam and Schiphol share the characteristic of *visibility*. There is hardly a Dutch person that does not get an image on his mind when Rotterdam harbour or Schiphol airport is mentioned. The infrastructure is large, visible and appealing.

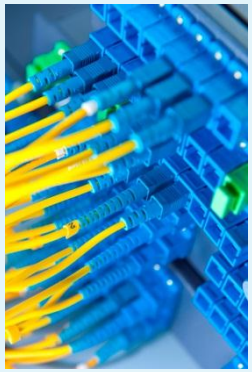
There is, however, a third mainport in the Netherlands. Like Rotterdam and Schiphol, it has a unique role of an international gateway for a specific type of traffic. It has a relatively small direct impact on the economy, but a large indirect impact. There is however one big difference: the infrastructure on which it relies is largely invisible for most people. Yet, this infrastructure is the backbone for many economic activities in our society and attracts world class companies for whom unique features of this infrastructure are of vital importance. We call this the third mainport of Holland: the Digital Infrastructure.

The Dutch Digital Infrastructure is part of a global backbone for delivering digital services to enterprises and consumers on a variety of devices

Digital Enabled Services

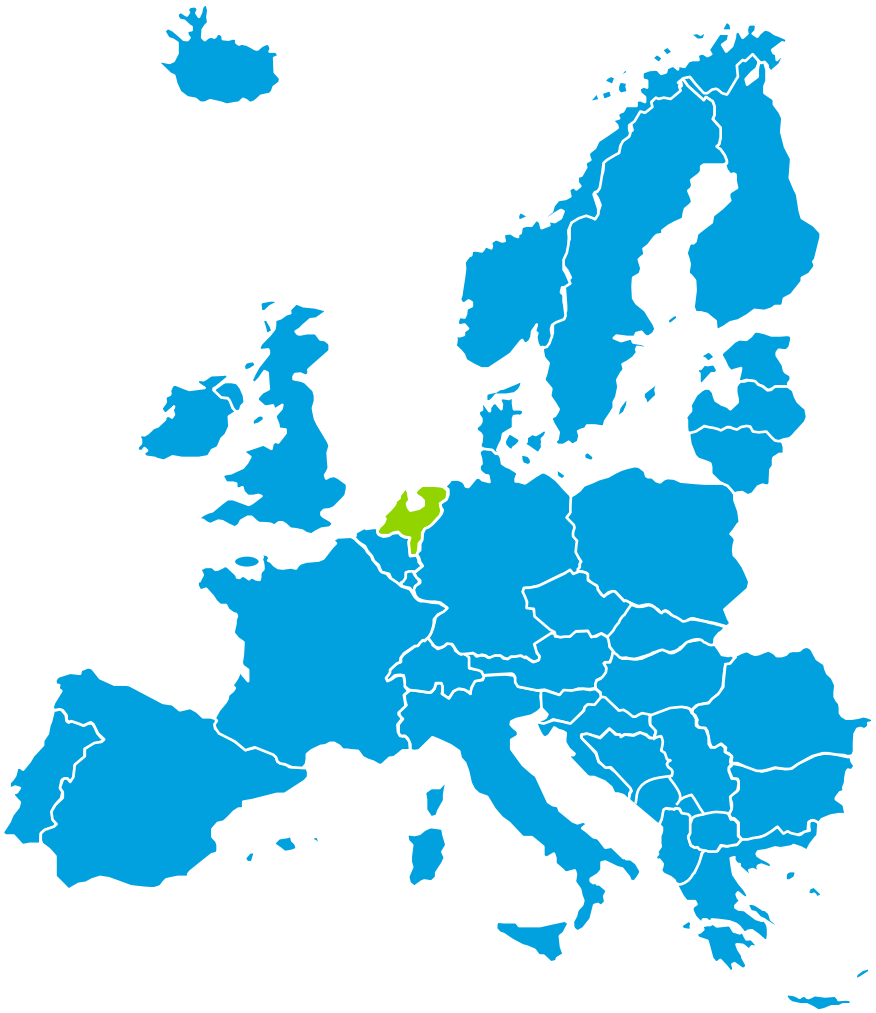
Enterprise Applications	E-commerce	Digital Media	Cloud	Payment providers	Online gaming	Social media
ERP CRM	bol.com amazon.com	NETFLIX	salesforce	EQUENS	ELECTRONIC ARTS	

Digital Infrastructure



End User Devices

In this global Digital Infrastructure, the Netherlands is among the leading countries



Internet Connectivity

- The Amsterdam Internet Exchange (AMS-IX) is the largest Internet Exchange worldwide in terms of number of connected peering networks. It is the 2nd largest Internet Exchange worldwide in terms of traffic (bits per second)
- The Amsterdam Internet Exchange (AMS-IX) is a mainport for Internet traffic more than the port of Rotterdam and Schiphol are for containers and passengers respectively
- The Netherlands scores 2nd place in EMEA and 6th place globally on broadband penetration and average measured connection speed

Data centres

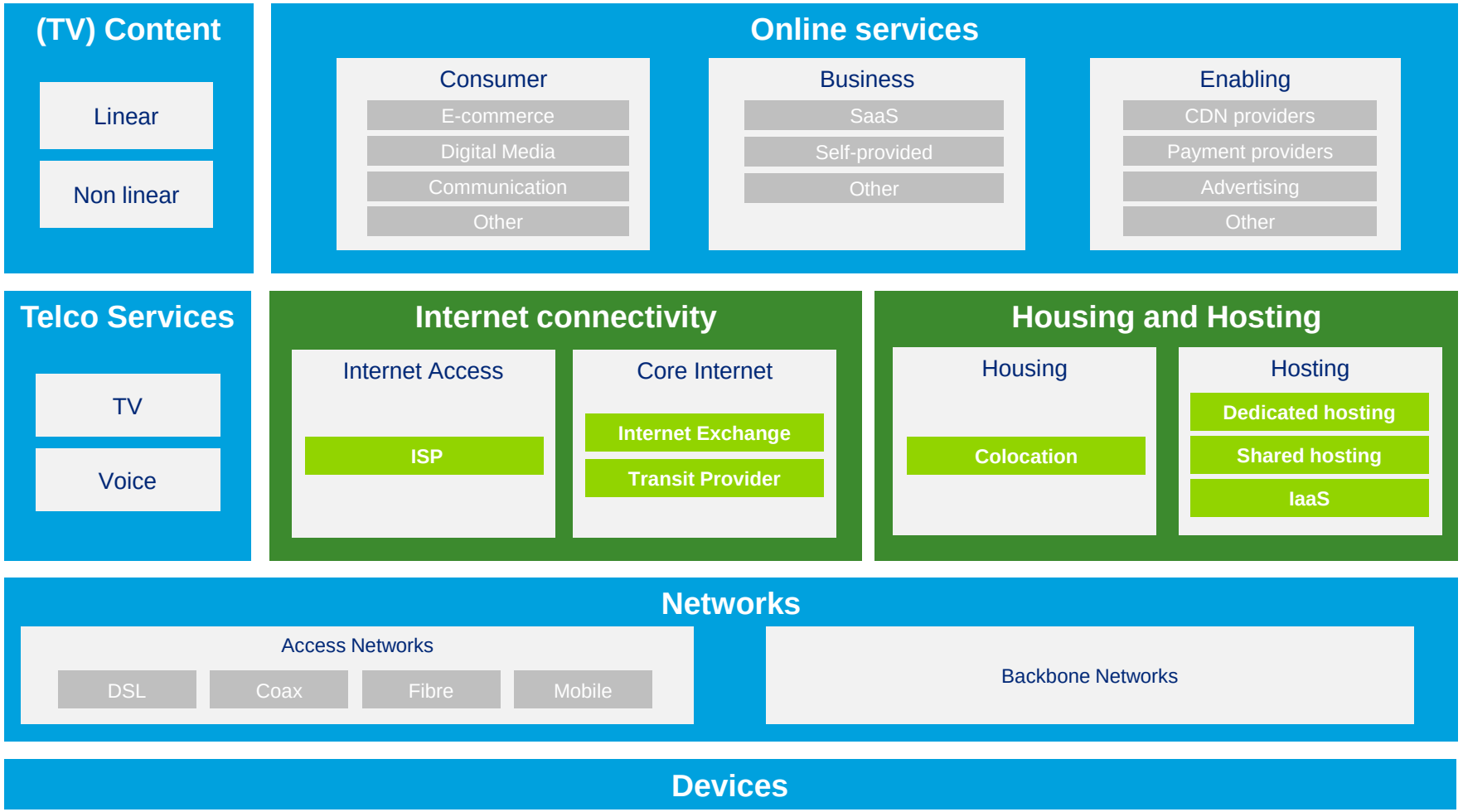
- The Amsterdam region is part of a leading group of tier-1 data centres (together with London, Frankfurt and Paris) and shows the highest increase in square meters

2. A digital nervous system: sector overview

- Products and services
- Supplier ecosystem
- Financial revenue
- Historic growth
- Ecological footprint

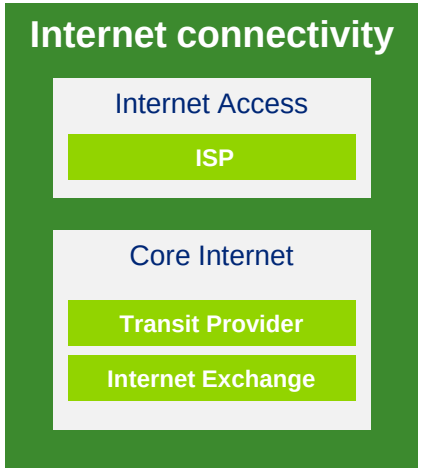
Products and Services

The Digital Infrastructure consists of Internet connectivity and Housing / Hosting and is part of the larger online ecosystem

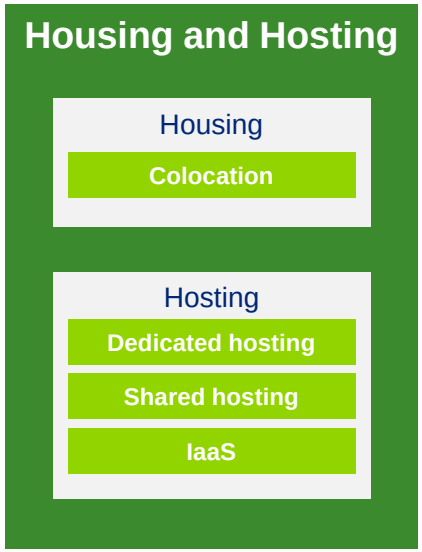


Source: Analysys, AT Kearney, Deloitte analysis

Services encompass Internet Access and Core Internet on one hand and Colocation, Hosting and IaaS on the other hand



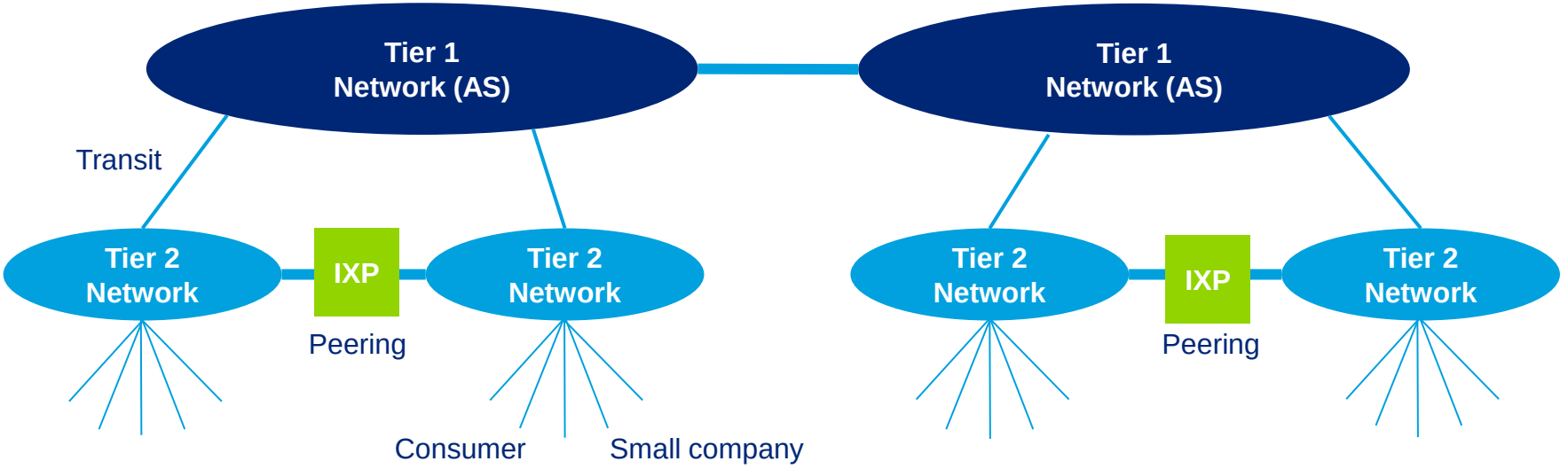
- **ISP**: Internet Service Providers, also called Internet access providers, offer end users (enterprises as well as consumers) access to the Internet via various means such as DSL, Coax, Fibre and Mobile.
- **Transit Provider:** Parties that provide network traffic in the 'core' Internet and connect smaller Internet service providers (ISPs) to the larger Internet.
- **Internet Exchange:** Parties that facilitate networks to interconnect with each other to exchange Internet traffic mutually (peering). This is typically done without charging for the traffic.



- **Colocation:** Delivering facilities (floor space, power, cooling, network connectivity) to enterprises and service providers for housing servers, storage and other computer equipment as an alternative for an in-company data centre
- **Dedicated hosting:** Delivering computing power and storage via equipment dedicated to a specific client but managed by the hosting provider
- **Shared hosting:** Delivering computing power and storage by sharing the resources of physical equipment among multiple customers
- **IaaS:** Infrastructure-as-a-Service, delivering computing resources (e.g. servers, storage) according to a model that meets the essential characteristics of Cloud computing: on-demand self-service by the customer, measured service (pay-per-use), rapid elasticity (any quantity at any time), resource pooling (multi-tenant model) and broad network access (infrastructure is available over the network via standardised mechanisms) [NIST, 2011]

The Internet is a network of c. 41,000 networks called ‘autonomous systems’ who connect to each other to exchange traffic

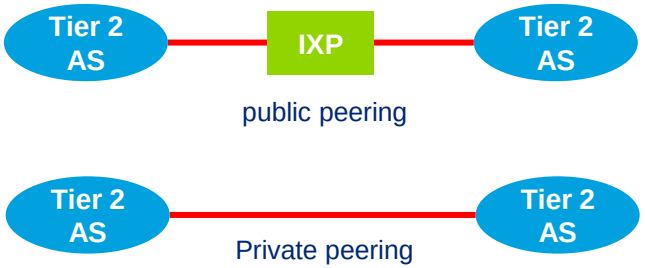
- Each Autonomous System (AS) is uniquely identified by an Autonomous System Number (ASN), maintained by IANA, and is owned by a single party. These parties can be of different types, for example:
  - Internet Service Providers (ISP)
  - Hosting providers
  - Telecommunication providers
  - Large multinationals
  - Large content and service providers (e.g. Facebook, Google, Microsoft)
- Technically, Autonomous Systems exchange traffic via the Border Gateway Protocol. Economically, there are two types of arrangements for these interconnections: “*peering*” and “*transit*”. These are explained on the next page.
- Of the c. 41,000 AS, there are about 15-20 tier-1 networks that together form the backbone of the Internet. A tier-1 network peers with all other tier-1 networks and together, the tier-1 networks connect to every AS there is.
- Tier-2 networks connect consumers and (smaller) companies to the Internet. They peer with other tier-2 networks and use tier-1 networks as transit providers additionally.



Peering at Internet Exchange Points (IXPs) complemented with IP Transit ensures full connectivity between all users and services on the Internet

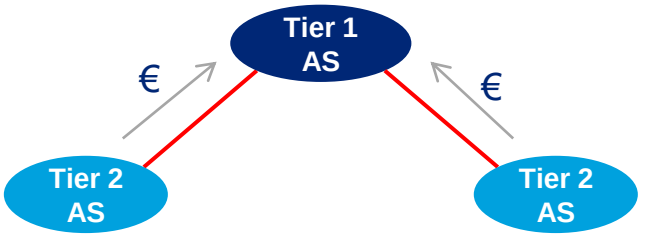
Peering

- Peering is when two or more Autonomous Systems (AS) interconnect with each other to exchange Internet traffic mutually. It is typically done without charging for the interconnection of the traffic.
- In general, parties peer at an IXP (*public peering*) to decrease network (transit) costs, to improve network performance (shortest route) and to make their network more redundant.
- Internet Exchange Points are established to facilitate peering between Autonomous Systems. For example: AMS-IX facilitates 616 Autonomous Systems. In Europe, IXPs are typically not-for-profit associations.
- Besides public peering, Autonomous Systems can also peer via direct interconnects, thus bypassing the IXP. This is called *private peering*



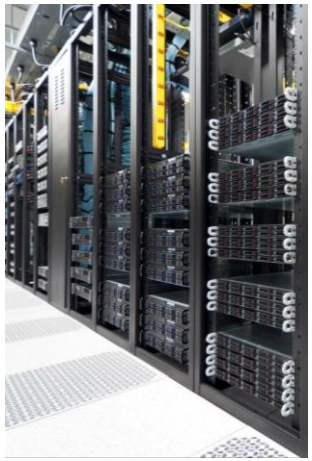
Transit

- A large (tier-1) Autonomous System agrees to receive the traffic from a tier-2 Autonomous System and to distribute this traffic to all Autonomous Systems for which it is intended.
- Transit is provided on a commercial basis. The transit network charges a fee for this service to the tier-2 network that uses the transit services.
- Since no tier-1 Autonomous System is directly connected to all other Autonomous Systems, the transit network will deliver part of that traffic indirectly via other tier-1 transit networks. For that purpose, all tier-1 transit networks peer with one another.



Source: OECD, Internet Traffic Exchange: Market Developments and Policy Challenges, 2013

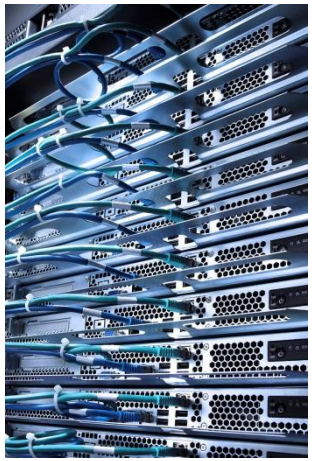
The co-location providers provide floor space and facilities for IT equipment while hosting providers deliver server and storage capacity



Housing (co-location)

Delivering facilities for servers and other computer equipment

- Fitted floorspace (sq m)
- Racks
- Power (Watts)
- Cooling
- Networks and connectivity
- Other facilities (fire extinguishing, universal no-brake)



Hosting / IaaS

Delivering dedicated servers or shared storage and computing power

- Dedicated (entire) servers (type, CPU, RAM)
- Shared resources (CPU and RAM)
- Storage (Tbytes)
- Computing power
- Internet access

The hosting sector ranges from traditional (shared) web hosting and dedicated server hosting up to rapidly evolving infrastructure cloud (IaaS)

	Shared (web) hosting	Dedicated hosting	Cloud IaaS
	Capacity of one physical server is shared among multiple different customers (e.g for websites)	Dedicated server is managed for each individual customer	Customer purchases storage and computing power on-demand
Shared or Dedicated	Shared	Dedicated	Shared
Standardized/ automated	High	Medium	High
Agreements	Highly standardized agreements	Contracts Potentially standardized	No contracts On demand
Billing	Fixed fees	Fixed fees	Metered
Provisioning	Provider	Provider	User

Supplier Ecosystem

The colocation market is a mix of global and local colocation providers

Global Players

Wholesale Colocation

- Long term lease of large scale data centre space at commodity rates
- Typically limited to floor space, power and cooling, the client is responsible for everything else
- Clients are large scale users such as banks, government departments, multinationals and IT service providers
- Wholesale capacity can be repackaged as retail colocation

Retail Colocation

- Contracts for provisioning of floor space and all facilities (power, cooling, network connectivity)
- Network neutral offer access to multiple network carriers
- Varies from multiple racks (caged) to slots in racks
- Beneficial for companies that do not want to make the capital investment in in-house data centres

Carrier Biased Colocation

- Colocation services provided by network service providers as an extension to their networking service
- Limited connectivity options as providers will push their on connectivity solutions

Local Player Colocation

- Colocation services limited to one country or geographical area
- Often operates multiple data centres spread over the country to offer local presence (close to the customers)
- Suited for companies who do not need global presence in data centres at the major hot spots in the world (East coast, West coast, Europe, Asia)

DIGITAL REALTY Data Center Solutions
GLOBAL SWITCH
EQUINIX
TelecityGroup
interxion
evoswitch NEXT GENERATION DATACENTERS
Level(3) COMMUNICATIONS
BT
colt
kpn
previder
DATACENTERGROUP
switch datacenters
Interconnect

Source: CBRE, EMEA & APAC Data Centres

The housing market is dominated by large international players who can leverage scale in this capital intensive industry

