Annual
Report 2019

ams*ix*

1994

2019

Connecting you to everyone and everything

Chapter 1

History of AMS-IX

The Way the Web works
… and the Role of AMS-IX in the World Wide Web

AMS-IX is one of the largest interconnection platforms in the world. But what is an interconnection platform? How does it fit in the workings of the Internet? And why is it useful to connect to AMS-IX?

On the surface, the World Wide Web looks like a huge, homogeneous network connecting everyone and everything. But when you take a closer look, you can see that this is not really the case. The Internet can rather be described as a network of networks. Currently, the Internet consists of more than 55.000 networks from various companies, all with their own infrastructure, technology needs, background and commercial vision or ideals.

The glue that holds all these 55.000 networks together is the Internet Protocol (IP). The protocol defines a common language, making sure that traffic can be exchanged from one network to another. And in order for networks to exchange IP traffic, they need to physically connect to one another.

This process is called peering. And this is where interconnection platforms come in.

There are three ways networks can peer with one another:

IP TRANSIT

You interconnect with another party via a transit provider. A transit provider provides the service of allowing network traffic to cross (or "transit") their computer network to the larger Internet. The transit provider requires a fee for their services.

PRIVATE PEERING

You interconnect directly with another party to exchange traffic without any third parties involved. Since the interconnection is beneficial for both sides there are usually no costs involved. The downside of this form of interconnection is that it quickly becomes unmanageable when there is a high demand for connectivity.

PUBLIC PEERING

You interconnect with another party using an interconnection platform, e.g. AMS-IX. An interconnection platform is a place where multiple networks connect and exchange IP traffic. With only one connection to an interconnection platform you can reach all the other parties that are also connected to the platform.

Peering via an interconnection platform is just one of the ways networks can interconnect. AMS-IX operates several of these interconnection platforms around the world.

AMS-IX Amsterdam

The platform in Amsterdam is extra special. It was founded over 25 years ago and is one of the first interconnection platforms. Moreover, AMS-IX is one of the largest platforms in the world, with over 875 networks in Amsterdam connected to it. This number corresponds to a variety of companies ranging from Internet Service Providers, Cloud Providers, Content Providers (social media, streaming services), Gaming companies, Healthcare Platforms, E-commerce companies, Applications providers (CRM, HR, ERP), Payment Service Providers, Video Conferencing Solutions and many more.

25 years

Why connect to AMS-IX

There are several benefits when connecting to AMS-IX:

Cost-effectiveness

Connecting to AMS-IX saves costs. Traffic that you can exchange directly with other parties locally at low cost does not need to be sent via more expensive transit providers.

Increased network redundancy

Connecting to an AMS-IX location gives networks a greater resilience. The platform in Amsterdam is for example distributed across 14 different data centers. As a result, the chance of the entire infrastructure failing is extremely small.

A rich ecosystem

AMS-IX is a very diverse and international interconnection platform. More than 75% of the connected parties come from outside the Netherlands.

Better control

Connecting directly to a network means that companies know which routes the IP traffic takes (which is not the case with IP transit). This can be very important for companies with high demand for quality connections, like gaming companies. Networks can monitor traffic live via an online customer portal.

Low latency and optimal traffic flows

An interconnection platform has a lot of networks attached to it. Therefore, if a network connects to AMS-IX, it helps them ensure that IP traffic flows via the fastest and most efficient route. This reduces the amount of latency on the network. For example: before AMS-IX was founded, a lot of internal internet traffic in the Netherlands ran via Miami. AMS-IX made sure there was a more direct and efficient route for traffic.

A short history
of AMS-IX

Over the course of 25 years, AMS-IX developed from an association of 20 organizations to a world-leading interconnection platform. How did it all start and what made AMS-IX so successful over the years?

The history of AMS-IX is strongly correlated to the development of the Internet itself. In the early 90s, research groups and associations all over the world were experimenting with building networks based on the new internet technology from the US army (ARPANET). In the Netherlands, the infrastructure of these new networks concentrated around SARA (Stichting Academisch Rekencentrum Amsterdam) and NIKHEF (Nationaal Instituut voor Kernfysica en Hoge-Energiefysica) research centres in Amsterdam Science Park.

Initially, these interconnection-related experiments were mainly fuelled by scientific institutions. But this changed when, in 1994, the telecommunications' market opened up. New commercial internet and telecommunication businesses like Digitale Stad, Unet, XS4ALL, etc. were formed and started building infrastructure near the research facilities in Amsterdam Science Park.

A community of businesses began to arise within Watergraafsmeer (neighbourhood in the south-east of Amsterdam) as its main connectivity hub; at that time, it became — informally— known as Amsterdam Internet Exchange (AMS-IX).

Establishment
Between 1994 and 1997 there were regular technical meetings of participants of the exchange. SURFnet managed and maintained the infrastructure at NIKHEF and SARA at that time. In the course of 1996, it was decided in one of the meetings that a more formal structure should be established independent of SURFnet. After extensive analysis, the participants of the exchange founded a neutral, non-profit association on 1 January 1997. All the parties connected to the exchange would be members of the association and would have the right to vote in the general assemblies.

More-IP 2019

In 2000, the AMS-IX company was formed, with ownership falling under the association. Any profits would be invested in further development of the infrastructure and/or reducing port fees. Initially, the AMS-IX company took over administrative management and financial operations from SURFnet, which had been performing those tasks up until then. In 2001, the company was expanded to also take care of the technical operations. That same year, Henk Steenman, at that time chair of the AMS-IX association, joined the company as CTO (which he still is to this day).

Neutrality
This Exchange model, by emphasising on neutrality, attracted many networking companies, especially during the first years. Networking businesses from all corners of the world, which would not necessarily peer in their own countries, came to Amsterdam to interconnect and exchange IP traffic.

AMS-IX also had a liberal and neutral stance when it came to new and alternative members who wanted to exchange traffic.

Westeinde 12, Amsterdam

"a continuous battle to keep up with the **ever-increasing demand for more capacity and bandwidth** on the platform"

In the beginning, AMS-IX was an interconnection hub for carriers and ISPs, but in the late 90s and in the beginning of the new millennium, new content delivery networks also showed an interest in connecting to Exchanges. This started controversy among the larger operators, who were of the opinion that content networks should still be paying for access to their customers. The London Internet Exchange (LINX), for example, banned Microsoft for a while, because the members would not allow a content delivery network in their midst. At AMS-IX however, no such restriction existed, and the content delivery networks could connect without a problem.

The Exchange attracted many digital companies, which in turn, also attracted other companies. This created a 'snowball effect', making Amsterdam one of the major technology hubs and places of settlement, for internationally operating telecommunications, Cloud, and IT companies. One important consequence of this was the creation of jobs in and around the Amsterdam region. Today, about a quarter of the working population in the Netherlands either works in IT or has an IT-related job, and this percentage will become even higher in the coming years. In the report "The Future of the Digital Economy - Time for Fundamental Choices" the impact of the digital mainport on the Dutch economy is estimated to account for 3.3 million jobs.

Innovations
The success of the platform also posed a challenge for the operational staff of AMS-IX. The first twenty years were a continuous battle to keep up with the ever-increasing demand for more capacity and bandwidth on the platform. At certain points, the traffic on the platform more than tripled. This forced the AMS-IX technical team to constantly innovate and experiment with new technologies, especially in the field of network and provisioning automation.