International Players

Country of origin	Company	Footprint in NL Facilities	Size (m^2)
	DIGITAL REALTY Data Center Solutions	5	33,771
	GLOBAL SWITCH	1	38,723
	kpn	11	30,000
	EQUINIX	3	12,800
	TelecityGroup	5	19,000
	interxion	7	13,300
	Level (3)	3	12,800
	evoswitch NEXT GENERATION DATACENTERS	1	10,000
	eunetworks	1	6,000
	terremark	1	2,700

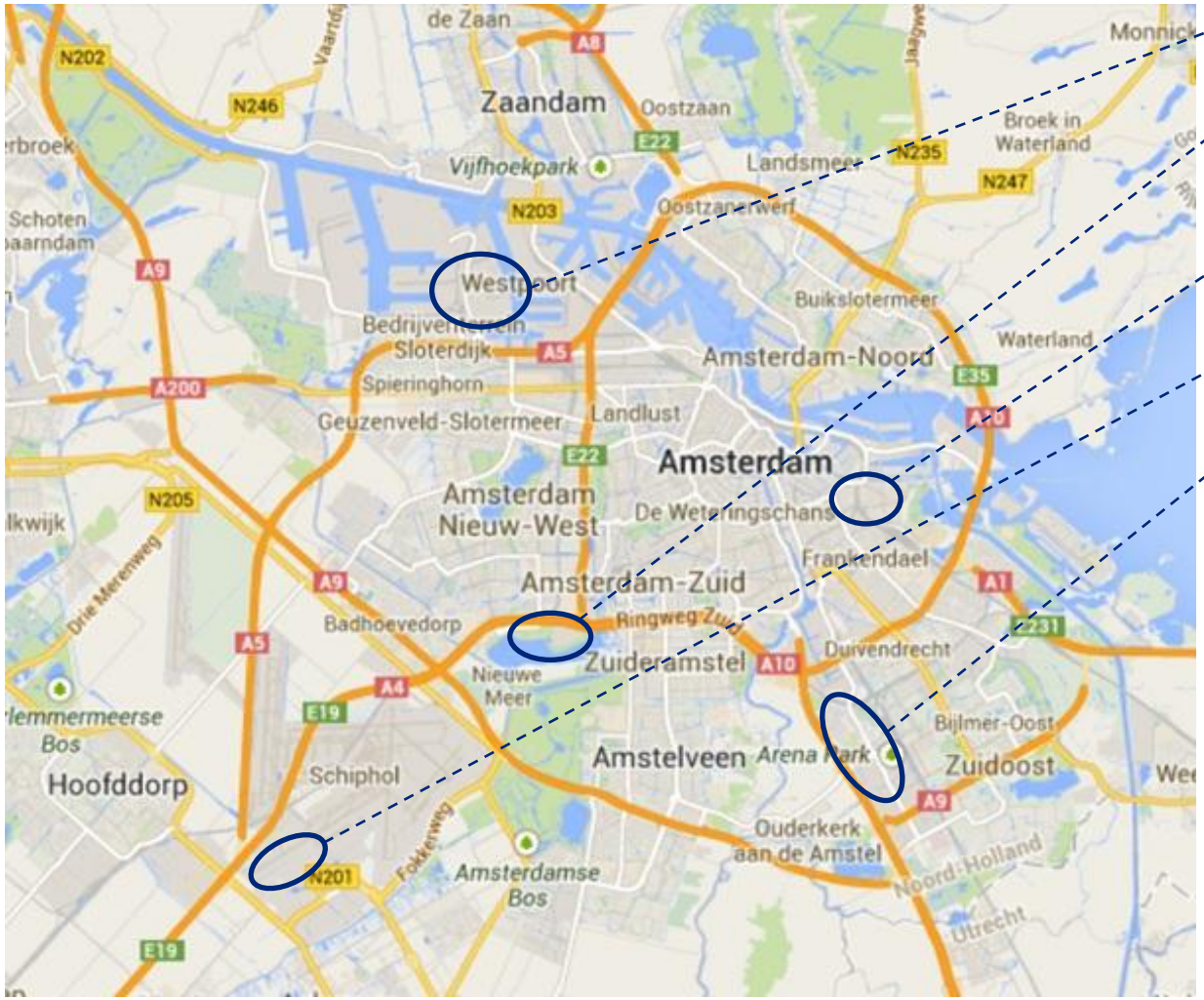
Dutch local Players

Country of origin	Company	Footprint in NL Facilities	Size (m^2)
	previder	2	6,100
	DATACENTERGROUP	2	5,200
	switch datacenters	1	4,100
	Interconnect	2	3,700
	SmartDC Dataport of Rotterdam	1	3,500

Further data centres of Dutch local players:
- **≈ 10 data centres with 1,000-2,000 m^2**
- **≈ 15 data centres with 500-1,000 m^2**
- **≈ 100 data centres with <500 m^2**

Source: Company websites, www.datacentrumgids.nl

The Amsterdam region is a colocation hotspot with c. 40 facilities, of thousands m² each, clustered at five geographical sites



- Amsterdam Sloterdijk
- Amsterdam BusinessPark Riekerpolder
- Amsterdam Science Park
- Schiphol area
- Amsterdam Zuidoost (Amstel III en Amstel I)

This clustering is explained by:

- AMS-IX started at the Science Park, where ''Mathematisch Centrum'/ CWI were located. The area is extremely well connected by glass fibre networks
- Clusters in Sloterdijk and Zuidoost emerged due to present fibre network access and empty real estate
- Cluster Schiphol emerged due to available land parcels

Alliander and Tennet engineered the electricity distribution network to facilitate data centre power needs at these sites

Sources: Gemeente Amsterdam, Dienst Ruimtelijke Ordening, *Vestigingsbeleid datacenters*, 29 October 2013

Although Amsterdam is a data centre hotspot, colocation facilities are scattered all over the Netherlands

- Colocation > 1,000 m^2
- Colocation 500 - 1,000 m^2
- Colocation 250 – 500 m^2

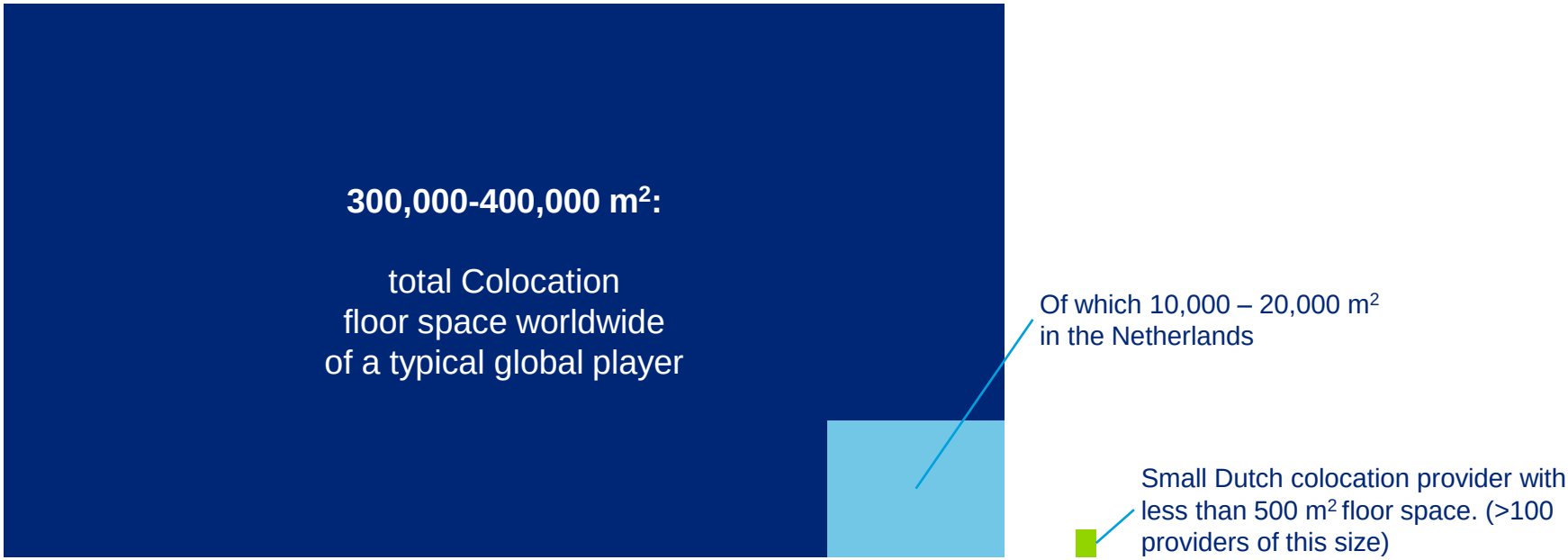
Important: this map only shows the commercial colocation data centres. Large proprietary data centres of enterprises or IT providers like Google and Microsoft are not shown here.

Since only a fraction of all IT equipment is housed in a colocation data centre, a complete overview of all data centres in NL is much more extensive.

Sources: www.datacentrumgids.nl

The large global players are of a completely different scale compared to the majority of local Dutch colocation providers

- The ecosystem of companies that provide colocation services in the Netherlands consists of companies that differ in size enormously.
- On one hand of the spectrum there are large global colocation providers like Equinix and Telecity, who have several hundreds of thousands square meters floor space worldwide of which tens of thousands square meters floor space in the Netherlands.
- On the other end of the spectrum there are small local players who have less than 500 square meters in total.
- **The companies on both ends of the spectrum differ in total floor space by a factor 1,000 easily**



Source: Company websites, www.datacentrumgids.nl

The hosting and infrastructure cloud market is fragmented with many small players, a few larger international players and new entrants from other directions

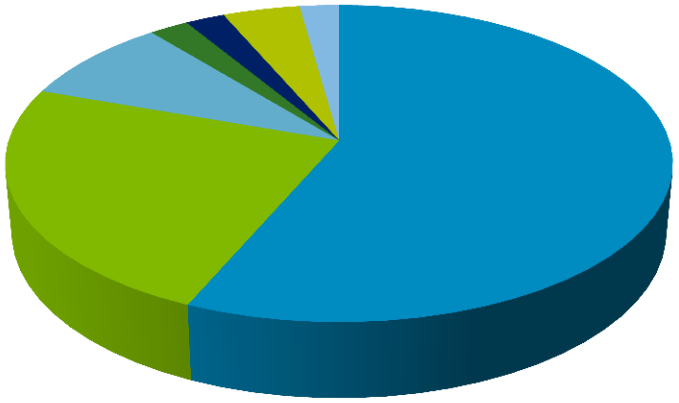
Cloud giants	Enterprise hosters	Mass market hosters	Small local players
• Pure players in the cloud • Global presence and very large scale • Standardized offer	• Aiming at larger enterprises • Larger contracts and specific needs • In combination with transformation and integration services	• Standardized portfolio of hosting services • Aiming at small and medium businesses • Large scale with international activities	• Small companies • Originating from web hosting and internet access • Evolved into shared and dedicated hosting and cloud • Ability to provide local and personalized service
amazon web services Azure Google	hp BT	leaseweb reliable hosting	**Many** (> 1,000 according to DHPA)

A survey among 55 small and medium sized hosting providers reveals a heterogeneous market

Respondent characteristics of online survey among NL hosting and cloud providers

Sample of
55 Companies

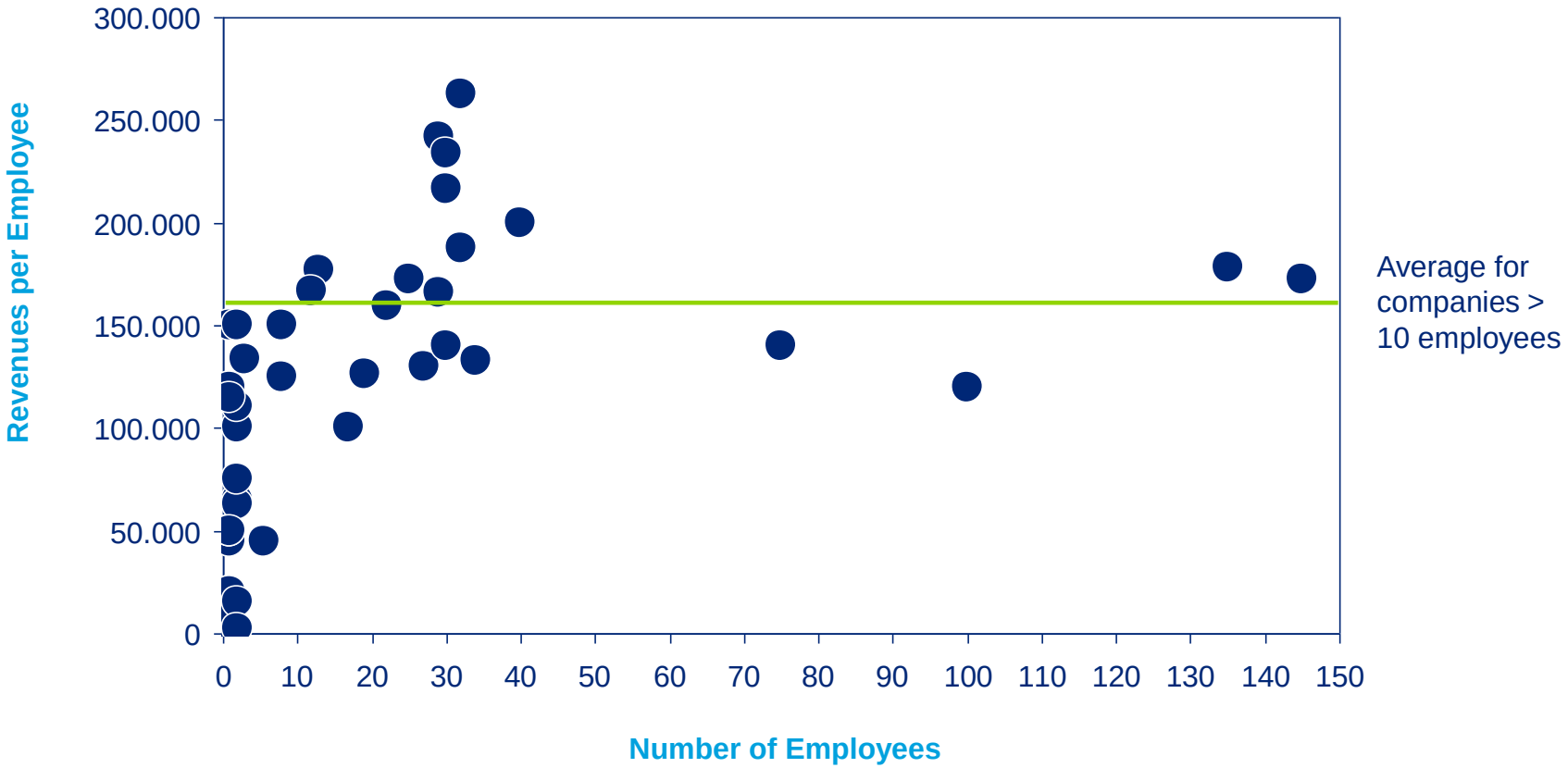
Average FTE:	37
Median FTE:	5
Minimum FTE:	1
Maximum FTE:	1,000



Source: Online survey

The hosting sector consists of many small companies (1-3 employees) with relatively low revenues per employee compared with the rest of the sector

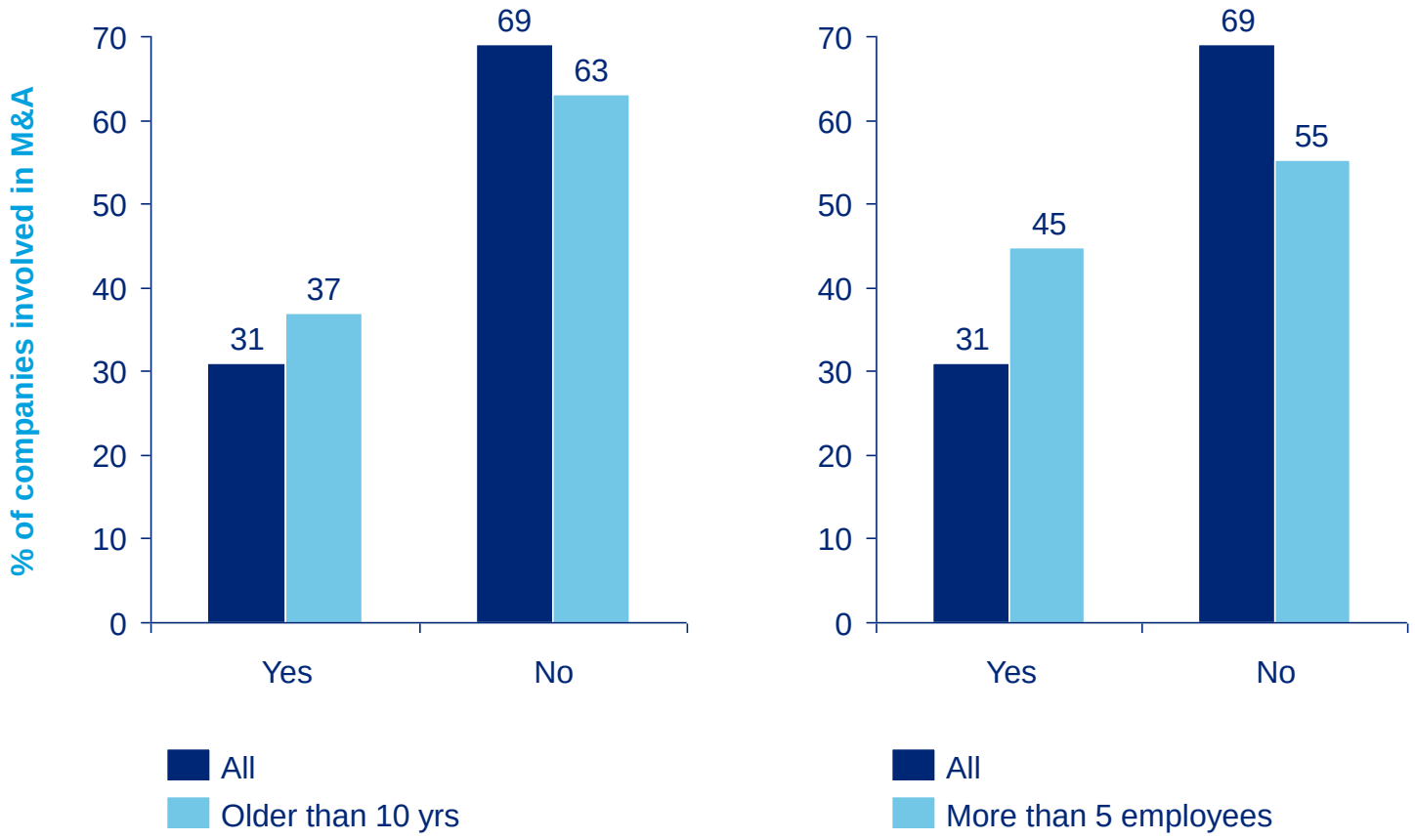
Annual revenues of hosting companies (€)



Source: Online survey

M&A is an important growth factor for most hosting companies especially for larger and older companies

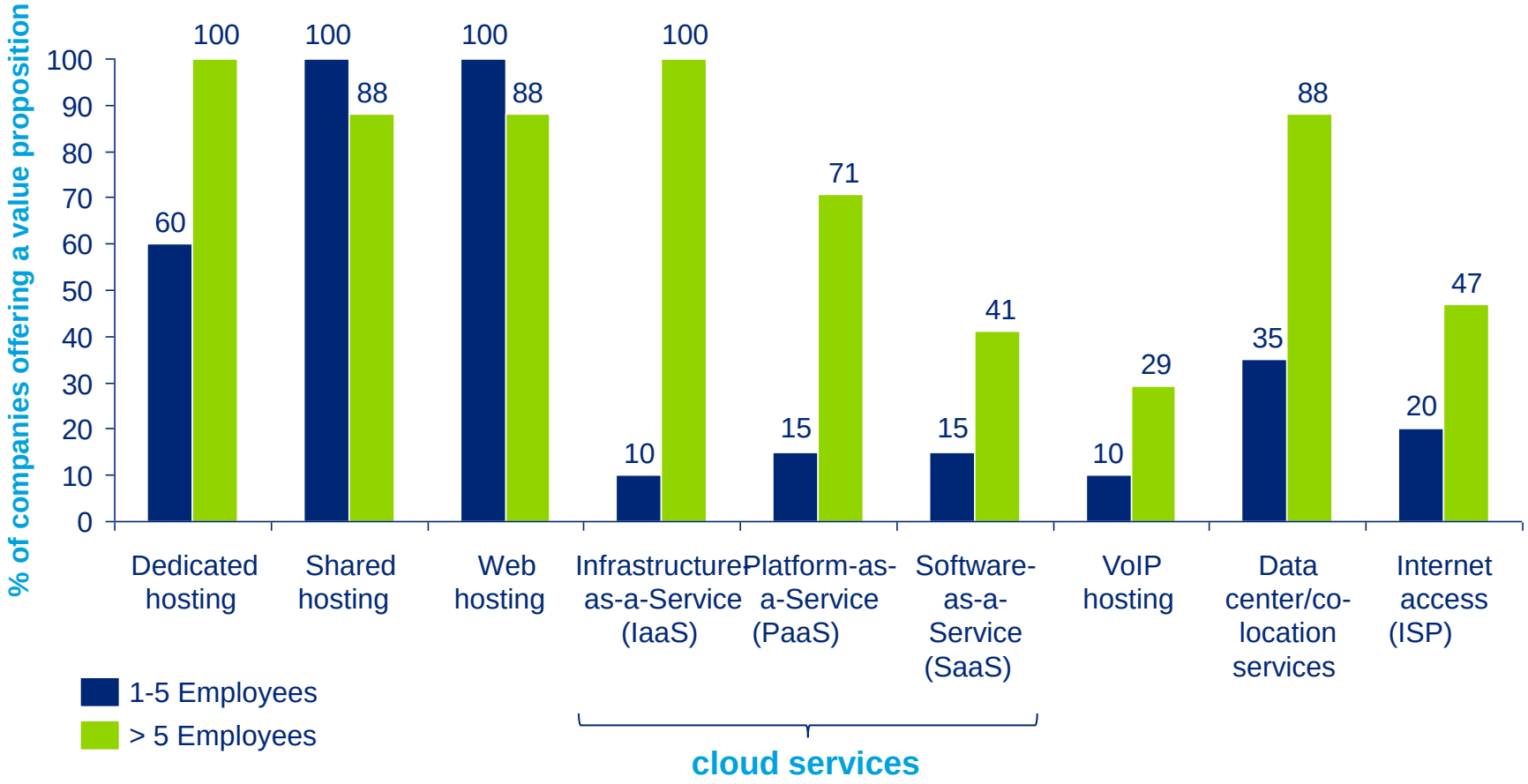
Hosting companies with acquisitions in last 5 years (%)



Source: Online survey

Small hosters are focused on traditional web/shared hosting while larger hosters are much stronger in dedicated hosting, cloud and co-location

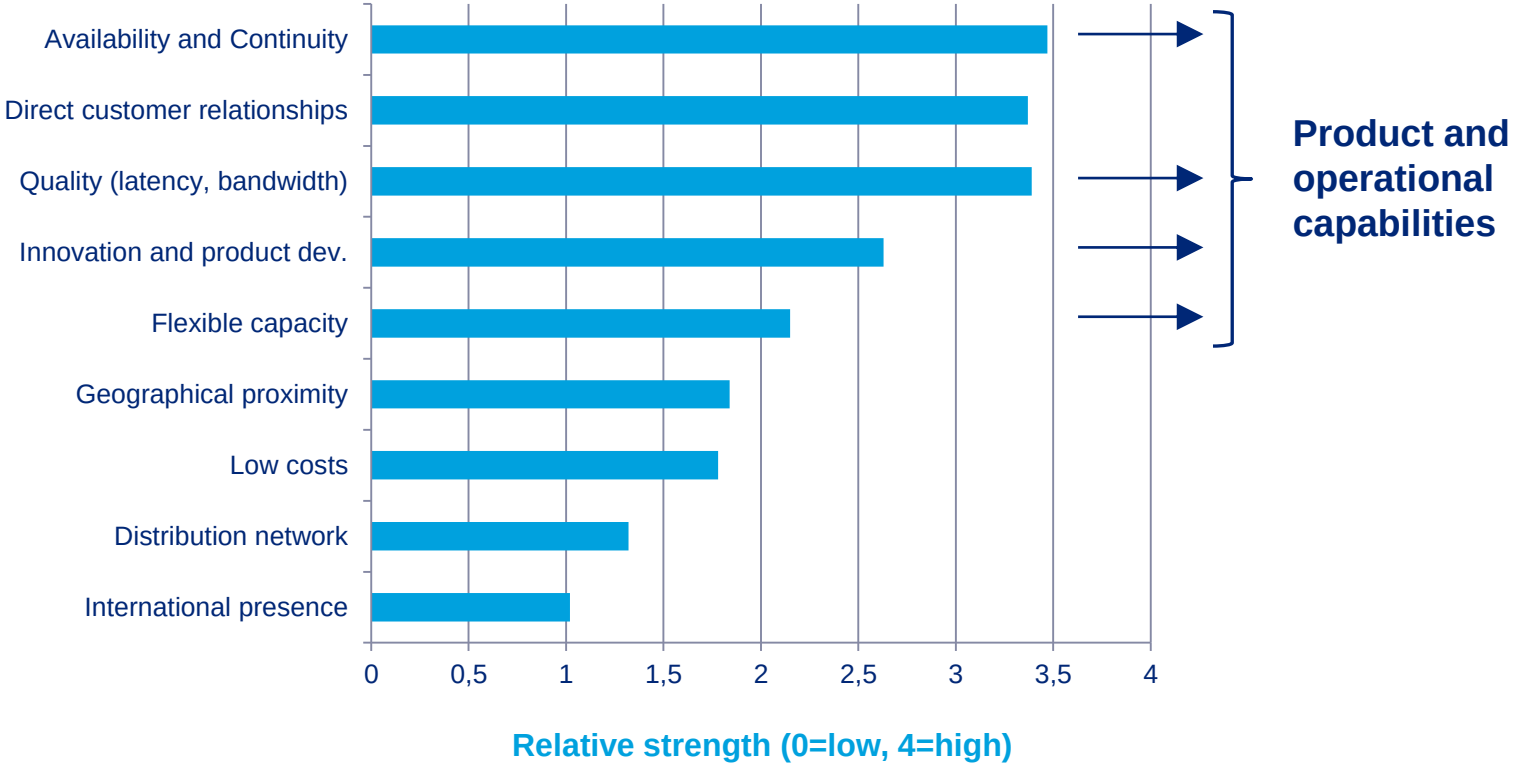
Value propositions of NL hosting and cloud provider



Source: Online survey

Apart from strong customer relationships, hosting companies consider their strengths to be in product and operational capabilities

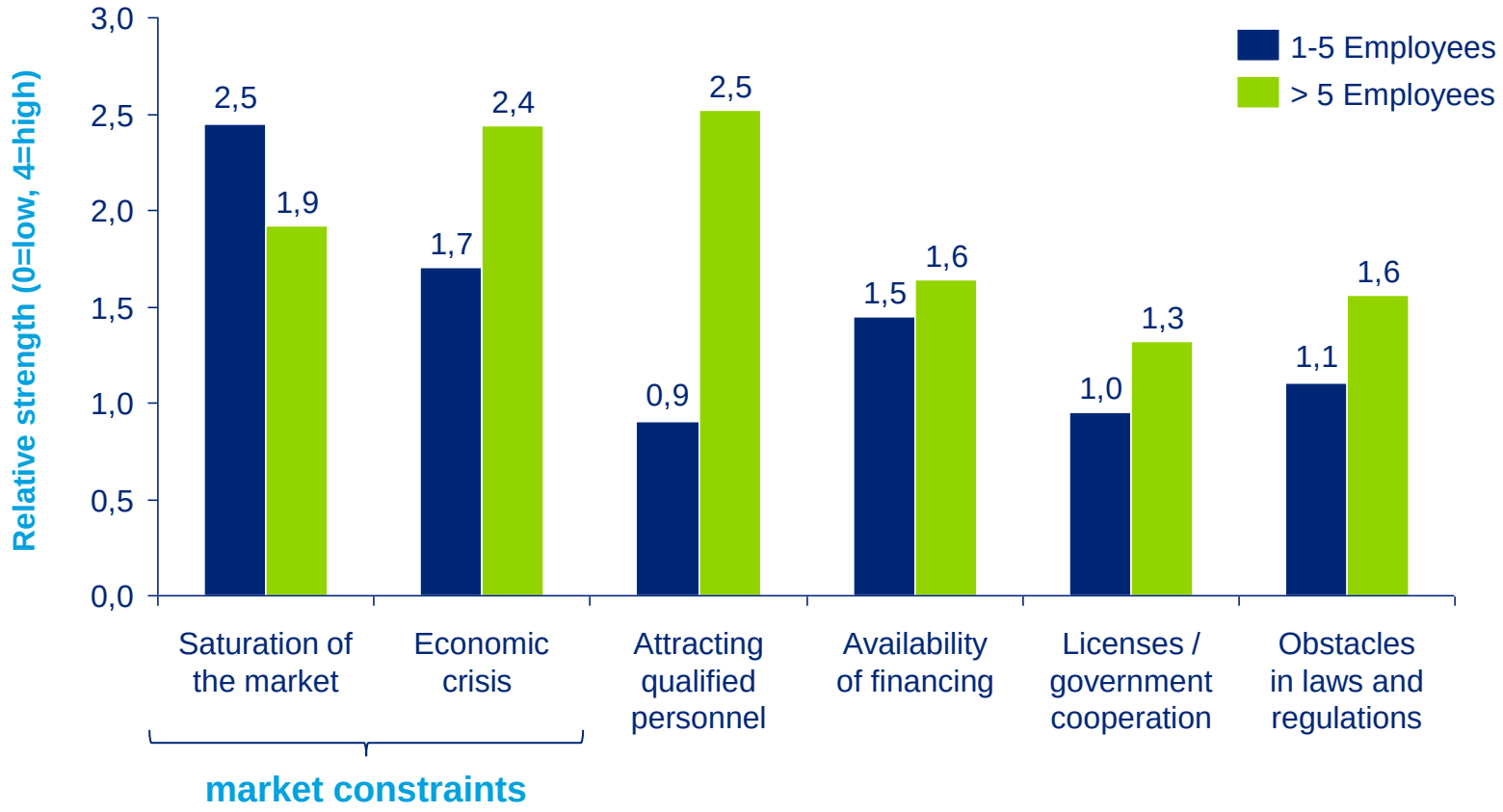
Characteristics as major strength of hosting company



Source: Online survey

Main growth constraints are in the market but reasons differ according to small and large companies. Larger companies also have difficulties attracting qualified personnel

Constraints for growth as mentioned by survey respondents

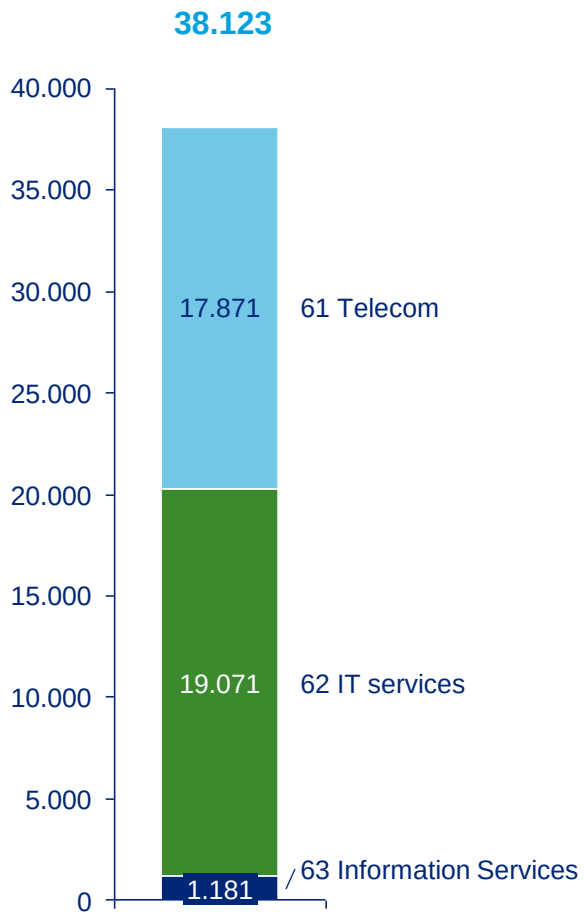


Source: Online survey

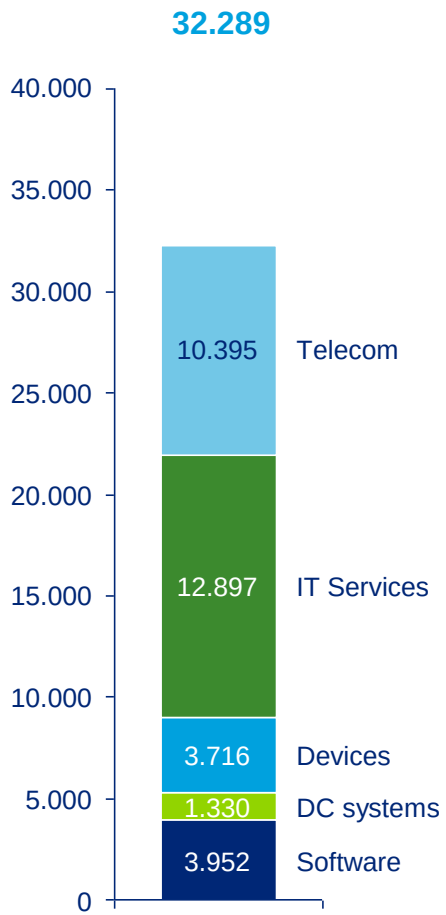
The size of the NL Digital Infrastructure sector

The total Telecom and ICT market in the Netherlands is around €35 bn mainly split between Telecom and IT services

CBS – NL ICT revenues 2011 (m€)



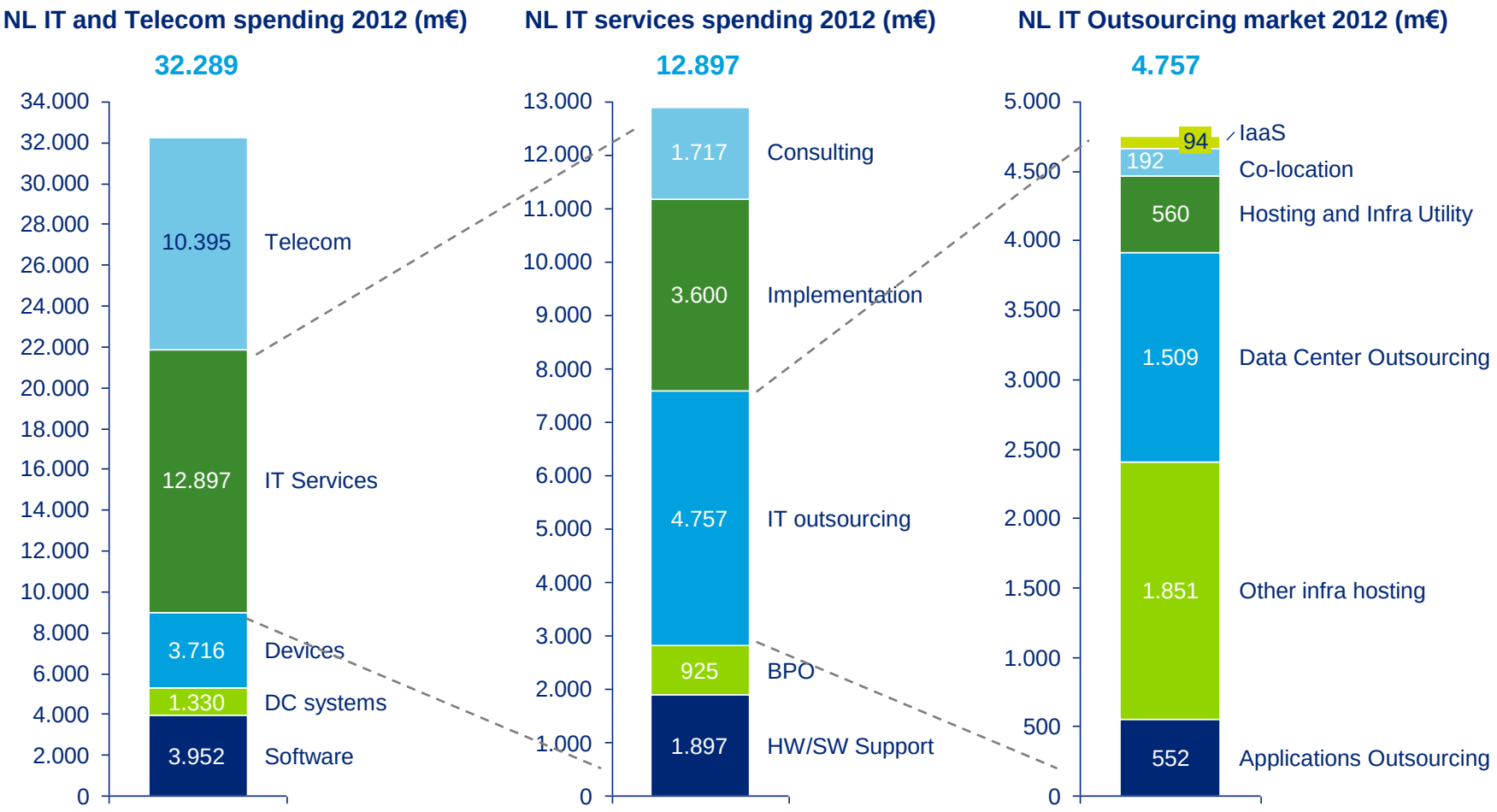
Gartner – NL end user spending 2012 (m€)



Sources: CBS, Gartner, Deloitte analysis

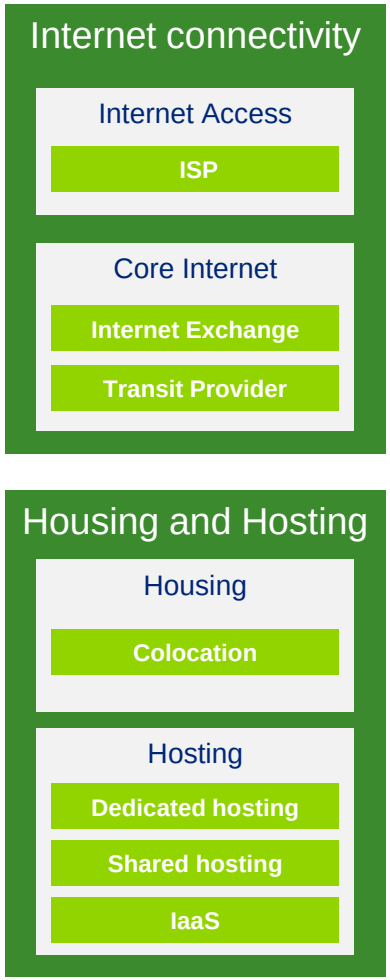
Of the IT services market the Housing & Hosting market amounts to c. €1 bn

The business services related to Internet connectivity, Housing and Hosting do not match with the SBI codes defined for categories 61, 62 and 63 (see next page). Due to this mismatch, detailed CBS figures on revenues per type of service are not applicable. Therefore, solely Gartner data has been used..



Sources: Gartner

CBS revenue figures are based on the SBI code system. This classification does not reflect the Digital Infrastructure sector adequately however



SBI-codes 61, 62 and 63

61	**Telecommunicatie**
61.1	Draadgebonden telecommunicatie
61.10	Draadgebonden telecommunicatie
61.2	Draadloze telecommunicatie
61.20	Draadloze telecommunicatie
61.3	Telecommunicatie via satelliet
61.30	Telecommunicatie via satelliet
61.9	Overige telecommunicatie
61.90	Overige telecommunicatie

62	**Dienstverlenende activiteiten op het gebied van informatietechnologie**
62.0	Dienstverlenende activiteiten op het gebied van informatietechnologie
62.01	Ontwikkelen, produceren en uitgeven van software
62.02	Advisering op het gebied van informatietechnologie
62.03	Beheer van computerfaciliteiten
62.09	Overige dienstverlenende activiteiten op het gebied van informatietechnologie

63	**Dienstverlenende activiteiten op het gebied van informatie**
63.1	Gegevensverwerking, webhosting en aanverwante activiteiten; webportalen
63.11	Gegevensverwerking, webhosting en aanverwante activiteiten
63.12	Webportals
63.2	Overige dienstverlenende activiteiten op het gebied van informatie
63.21	Persagentschappen
63.29	Overige dienstverlenende activiteiten op het gebied van informatie n.e.g.

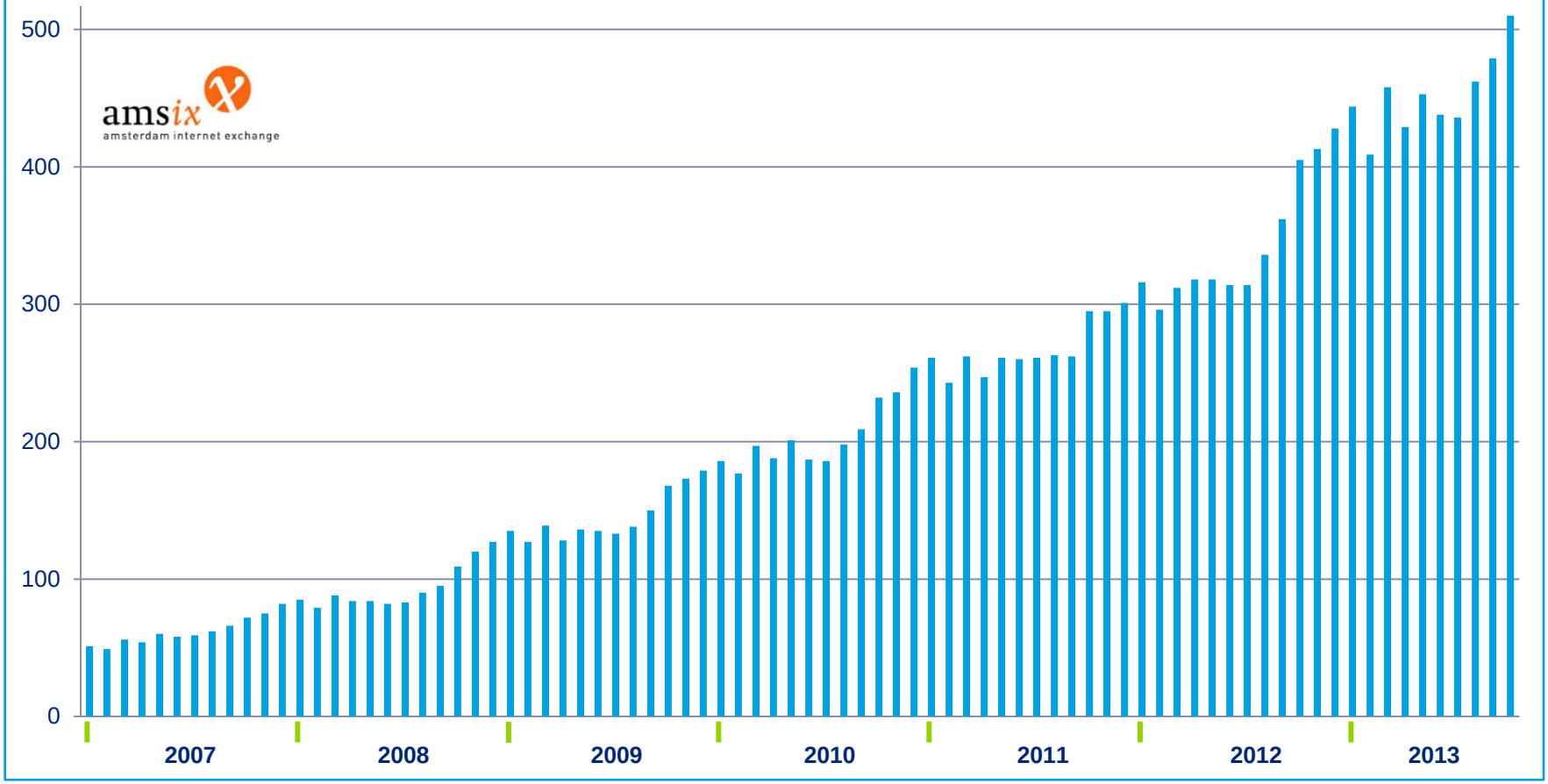
- The business services related to Internet connectivity, Housing and Hosting (left hand part of this page) do not match with the codes defined for categories 61, 62 and 63.
- Due to this mismatch, detailed figures on revenues per type of service are not available.
- In our view, his mismatch is one of the reasons why the sector is not yet recognised as such.

Sources: CBS, Standaard Bedrijfs Indeling 2008 Versie 2013

Historic growth

Internet traffic has grown 10-fold in the past seven years and the pace at which this growth takes place is not decreasing

Monthly volume (in PetaByte) of AMS-IX Internet traffic of the last seven years



Source: www.ams-ix.nl - Historic Traffic Data

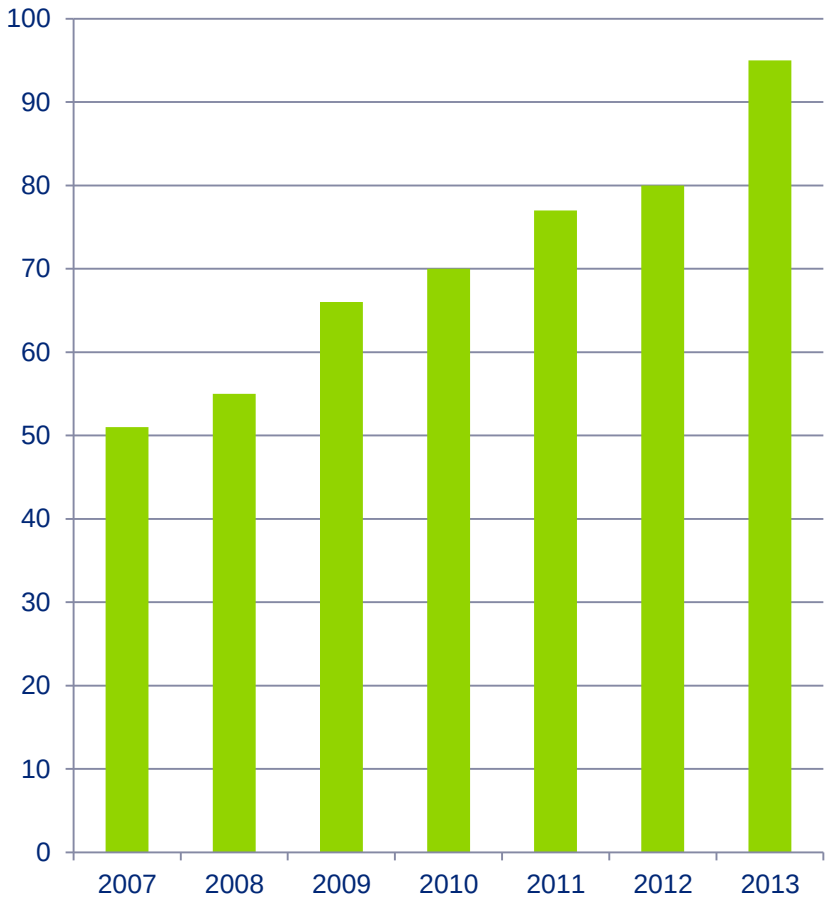
Despite a huge growth in server performance each year, colocation floor space nearly doubled in the past six years

- Total computing power shows a consistent and steep increase. On one hand, as server capacity increases, total computing power per m^2 increases. In addition, the total amount of colocation floor space increased too.

"The trends in performance for the same footprint follow an approximate 25% to 35% compound growth rate (CGR)" (1)

"At any one time the older datacom equipment that is replaced with newer equipment may take a 100% or more jump in performance for the same space occupied by the older equipment" (1)

Amsterdam co-location floor space (1000 m^2) (2)



Source (1): ASHRAE, *Datacom Equipment Power Trends and Cooling Applications – Second edition*, 2012
Source (2): CBRE - T2012_Viewpoint_European_data_Centres.pdf

Ecological footprint

As total energy usage of all NL data centres is estimated at 2% of total electricity consumption, efforts are made to reduce this ecological footprint

Total electricity usage of all NL data centres (commercial and private):

1,6 TWh in 2012
2,1 TWh in 2015

c. 2% of total NL electricity usage

Total CO2 emission of all NL data centres (commercial and private):

0.7 megaton in 2012
0.9 megaton in 2015

c. 1.2% of total NL CO2 emission

Reduction of the ecological footprint of data centres is done in four ways:

1. Power usage effectiveness (PUE) is a measure of how much of the power is actually used by the computing equipment (servers, storage, network) in contrast to cooling and other overhead. PUE is the ratio of total amount of power used by the data centre facility to the power delivered to computing equipment. CE Delft estimates the effect of a PUE decrease of all data centres to 1.3 to result in a total energy saving of 0.3 TWh (the energy consumption of 865.000 households)

2. Servers are rarely used at 100% of their capacity. Companies can increase the asset efficiency of servers by applying virtualisation techniques that increase the effective usage of server capacity significantly. This reduces the total number of servers for a specific workload and hence the total electricity usage for that workload.

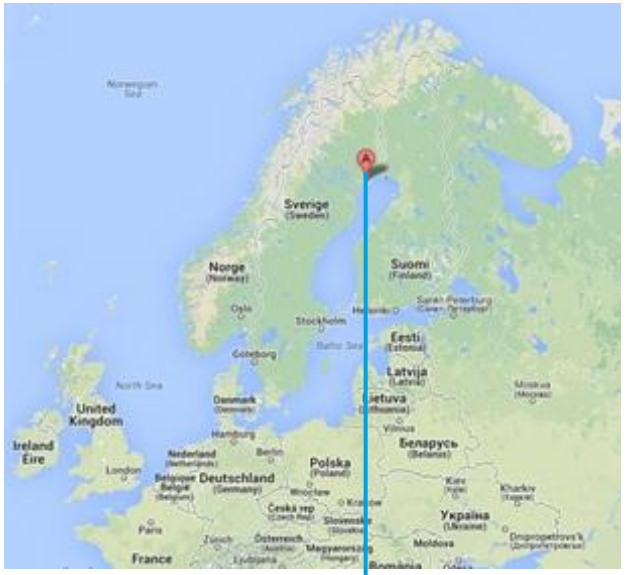
3. After reducing the power consumption via the two approaches described above, a data centre can further reduce the ecological footprint by using ‘green power’

4. In general, large data centres are better equipped to take measures to reduce the energy consumption. On average, older and proprietary data centres of companies have a much higher PUE compared to large industrialised commercial data centres. The trend to move from a small proprietary data centre to an colocation contributes to lowering the ecological footprint.

Source: CE Delft, *Vergroenen datacentres 2012-2015*, March 2012

In the search for minimal ecological footprint, several companies decided to move their data centres to remote locations with renewable energy

- In June 2013, Facebook opened a new data centre in Luleå, Sweden which will be serving user traffic from around the world.
- The location of this new data centre is on the edge of the Arctic Circle. This allows Facebook to use the cold Nordic air to cool the thousands of servers.
- The data centre servers and storage are powered by locally generated hydro-electric energy. According to Facebook, this energy is not only 100% renewable, but so reliable that the number of backup generators could be reduced by more than 70 percent.
- Facebook claims to have reached a Power User Efficiency (PUE) score of 1.07, which is very close to the theoretical minimum of 1.



Credits: www.facebook.com/LuleaDataCenter

Power User Efficiency (PUE)
1.07

Source: http://newsroom.fb.com/News/632/Data-Center-Update-Lule%C3%A5-Goes-Live

However, moving all data centres to remote locations is not a viable option as geographical proximity remains important

- Data centres are heavy consumers of energy and occupy scarce parcels of land. One could argue that in order to reduce carbon footprint, the best course of action would be to move all data centres to remote locations where green energy is available in large quantities.
- There are, however, some good reasons for locating a significant part of data centre capacity locally. These are:

"Geographical proximity allows engineers to reach the facility in short time"

- Companies that operate a data centre will have to visit the data centre for maintenance on the equipment and in case of incidents. Geographical proximity between the technical team and the servers and storage in the colocation facility is an important factor. Completely relying on outsourced IT support ("remote hands") on their mission critical IT infrastructure will not be a viable option for most companies.

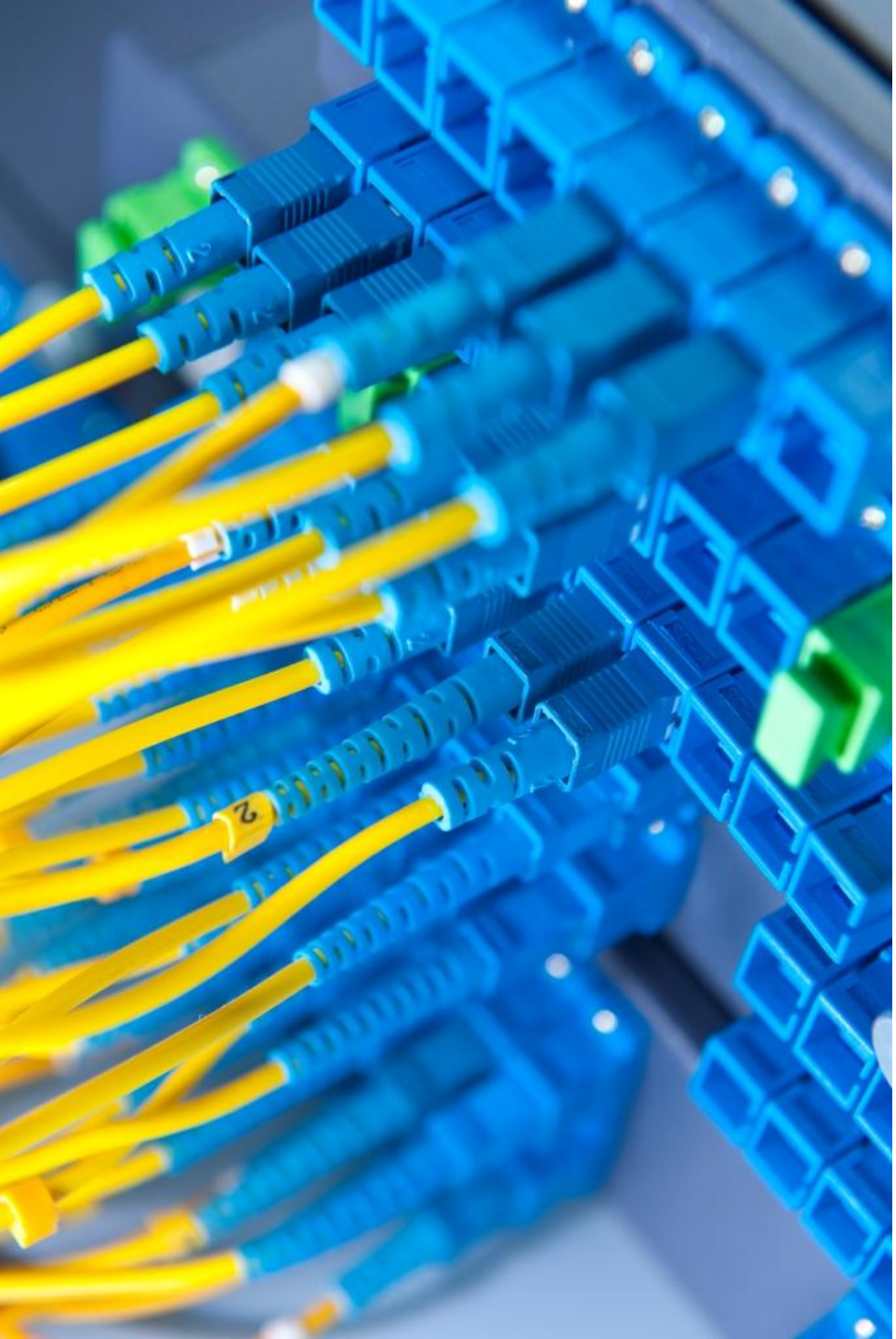
"Geographical proximity contributes to low latency"

- The geographical distance between a data centre and its end-users has a direct relationship with latency. Some types of computing such as storing archives of rarely accessed data, does not require low latency. For other types of computing, however, low latency is very important and a reason to locate the data centre close to the end-users.

"Bits-to-energy is not always better than Energy-to-bits"

- To reduce carbon footprint one can follow two strategies:
  - *Bits-to-energy*: locate the data centre remotely and transport data from users in the Netherlands to that remote data centre
  - *Energy-to-bits*: locate the data centre locally and transport 'green' energy from a remote location to the data centre
- SURF researched the consequences of the two scenario's. A conclusion is that in many data scenario's where the local data centre can import cleaner energy from elsewhere, the best course of action is to keep the data local and perform calculations locally.

Source: SURF, *Transporting Bits or Transporting Energy: Does it matter?, A comparison of the sustainability of local and remote computing,* May 2013



3. Healthy blood, healthy body: sector contribution

- International position/ranking
- Attractiveness and strengths
- Governmental policy
- A leading position through research
- Significance for the Dutch economy

International Position/Ranking & Attractiveness and Strengths

The international position of the Netherlands in Digital Infrastructure is strong, we are part of a leading group of countries and cities

Core Internet (Transit & IXS)

- The Amsterdam Internet Exchange (AMS-IX) is the largest Internet Exchange worldwide in terms of number of connected peering networks
- AMS-IX is the 2nd largest Internet Exchange worldwide in terms of traffic (gigabits per second)
- AMS-IX is a mainport for Internet traffic more than the port of Rotterdam and Schiphol are for containers and passengers respectively

Internet Access (ISP)

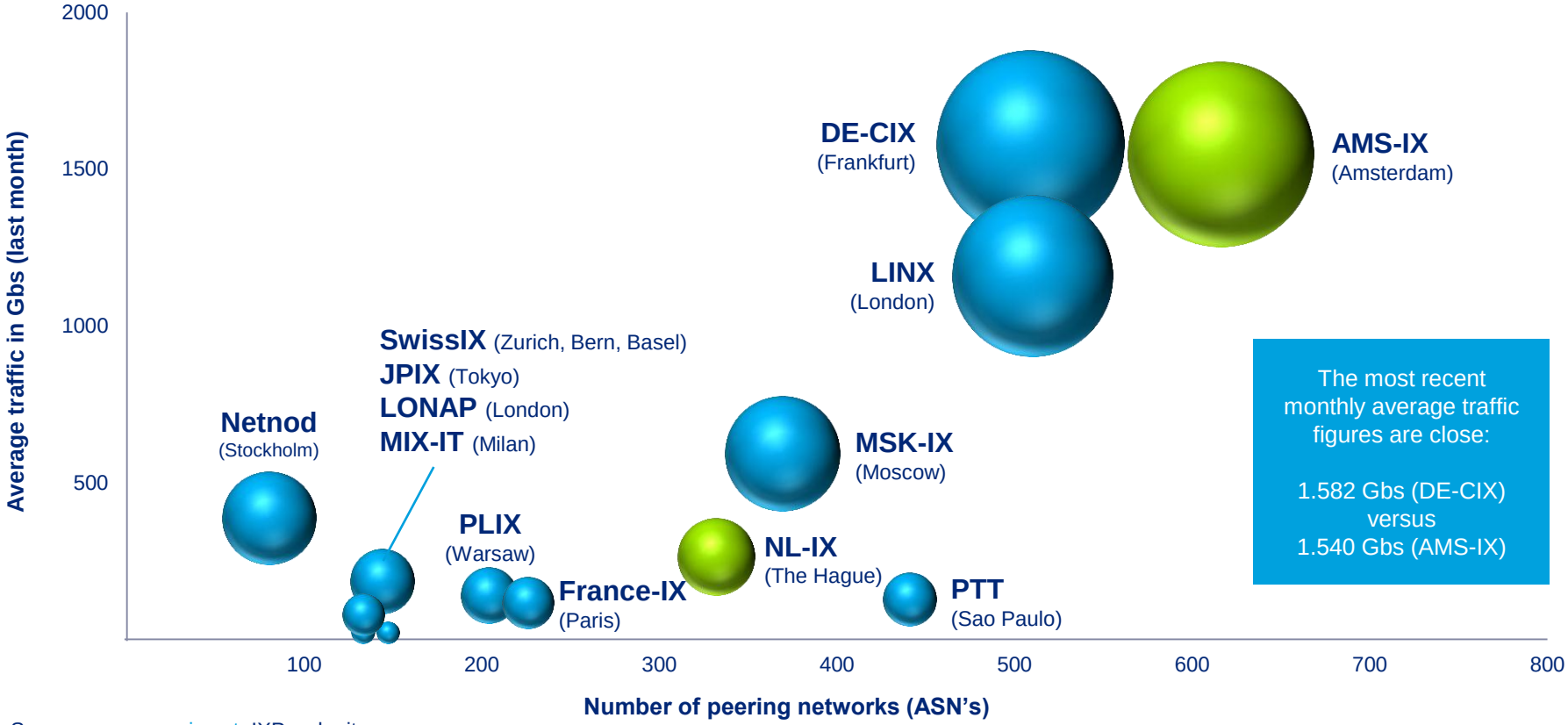
- The Netherlands scores 2nd place in EMEA and 6th place globally on broadband penetration and average measured connection speed

Data Centres (Housing & Hosting)

- Netherlands is among the leading co-location countries in Western Europe (4th place after UK, GE and FR), seen from the perspective of number of commercial data centres
- The Amsterdam region is part of a leading group of tier-1 data centres (together with London, Frankfurt and Paris) and shows the highest increase in square meters
    - Amsterdam is extremely well connected to the Internet submarine cables and large transit providers and realises the lowest pan-European latencies (together with London, Frankfurt and Paris)
    - Amsterdam has the required available capacity of electricity and high reliability of supply. Compared to EU average, industrial energy prices in Netherlands are favourable
    - Good accessibility (Schiphol) and a central location in Europe. Small country with a neutral position
    - Economic and political stability. Highly-educated and multilingual workforce. Focus on international trade. Favorable laws, regulations and tax climate

The Amsterdam Internet Exchange (AMS-IX) is the largest in terms of connected Autonomous System Numbers (ASN)

- The significance of an Internet Exchange is measured by (a) the number of peering networks (Autonomous System Numbers) and (b) the average Internet traffic (last year) measured in Gigabit per second.
- The graph shows these two metrics for the largest IXP's in the world (note: the IXP's from Equinix, Terramark and PTT Metro are not listed since traffic is not known).



Source: www.euro-ix.net, IXP web sites

AMS-IX is a mainport for Internet traffic more than Rotterdam and Schiphol are for containers and passengers respectively

Core Internet
Internet Access
Housing & Hosting
Enabling Services

Rank	Top internet exchanges (1) (by number of peering networks)	Top container ports (2) (by volume, 2012)	Top airports (3) (by passengers, 2011)
1	**AMS-IX**	Shanghai, China	Atlanta, USA
2	DE-CIX Frankfurt	Singapore, Singapore	Beijing, China
3	LINX	Hong Kong, China	London, UK
4	PTT Sao Paulo	Shenzhen, China	Chicago, USA
5	MSK-IX	Busan, South Korea	Tokyo, Japan
6	NL-ix	Ningbo-Zhoushan, China	Los Angeles, USA
7	Terremark	Guangzhou Harbor, China	Paris, France
8	PLIX	Qingdao, China	Dallas, USA
9	Equinix Zurich	Jebel Ali, Dubai, U.A.E.	Frankfurt, Germany
10	CoreSite - Any2 LA	Tianjin, China	Hong Kong, Hong Kong
11	SwissIX	**Rotterdam, Netherlands**	Denver, USA
12	JPIX	Port Kelang, Malaysia	Jakarta, Indonesia
13	France-IX	Kaohsiung, Taiwan, China	Dubai, U.A.E.
14	LONAP	Hamburg, Germany	**Amsterdam, Netherlands**
15	MIX-IT	Antwerp, Belgium	Madrid, Spain

Source (1): www.euro-ix.net
Source (2): www.worldshipping.org
Source (3): www.aci.aero

NL scores high on broadband penetration and average measured connection speed

Core Internet
Internet Access
Housing & Hosting
Enabling Services

High broadband (>10 Mbps) penetration

Netherlands ranked 2nd EMEA country in high broadband penetration (>10 Mbps)

Global Rank	Country	% above 10 Mbps
5	Switzerland	30%
6	**Netherlands**	**29%**
7	Sweden	25%
9	Czech Republic	23%
10	Finland	21%
11	United Kingdom	20%
12	Norway	20%
13	Denmark	20%
14	Belgium	19%
16	Romania	19%
19	Austria	15%
22	United Arab Emirates	13%
23	Germany	13%

High average measured connection speed

Netherlands ranked 2nd EMEA country in average measured connection speed (Mbps)

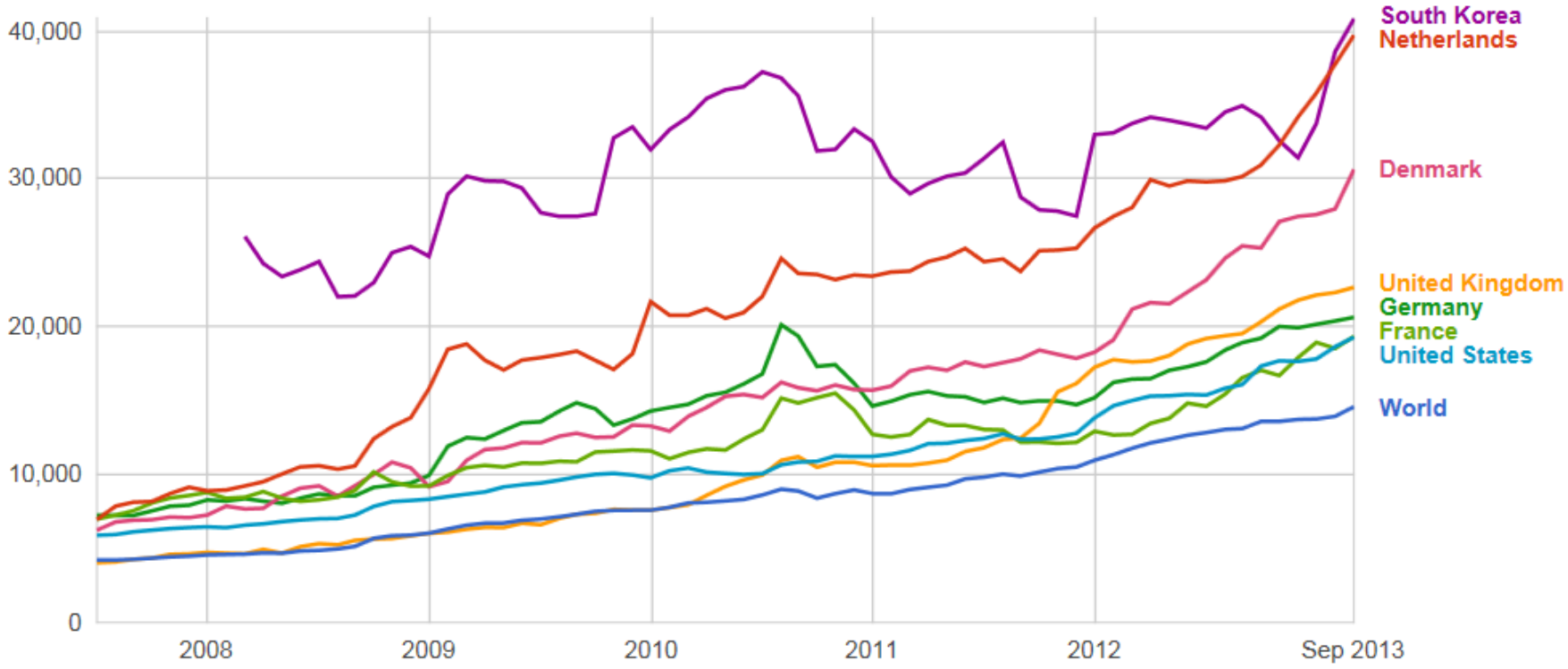
Global Rank	Country	Avg. conn. speed (Mbps)
4	Switzerland	10.1
5	**Netherlands**	**9.9**
7	Czech Republic	9.6
8	Sweden	8.9
10	Denmark	8.2
11	Austria	7.9
12	United Kingdom	7.9
14	Finland	7.7
15	Romania	7.5
16	Norway	7.4
17	Belgium	7.4
18	Ireland	7.3
19	Israel	7.0

Source: Akamai, *The State of the Internet*, 1st Quarter, 2013 Report (volume 6, number 1)

Netherlands outperforms the world average for increase of download speed in kbps

Core Internet
Internet Access
Housing & Hosting
Enabling Services

- Netherlands is a frontrunner in average download speed in kbps, it performs on the same level as South-Korea which is often mentioned as worlds leading country in this respect.



Source: http://www.netindex.com/source-data (Data from Net Index by Ookla)

Netherlands is among the leading colocation countries in Europe, judged by the number of commercial data centres

Core Internet
Internet Access
Housing & Hosting
Enabling Services

Country rank	Country	Number of data centres
1	United Kingdom	195
2	Germany	142
3	France	126
4	**Netherlands**	**74**
5	Switzerland	55
6	Spain	42
7	Italy	38
8	Russia	36
9	Romania	32
10	Sweden	30
11	Belgium	29
12	Turkey	29
13	Denmark	28
14	Poland	27
15	Portugal	22
16	Bulgaria	17
17	Czech Republic	16
18	Ireland	15

Country rank	Country	Number of data centres
19	Norway	13
20	Slovakia	13
21	Luxembourg	12
22	Austria	10
23	Greece	9
24	Hungary	8
25	Cyprus	7
26	Malta	7
27	Slovenia	7

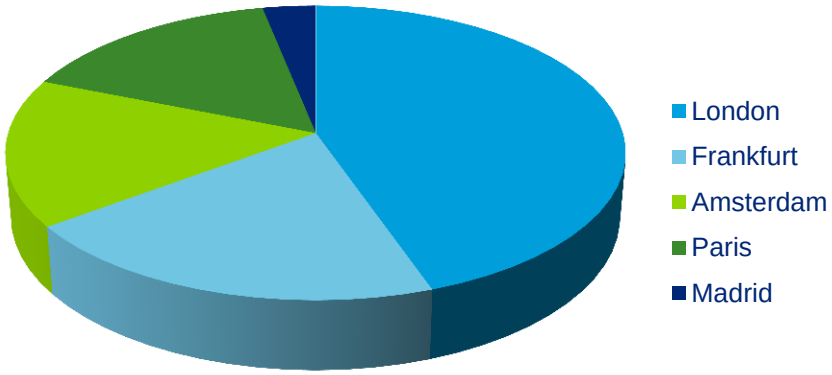
Source: http://www.datacentermap.com/datacenters.html

The Amsterdam region is part of a leading group of tier-1 data centres and shows the highest increase in square meters

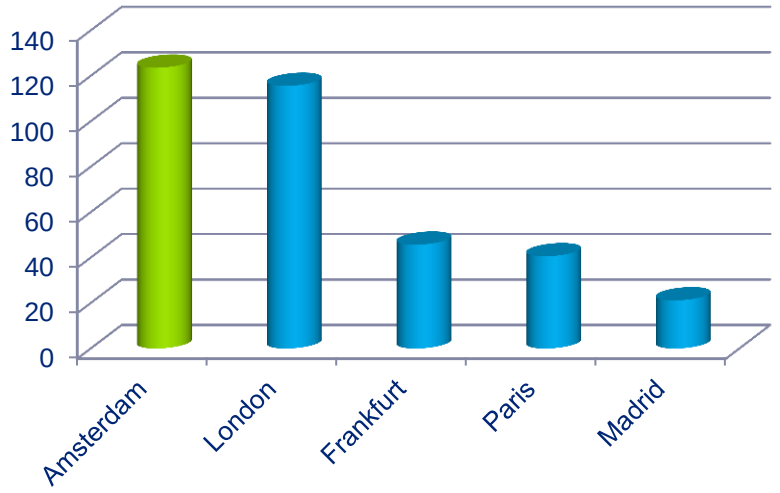
Region	Supply MW	Supply m^2	Availability m^2	Increase last year	Supply m^2 per b€ GDP
London	283	282,079	52,379	5,6%	115,6
Frankfurt	128	155,572	21,120	3,3%	45,7
Paris	100	106,174	12,582	8,6%	40,6
Amsterdam	**103**	**95,429**	**15,294**	**19,5%**	**123,6**
Madrid	20	28,564	857	3,4%	21,2

- London, Frankfurt, Paris and Amsterdam form the leading group of colocation data centres hot spots in Europe
- There is a large distance between this leading group of four and the runner up on position 5
- Measured in colocation supply m^2 per b€ GDP, Amsterdam exceeds all other cities
- Amsterdam has shown the largest increase in the past year

Co-location supply (in MW)



Co-location supply m^2 per b€ GDP



Source: CBRE, European Data Centres MarketView, Q2 2013

This position is the result of the combination of several criteria for data centre location decisions

Internet Connectivity

1. Extremely well connected to the core internet (submarine cables)
   a) Lowest latency to other major internet hubs
   b) Large available bandwidth
2. Presence of all major carriers and AMS-IX

Energy

3. Availability of required electricity capacity (production & distribution)
4. Reliable power supply
5. Favourable electricity prices (compared to EU average)

Geographical location

6. Good accessibility (Schiphol), central location in Europe
7. Small country with a neutral position

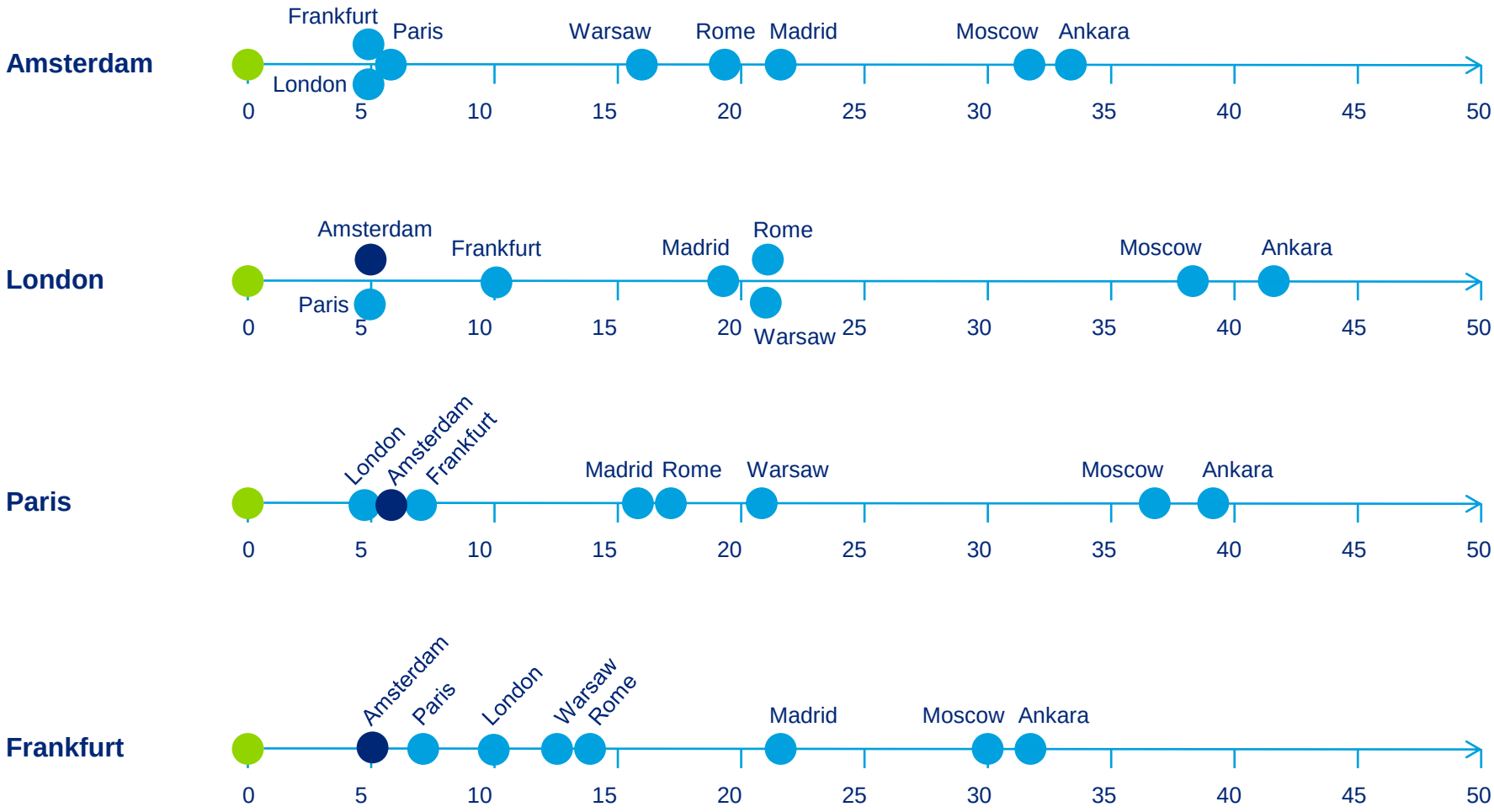
Political and economical climate

8. Economic and political stability
9. Highly-educated and multilingual workforce
10. Focus on international trade
11. Favourable laws and regulations
12. Favourable tax climate

- The market for data centres is characterised by a combination of large global players (e.g. Telecity, Equinix) and many smaller local providers (Netherlands only)
- The presence of most major global data centre providers in Amsterdam proves the attractiveness of the Netherlands
- This attractiveness of the Netherlands (and the Amsterdam region in particular) is a combination of several causes of which the most significant are listed on the left

Amsterdam realises the lowest pan-European latencies

Core Internet
Internet Access
Housing & Hosting
Enabling Services



Source: Gartner, *Where in Europe to Colocate?*, 16 April 2012

Compared to the other tier-1 locations (London, Paris, Frankfurt, Madrid) energy prices in Netherlands are favourable

Region	Energy price EUR per MWh
London, UK	109.7
Frankfurt, Germany	89.5
Paris, France	80.9
Amsterdam, Netherlands	**80.5**
Madrid, Spain	115.5

- The costs of electricity can make up to 30% of the running costs of a data centre
- Energy prices are therefore one of the significant factors in the decision where to locate a data centre
- In 2012, energy prices for industrial consumers were favourable.

Source: Eurostat, Electricity prices for industrial consumers, EUR per kWh, 2012

Governmental policy

The Dutch government has a stimulating policy towards founding new IT companies in the Netherlands

Ministerie van Economische Zaken

- The Dutch Ministry of Economic Affairs recently formulated the strategic plan "*Digital Gateway to Europe*". The objective of this plan is to attract, retain and expand foreign investments in IT companies in the Netherlands. In the next four years, NFIA aims to attract at least 20 new IT-companies.
- The rationale behind this strategy is IT being one of the drivers of economic growth as IT is increasingly interwoven with business processes and economical top sectors. The strategic plan states: the stronger Dutch IT clusters become by attracting foreign IT-companies, the better economical top sectors can be served with innovative solutions, knowledge and expertise.
- NFIA identified three sectors at which the efforts will be targeted:
  - Cloud computing / Data centres
  - Gaming
  - Cyber security

Netherlands Foreign Investment Agency

- The **Netherlands Foreign Investment Agency** is an operational unit of the Dutch Ministry of Economic Affairs. Its goal is to support companies from all over the world to successfully establish their business in the Netherlands.
- The NFIA was established for the specific purpose of helping and advising such companies by providing them with advice, information and practical assistance, quickly and on a confidential basis, as well as providing them access to a broad network of business partners and government institutions, all free of charge.

Source Agentschap NL Ministerie van Economische zaken, *Strategisch aanvalsplan The Netherlands: Digital Gateway to Europe*, July 2, 2013
Source: www.nfia.nl

The Amsterdam local government recently reconfirmed its positive attitude in a new data centre location policy

Gemeente Amsterdam

- In 2001, the city of Amsterdam formulated a location policy for data centres for the first time. In the decade there after, the Amsterdam region has grown to a digital infrastructure hot spot due to presence of AMS-IX and c. 100,000 m^2 data centre colocation facility.
- The Amsterdam City Council has the ambition to retain this leading position and to attract new digital infrastructure companies. Simultaneously, Amsterdam wants to stimulate efficient use of energy and space.
- Recently (October 29, 2013), the Amsterdam City Council approved a new data centre location policy as the foundation for these ambitions. Head lines are:
  - ✓ From a spatial planning point of view, data centres are allowed at every location designated as "business" area in the zoning plan. Use of existing empty real estate is preferred over new build
  - ✓ New colocation data centres must have a Power Usage Efficiency (PUE) factor on or below 1.2
  - ✓ The City Council will increase knowledge of the sector at employees via period training sessions.
  - ✓ Potential new data centres will be supported by a special team in which all relevant disciplines are involved (e.g. spatial planning, environmental, building permit & architectural advisory)
  - ✓ Structural consultations between city officials and the energy distribution company Alliander are started to coordinate extension of the electricity distribution network in anticipation of expected future colocation facilities

Data centres in the region are in general between 3,000 m^2 and 10,000 m^2 (with outliers of 30,000 m^2 and more)

Amsterdam expects an increase in colocation supply of 20.000 m^2 per year

New data centres must have a PUE < 1.2

Energy saving initiatives will save 68,000,000 KWh in the period 2013-2016

Source Gemeente Amsterdam Dienst Ruimtelijke Ordening, *Vestigingsbeleid datacenters: De Amsterdamse regio als Green Data Port*, October 29, 2013

However, other countries like Sweden and Luxembourg also have an active policy towards attracting large new data centres

Sweden
- green energy -

- The **Swedish Data Center Initiative** is a project managed by a group consisting of Swedish regions and commercial partners .
- The mission of the initiative is to position Sweden as a top choice for enterprises considering international expansion in strategic, large-scale data centres.
- The Swedish Data Center Initiative positions Sweden as a favourable choice for the following reasons:
  - Low and reliable electricity prices
  - Power supply is 100% green
  - Extremely robust electricity grid & infrastructure
  - Power production surplus
  - Excellent communications infrastructure
  - Attractive corporate, real estate and investment tax schemes
  - Outstanding engineering and ICT skills
  - Favourable climate for free cooling
  - Accelerated due diligence and site selection
  - Security & stability - political, economical, physical

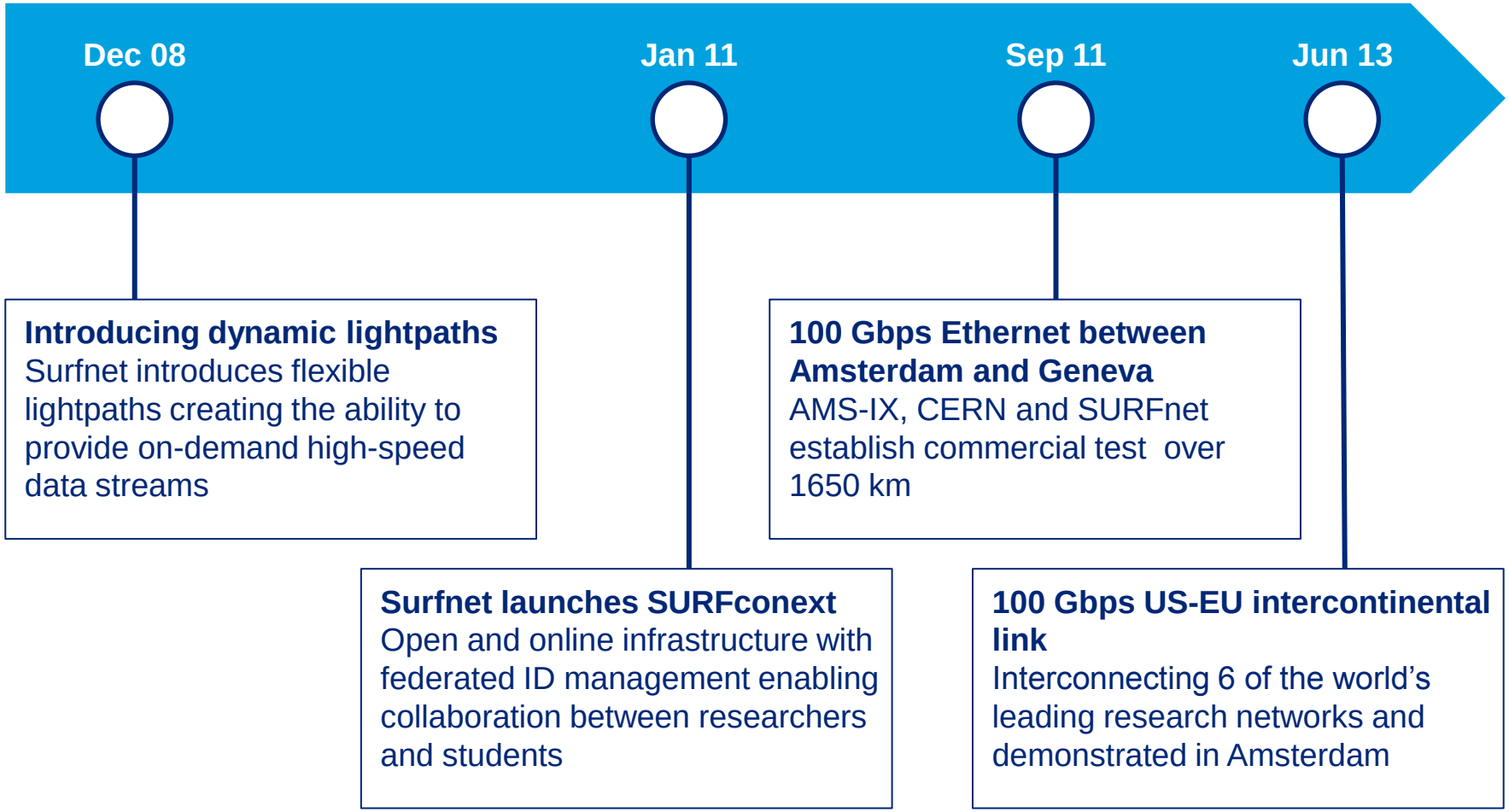
Luxembourg
- low latency -

- The **ICT division of Luxembourg for Business** provides companies with a “one-stop-shop” for detailed information on business opportunities in Luxembourg and hands-on administrative guidance and contacts in the ICT and media sectors.
- Luxembourg positions itself as one of the most modern data centre parks in Europe with low latency connections to all of the major European Internet hubs. Luxembourg claims to have one of the highest data centre densities in Europe and the world.
- Luxembourg is located in the middle of the so-called “Golden ring”, i.e. at close distance to the major Internet hubs of Europe: London, Amsterdam, Frankfurt and Paris.
- Low latency network connections are now available to a number of European destinations with round-trip times (RTT) around 5 ms (Amsterdam, Brussels, Frankfurt, London, Paris).
- Natural disasters such as earthquakes, floods or hurricanes are unknown to Luxembourg

Source: http://www.business-sweden.se/en/Invest/Industry-Opportunities/ICT/The-Data-Center-Initiative/
Source: http://ict.investinluxembourg.lu/ict/data-center-europe

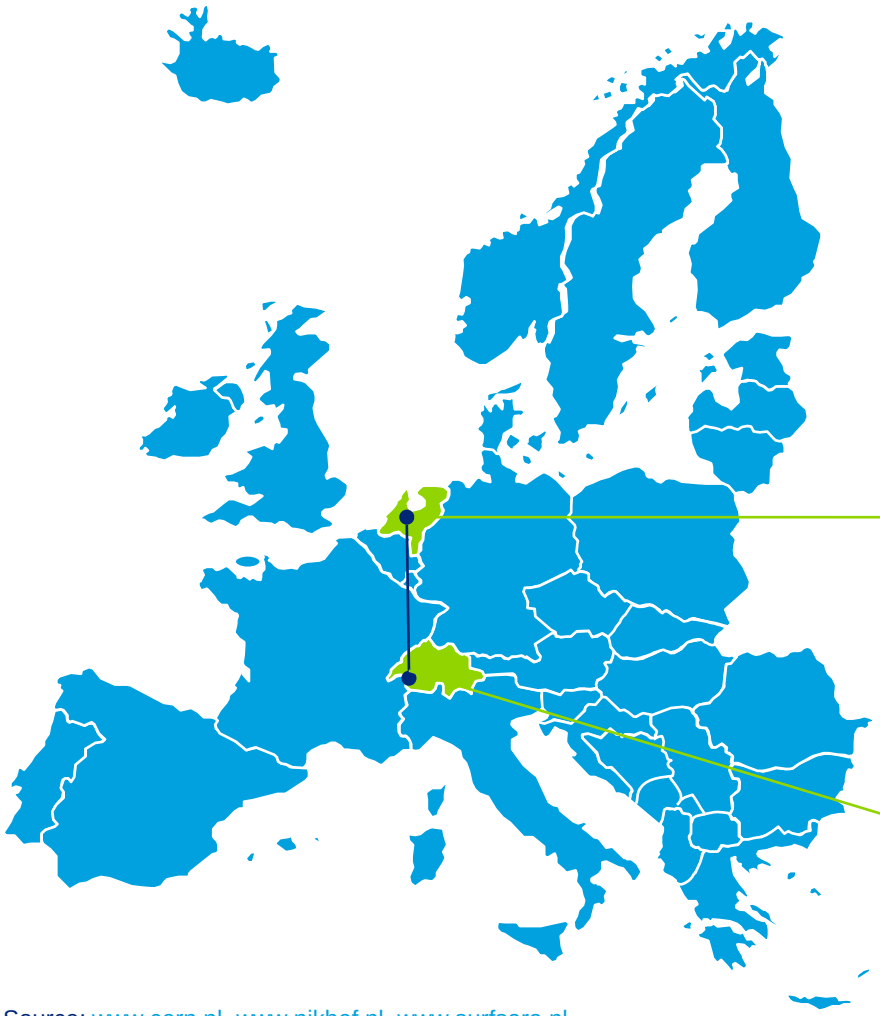
A leading position through research

The Netherlands international position is driven by a track record of continuous breakthroughs in Internet innovation



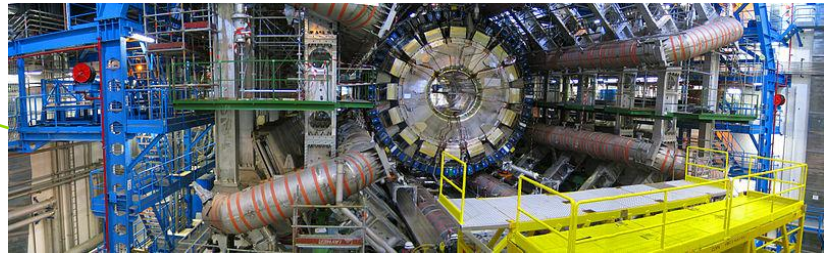
Source: SURFnet interview

NIKHEF and SURFsara serve as key data hub for world-wide research activities attracting further talent and excellence in research



- **CERN** executes large scale experiments in particle physics that produce enormous amounts of data
- Nikhef and SURFSara act as worldwide Tier-1 centres processing CERNs data
- An advanced high-speed (100 Gbs) network infrastructure between Geneva and Amsterdam is pre-conditional for transporting these large volumes of data

NIKHEF SURF SARA



Source: www.cern.nl, www.nikhef.nl, www.surfsara.nl

University of Groningen forms the centre for LOFAR data processing, facilitated by 80 Gbs high speed network connecting antenna stations

Source: www.lofar.org

- The **LOFAR** (Low-Frequency Array) radio telescope is the largest and most sensitive radio telescope in the world. Signals from a large number of small antennas are combined and manipulated in order to achieve extremely narrow beams and high sensitivity.
- The telescope consists of 40 phased-array stations spread over an area with a diameter of 100 km in the northern part of the Netherlands, as well as eight international stations maintained by partner institutions in Germany, France, Sweden and the United Kingdom.
- Full data processing and long term data archive is performed by a supercomputer at the University of Groningen.
- Data is transferred at a rate of 80 Gbs between telescopes and the Groningen super computer.

university of groningen

NL has always been an active contributor to Internet standardization but maintaining this role requires a new generation of experts

"The Netherlands has many important positions in internet standardization bodies like ICANN, IETF and RIPE. But a new generation is needed to take this role in the future"

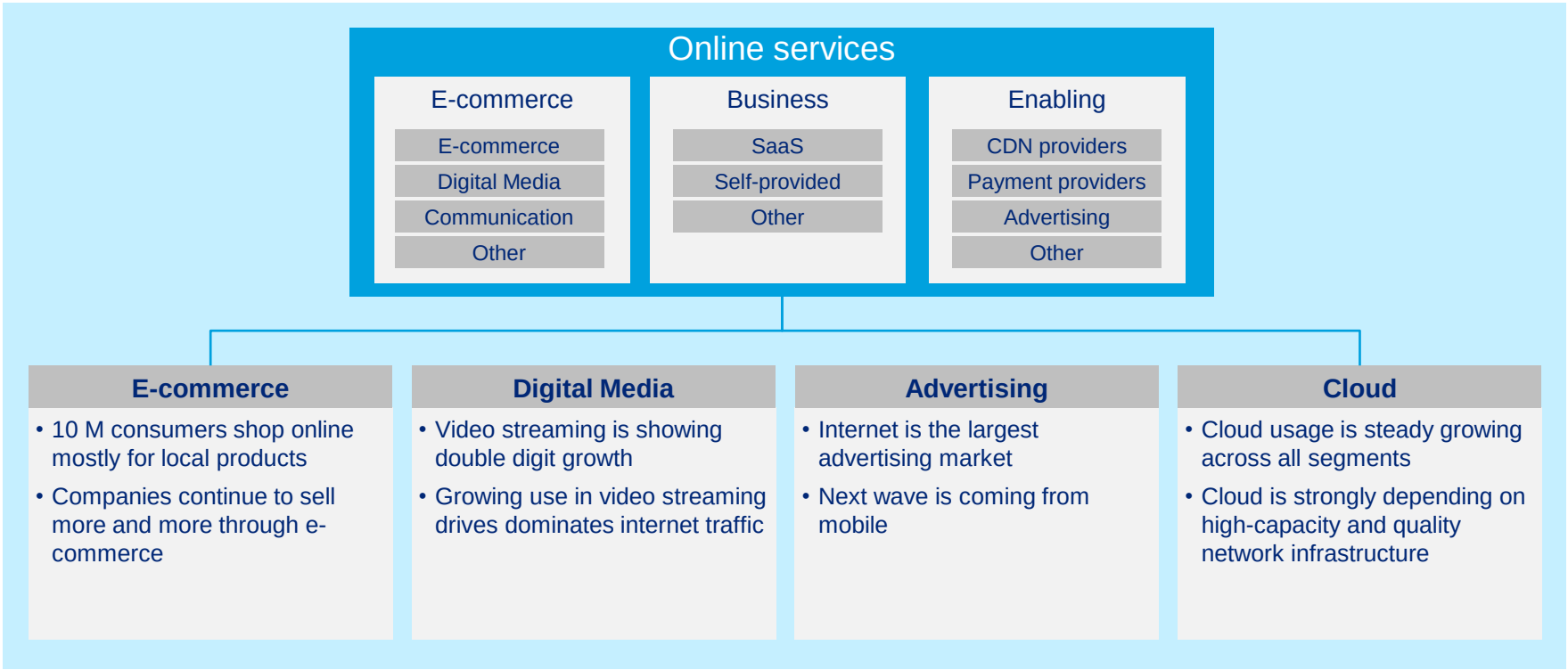
Erik Huizer – CTO Surfnet

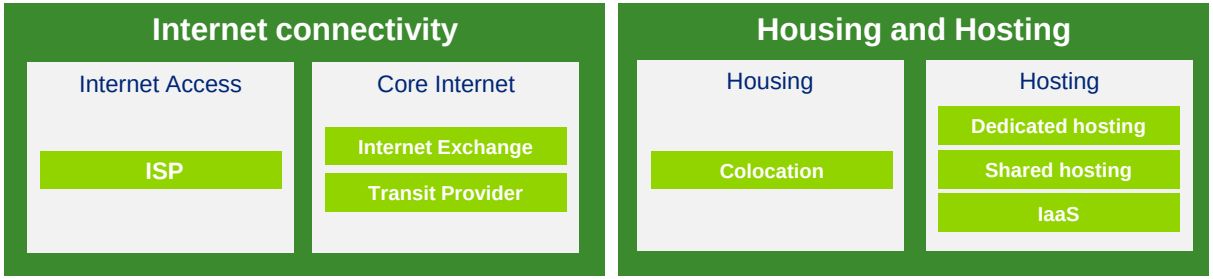
"Expertise on Internet technology is scarce and we often have to rely on the international resources to fill the positions in our organization"

Job Witteman – CEO AMS-IX

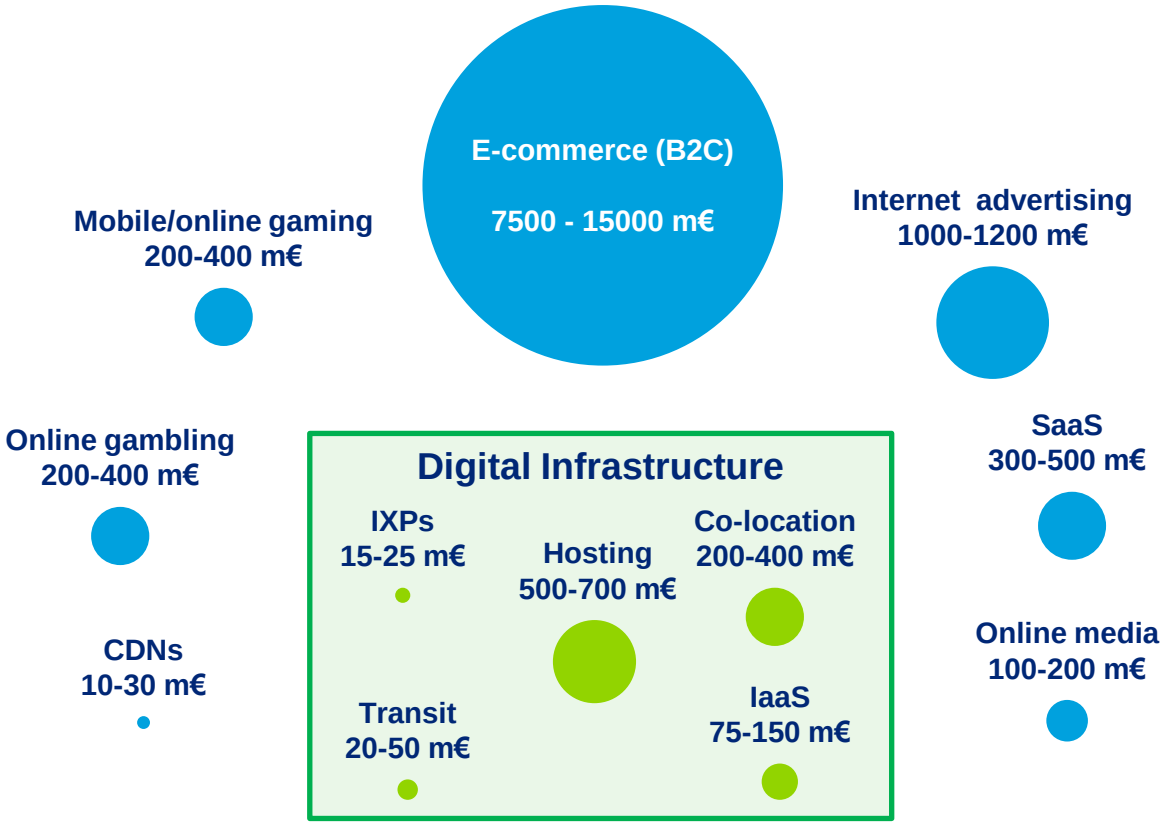
Significance for the Dutch Economy

The Digital Infrastructure sector is the foundation for a dynamic and expanding Online Services sector driving the Dutch economy





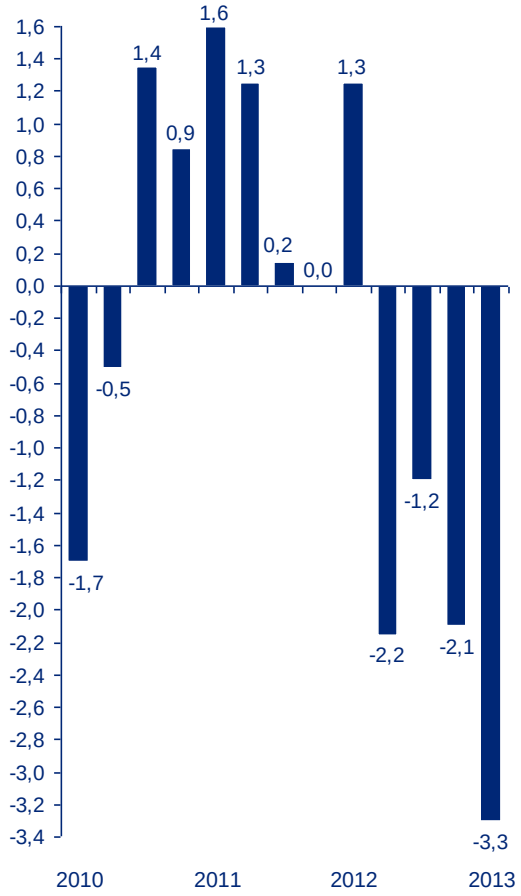
The economic value of the Online Services sector is 10 times the value of the Digital Infrastructure sector



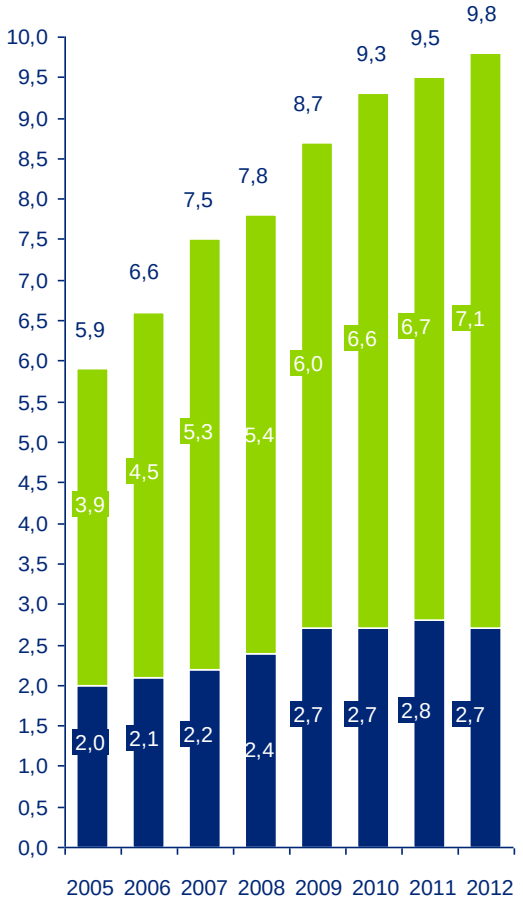
Source: Informa, Arthur D. Litte, Gartner, AMS-IX, Forrester, Deloitte analysis

While the overall NL retail sector is facing strong head winds, the number of e-shoppers is steadily growing and e-commerce revenues reach €10 bn

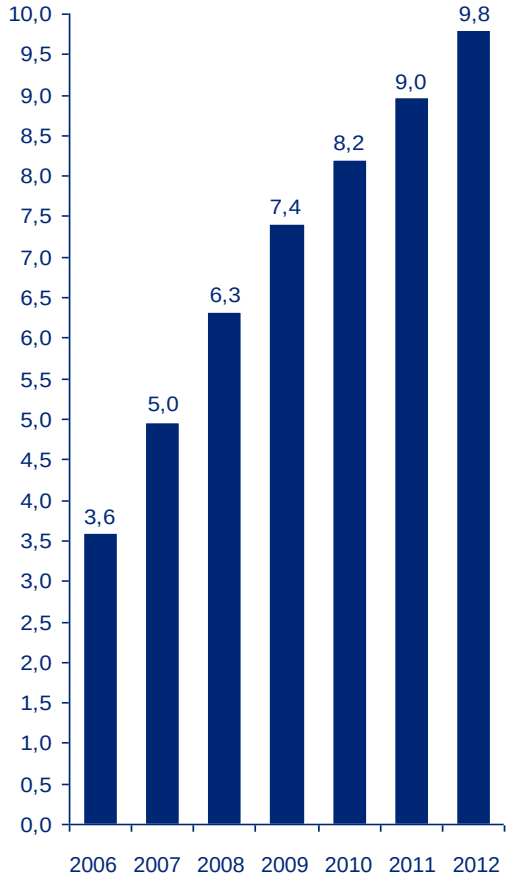
YoY change retail turnover (%)



Dutch e-shoppers (m)



B2C e-commerce turnover (€ bn)



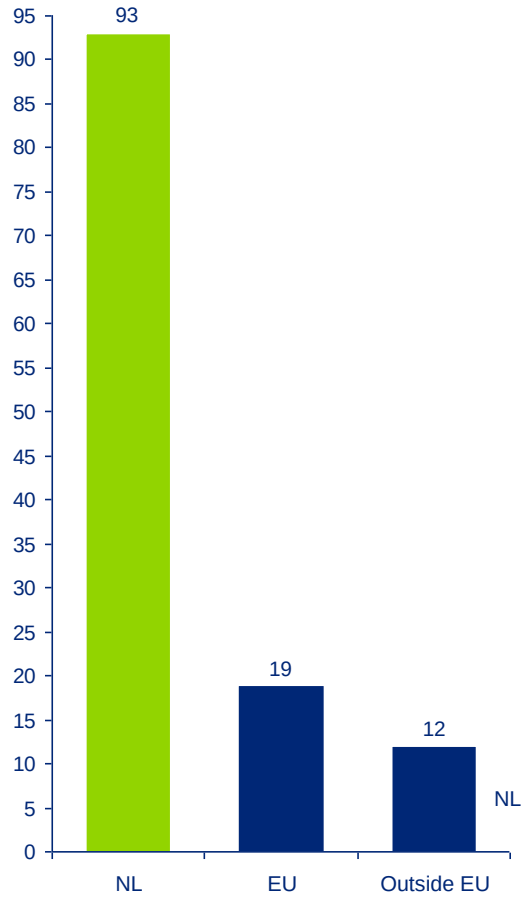
Source: CBS, TNO en Ministerie van Economische Zaken, *ICT, kennis en economie 2013*
Source: Ecommerce Europe

Frequent e-shopper
Less frequent e-shopper

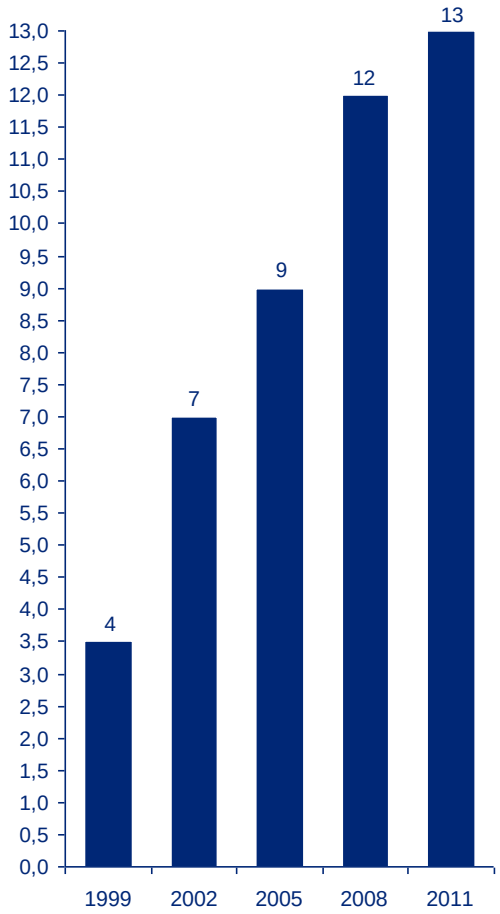
NL e-shoppers buy local goods, leading to companies more selling online and increased spending on solutions for e-commerce as software

E-commerce
Digital Media
Advertising
Cloud

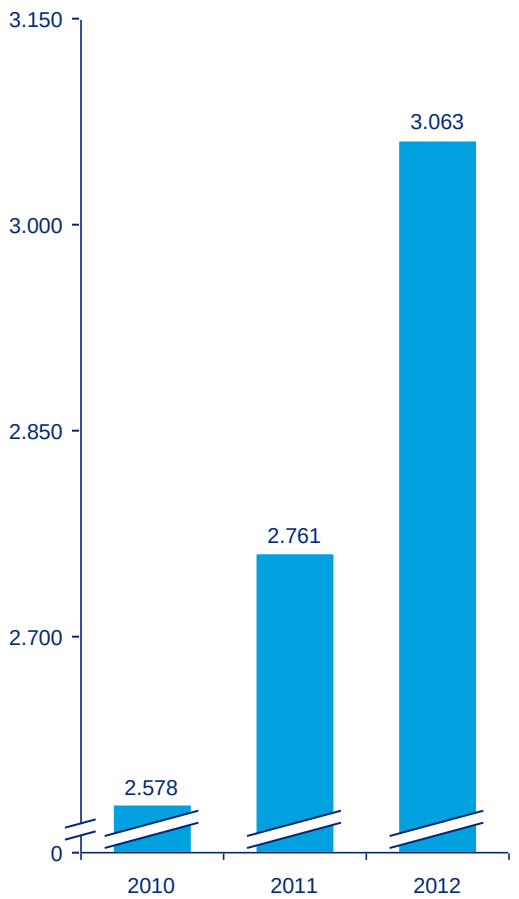
Percentage of e-shoppers buying NL, EU or WW goods (%)



% of revenues of NL companies via online



Spending on E-commerce software world wide ($ bn)

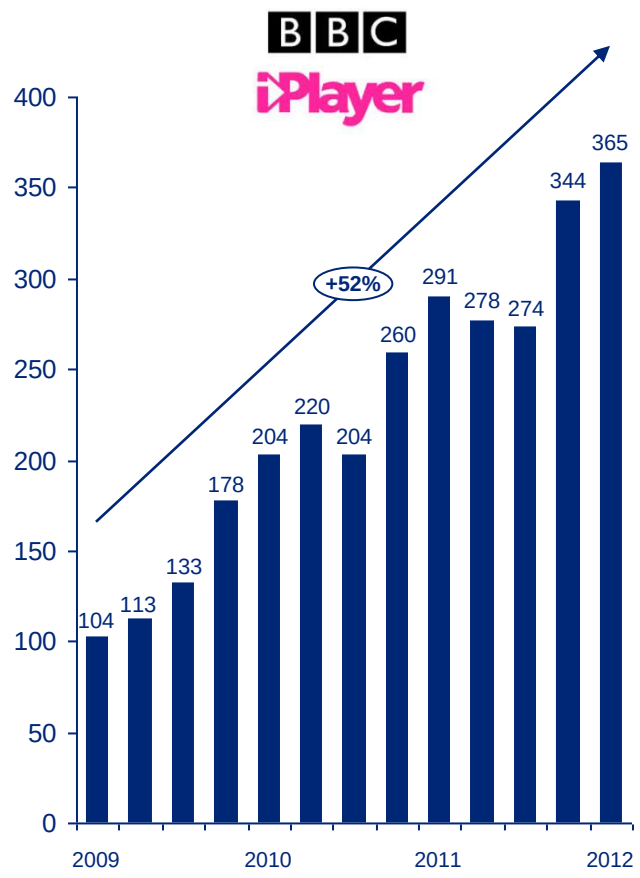


Source: CBS, TNO en Ministerie van Economische Zaken, *ICT, kennis en economie 2013*
Source: Gartner

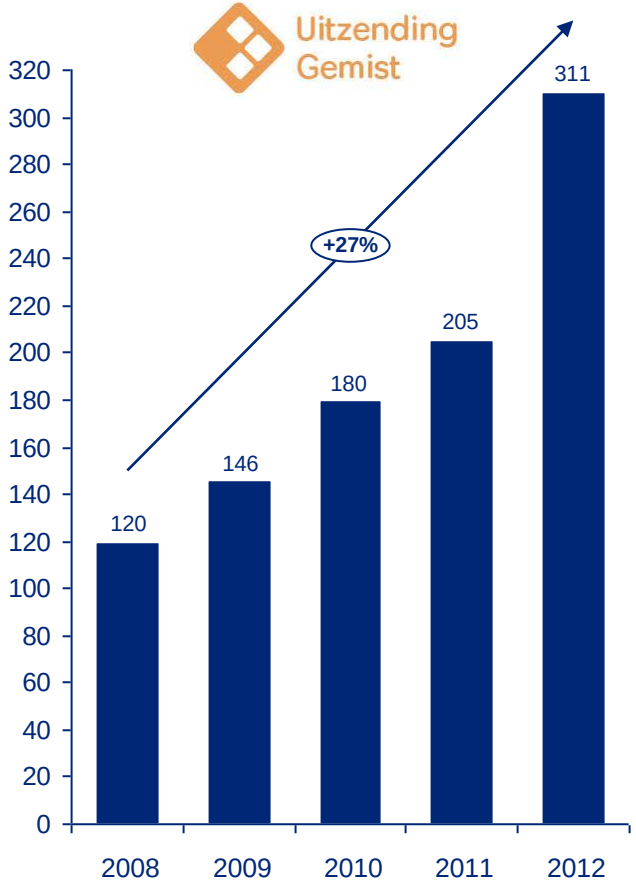
Worldwide video streaming is growing rapidly as illustrated by the BBC iPlayer and UitzendingGemist examples

E-commerce
Digital Media
Advertising
Cloud

Streaming requests – BBC iPlayer (m)



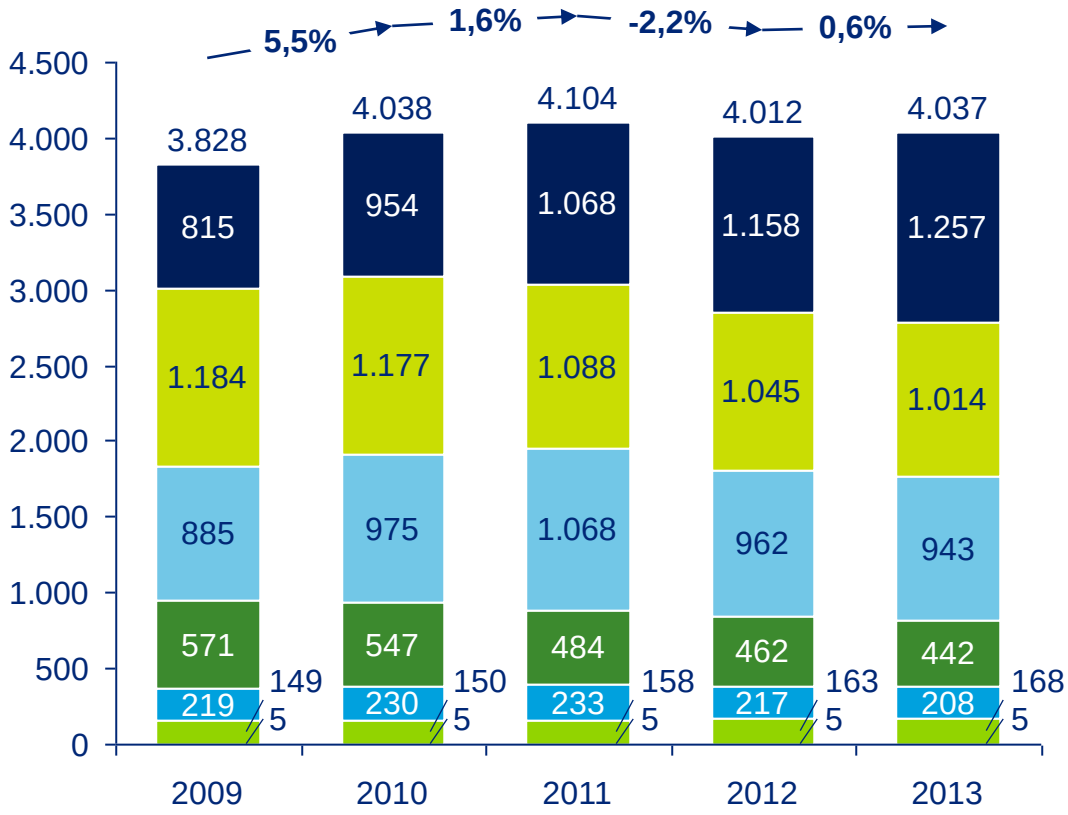
Streaming requests – Uitzending gemist (m)

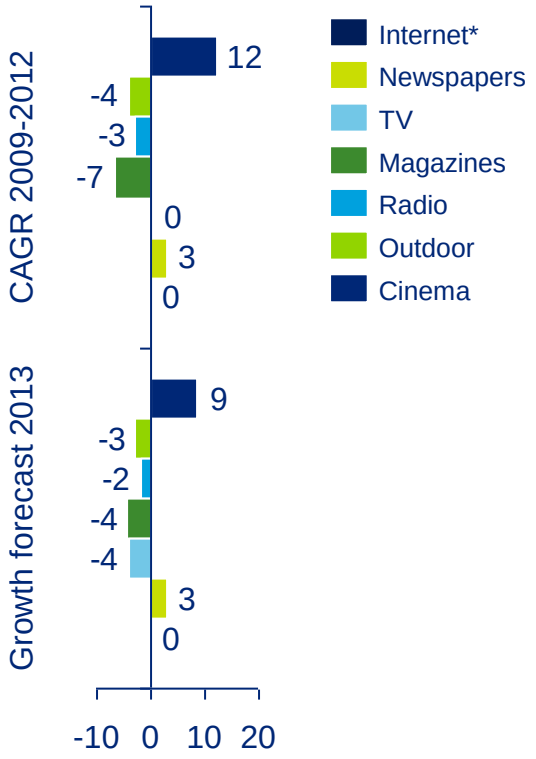


Source: BBC, NPO, Deloitte analysis

Internet is the largest advertising market and continues to grow and outperform other mediums

Estimated advertising market NL (€m)

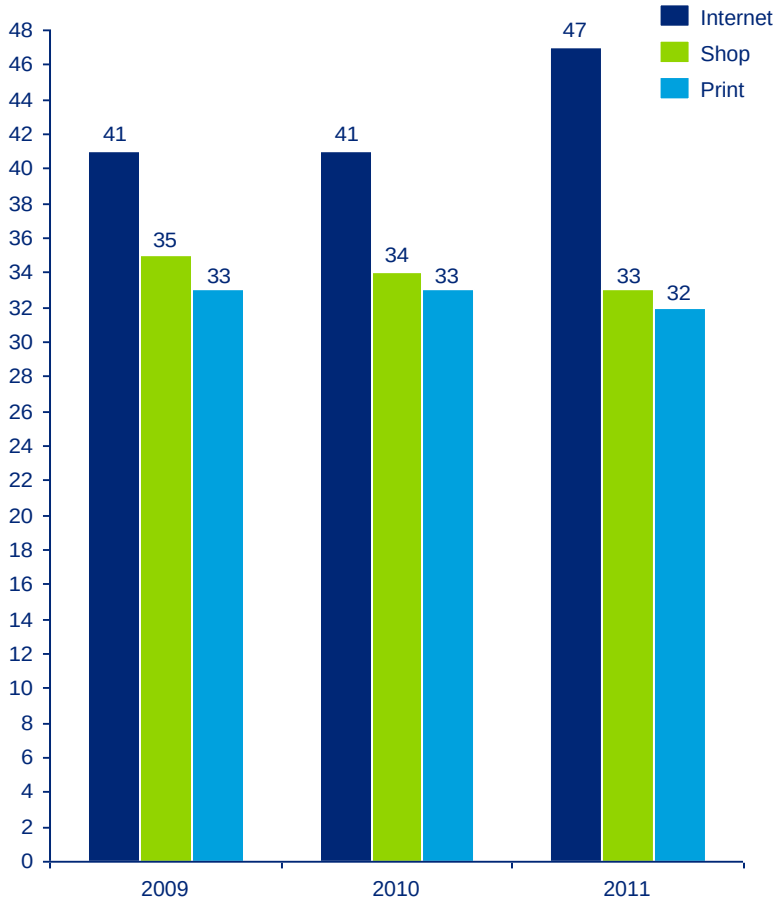




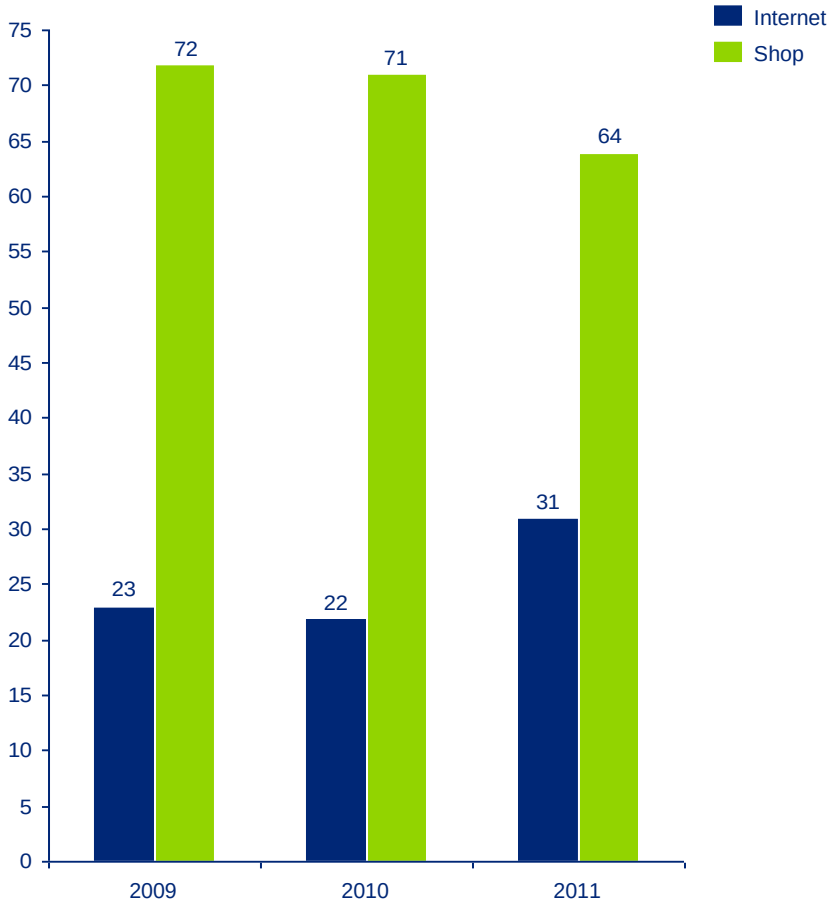
Source: IAB, Deloitte, *IAB report on Online Ad Spend*

This is driven by the fact that product search and orientation is already dominated by the web and online purchasing is getting a larger share

Product search/orientation per channel (%)



Product purchase per channel (%)

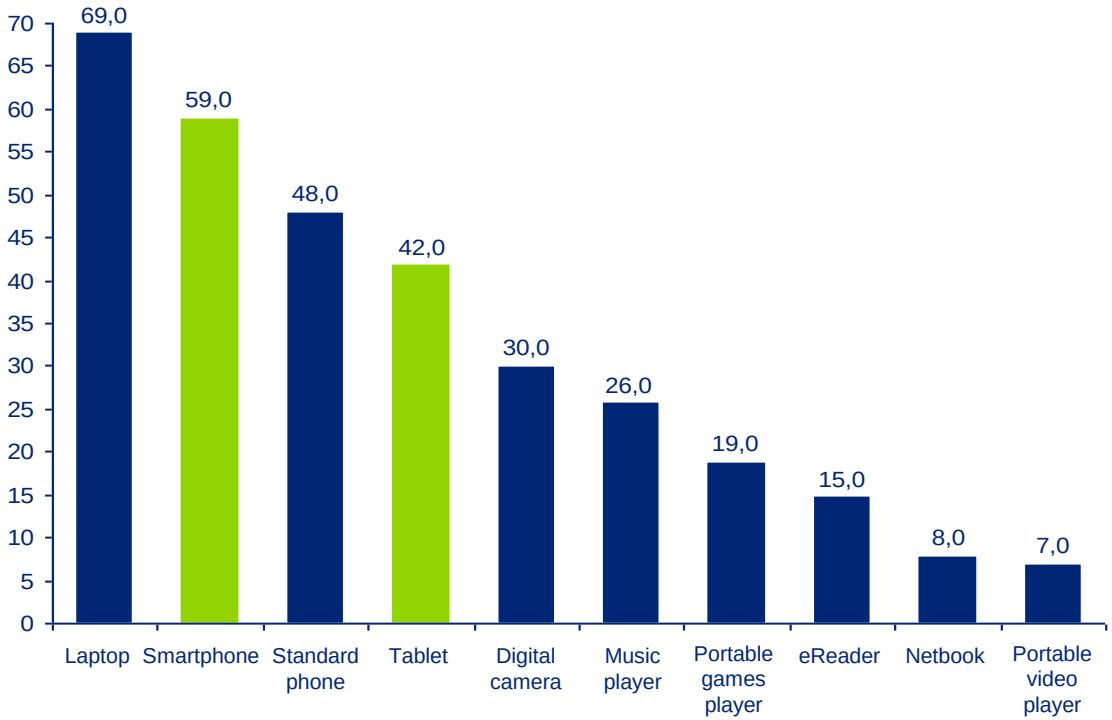


Source: HBD – Multichannel Monitor 2011

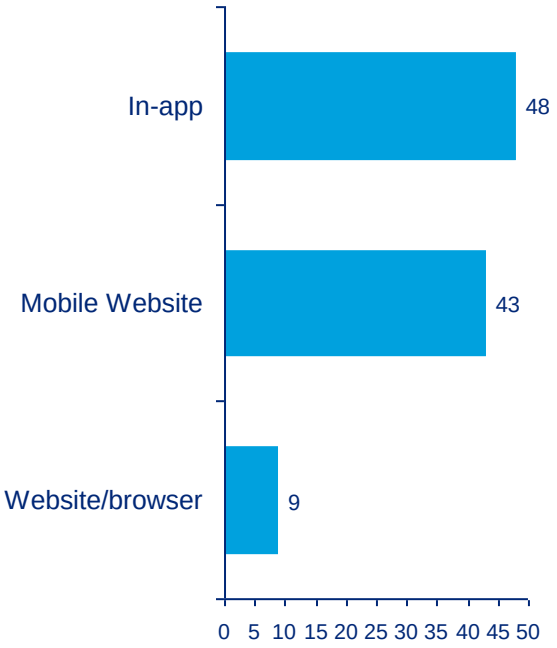
The next wave is coming from mobile with in-app and mobile website advertising driven by a growing availability of smartphone and tablets

E-commerce
Digital Media
Advertising
Cloud

Device accessibility and ownership NL consumers (%)



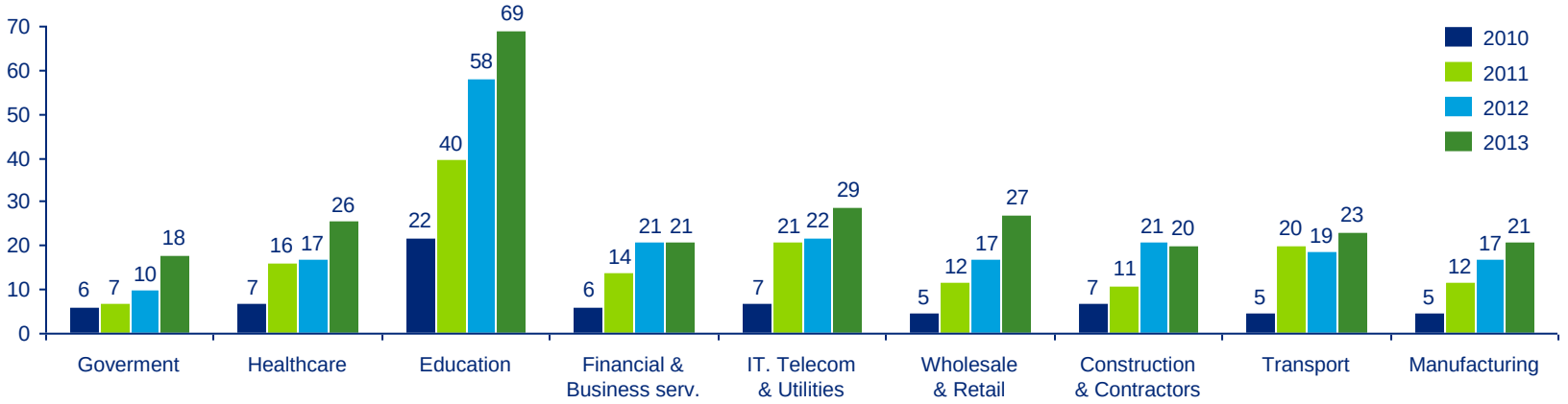
Growth expectations advertising (%)



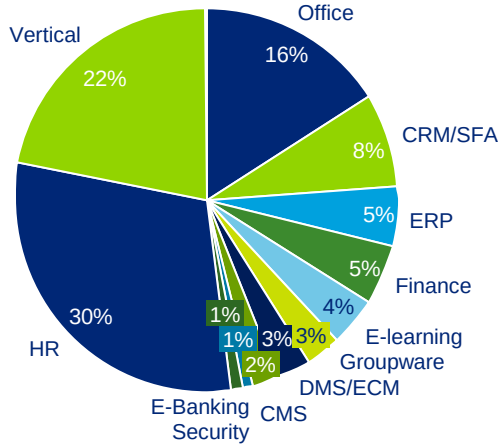
Source: Deloitte, *Global Mobile Consumer Survey Netherlands*
Source: IAB, Deloitte, *IAB report on Online Ad Spend*

As the use of cloud services by Dutch companies continues to grow, companies are more working in the online environment

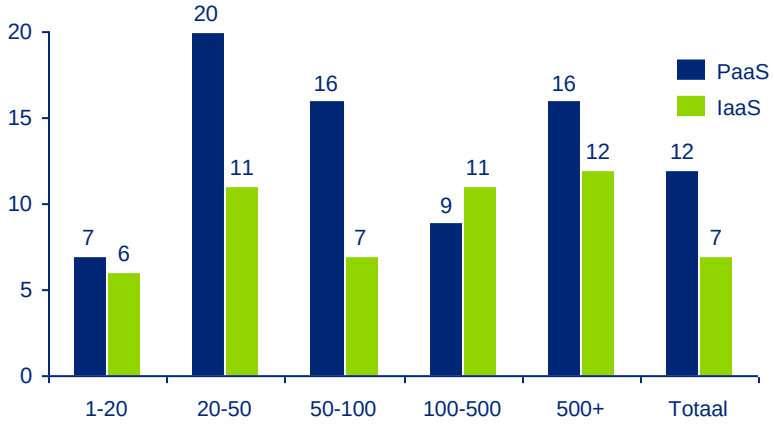
Saas development NL (%)



SaaS applications in use (%)



PaaS and IaaS usage per company size (%)



Source: Computer Profile, Heliview, Computable

4. Future of the sector

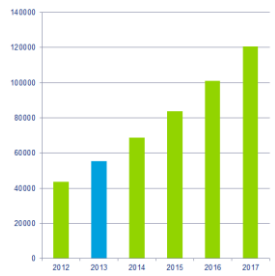
- Drivers for growth
- Conclusions
- Recommendations

Drivers for growth

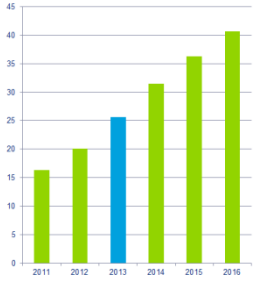
The Digital Infrastructure sector expands at double digit rates and will continue to do so in the next years

The Digital Infrastructure market will consistently show substantial growth rates during the next years

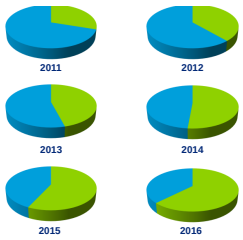
Global IP traffic doubles between 2013-2017



Total data centre workload increases with 66% between 2013-2016



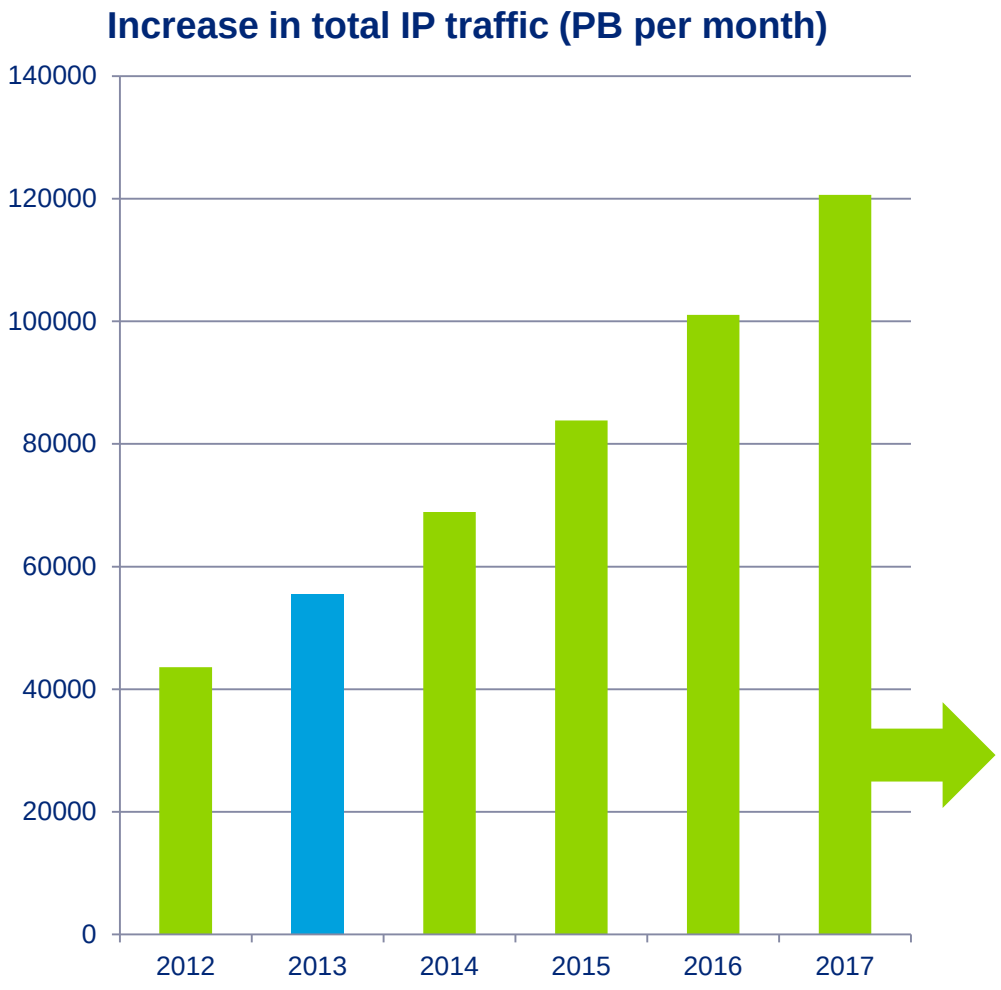
The share of total workload processed by cloud data centres increases to 62% in 2016



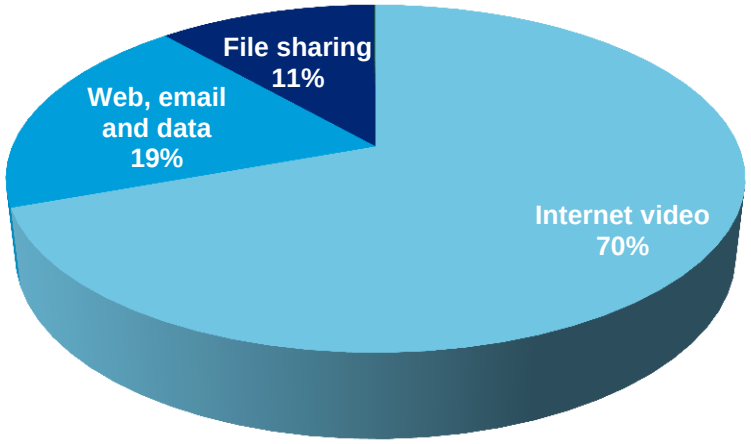
A combination of technology trends is expected to cause an huge increase of IT capacity

- Cloud Computing
- Big Data
- The Internet of Things

Global IP traffic doubles during 2013-2017 with an annual growth rate of 23%



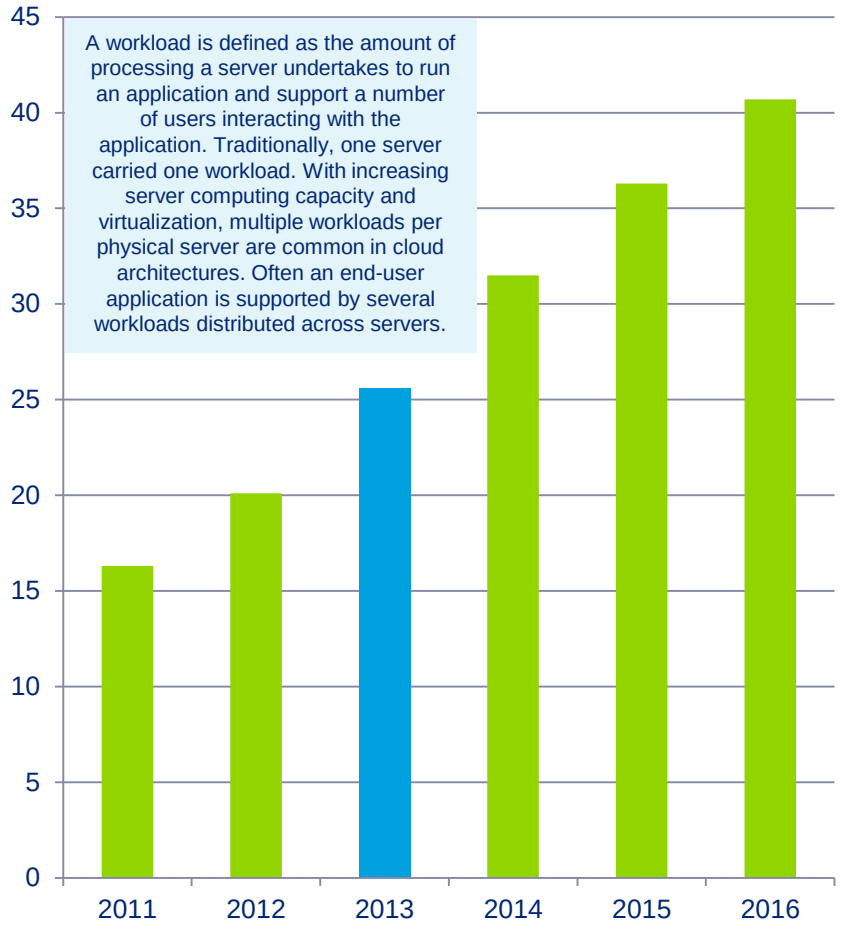
- Overall, IP traffic will grow at a compound annual growth rate (CAGR) of 23 percent from 2012 to 2017
- Traffic from wireless and mobile devices will exceed traffic from wired devices by 2016
- The number of devices connected to IP networks will be nearly three times as high as the global population in 2017
- Globally, consumer Internet video traffic will be 69 percent of all consumer Internet traffic in 2017, up from 57 percent in 2012



Source: Cisco, *Visual Networking Index: Forecast and Methodology, 2012–2017*, (2013)

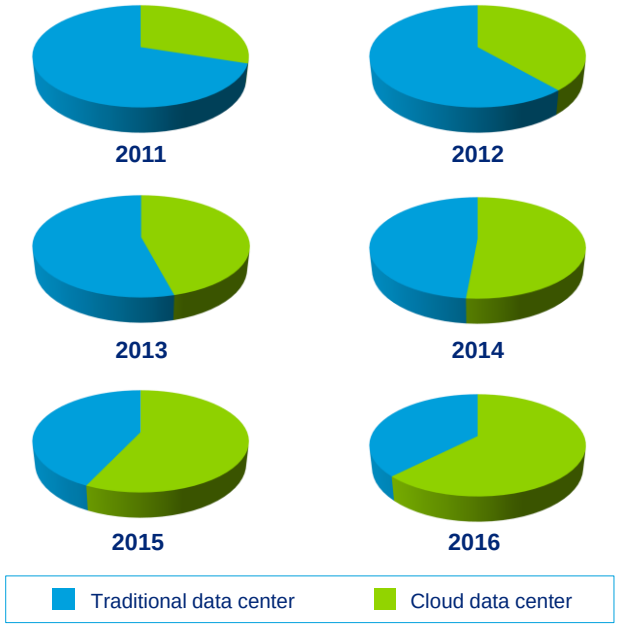
Total data centre workload in Western Europe increases with 60% between 2013-2016 at an annual growth rate of 20%

Total data centre workloads (in Millions)



- The total number of data centre workloads in Western Europe will grow from 25.6 million in 2013 to 40.7 million in 2016 (c. 60% growth)
- Simultaneously, a transition of workloads from traditional data centres to cloud data centers is taking place. By 2016, nearly two-thirds of all workloads will be processed in a cloud data centre

Share of Cloud Data Centers in total workload



Source: Cisco, *Global Cloud Index, Forecast and Methodology, 2011-2016* (2012)

A combination of technology trends is expected to cause a huge increase of IT capacity

Cloud Computing

Software as a Service (SaaS) is application software provided as a web-application, used in a multi-tenant model and purchased on a pay-for-use basis. By now, SaaS has entered mainstream technology.

Our expectation is that SaaS will grow substantially in functional areas like CRM and HR. Increasingly, companies will have the choice between a cloud solution that can be ready in days and an internal software implementation project that takes months.

Many companies that have always taken those implementation projects for granted will now choose for SaaS solutions instead. The number of employees who only use cloud solutions (office automation and some enterprise applications) will increase significantly.

Big Data

Big data is data which is too large to be processed by traditional database management and analysis tools.

Instead, big data requires a distributed approach with parallel software running on large numbers of servers.

Apart from volume, other characteristics of big data are: velocity (rapidly changing) and variety (heterogeneous content).

The increasing use of big data will have impact on required storage, bandwidth and processing power.

The Internet of Things

The Internet of Things is a concept in which a multitude of physical objects is equipped with sensors and Internet connection. The result is an ecosystem of ‘smart objects’ that become active participants in digital supported processes.

Once the Internet of Things becomes reality, it will generated huge volumes of data which in turn requires the processing power to turn this data into meaningful decisions and actions.

Large expected increase in required Digital Infrastructure capacity

Conclusions and Recommendations

The Digital Infrastructure is our third main port ('data port') and the arteries for economic lifeblood of the expanding digital economy

- **NL has a leading position in the world and forms an attractive location for digital infrastructure**
  - AMS-IX is the largest Internet Exchange in the world in terms of connected peering networks and the 2nd largest in terms of traffic (gigabits per second)
  - AMS-IX is a mainport for the Internet more than Rotterdam and Schiphol are for containers and passengers
  - NL scores 2nd place in EMEA and 6th place globally on broadband penetration and average connection speed
  - NL is among the leading data centre co-location countries in Europe (together with UK, GE and FR) and Amsterdam is showing the fastest growth in m^2
  - Despite a 25%-35% compound growth rate of server performance, data centre colocation floor space nearly doubled in the past six years
- **Our country has achieved this by acting as innovator/early mover and creating the right pre-conditions**
  - Being a first in Internet innovation and by active participation in Internet communities
  - Open and neutral environment without market domination
  - Open market for Internet services and early adapter user community
- **The NL Digital infrastructure is the foundation for the expanding digital economy and society**
  - Digital services become an ever larger part of our economy; in a slow economical climate our digital economy and society is growing significantly
  - A superior Digital Infrastructure is pre-conditional for growth of our digital economy. The Digital Infrastructure hot spots (London, Frankfurt, Paris, Amsterdam) are magnets for high-tech web centric companies
  - The Digital Infrastructure sector has been the nursery for new Dutch technology enterprises which have grown at a very fast pace in short time and serve customers on a global scale
  - Apart from the leading group of large companies, the Digital Infrastructure sector encompasses c. 1,000 (DHPA estimate) SME companies which are a source of innovation and growth

The Digital Infrastructure sector will continue to grow in a high pace. Our leading position is however challenged

- **The Digital Infrastructure sector has a high potential for future growth**
  - Global IP traffic will double during 2013-2017 at an annual growth rate of 23%
  - Data centre workload in Western Europe will increase with 60% between 2013-2016 at an annual growth rate of 20%
  - Cloud computing, Big data and The Internet of Things will cause a huge increase in the demand for IT capacity
  - Industrialisation of the data centre has only just begun. The vast majority of IT equipment is still housed in proprietary servers room and data centres. A consolidation to large industrialised data centres is expected
  - As large industrialised data centres are more energy efficient than most proprietary server rooms and data centres, this consolidation will contribute to reducing our ecological footprint

- **However, Digital Infrastructure is a global sector where a leading position can easily be lost**
  - Barriers between countries in the digital economy are low, companies can easily move their equipment and organization to other places in the world
  - Many countries are actively attracting new Internet companies and activities
  - The digital economy is strongly dependent on physical factors as space and electricity, two factors that require sound long term planning to secure availability

To maintain our leading position, we have six recommendations for reaching the next level and strengthening our leading position

1. **Focus and stimulate innovation and entrepreneurial spirit.** We have reached our current position by an innovative and entrepreneurial spirit, taking the next step ahead before being mainstream in the market. NL needs a continuous focus on innovation programs in collaboration between research institutes, enterprises and Internet organizations
2. **Apply adequate industry models** that match the major products and services in this rapidly evolving market. Currently, the Digital Infrastructure sector is invisible in the economic statistics due to SBI codes that do not match the products and services in this new sector. Based on these new industry models, future research is required to fully assess the economic value of the sector.
3. **Align education** to ensure a workforce that meets the needs of the digital economy. Currently, organizations have difficulties to attract the special skills required for the digital economy without going abroad. These skills are also needed to maintain our active role in the global internet community (e.g. ICANN, IETF)
4. **Establish a balanced regulatory framework** based on a detailed understanding of the sector within an international scope. The regulatory framework can be a healthy basis for the digital economy but policies affecting the neutral position can easily damage NL's position (level playing field). This not only applies to the legislation itself but also the way legislation is enforced. Internet companies are willing to contribute to support the legal framework but ask from the government that this does not affect the operational activities or customer experience more than necessary
5. **Secure long term availability of space and electricity** by coordinating between stakeholders to make the right long term planning choices. The digital economy is strongly dependent on physical factors as space and electricity, two factors that require strategic and long term planning in which multiple stakeholders (sector, government, energy production and distribution) must work together.
6. **Stimulate funding mechanisms** with specific knowledge of the digital sector. The digital sector is continuously evolving and requires ongoing investment. In the current financial climate, especially smaller companies have difficulties to attract sufficient funding

5. Appendices

- List of Sources
- About the Authors

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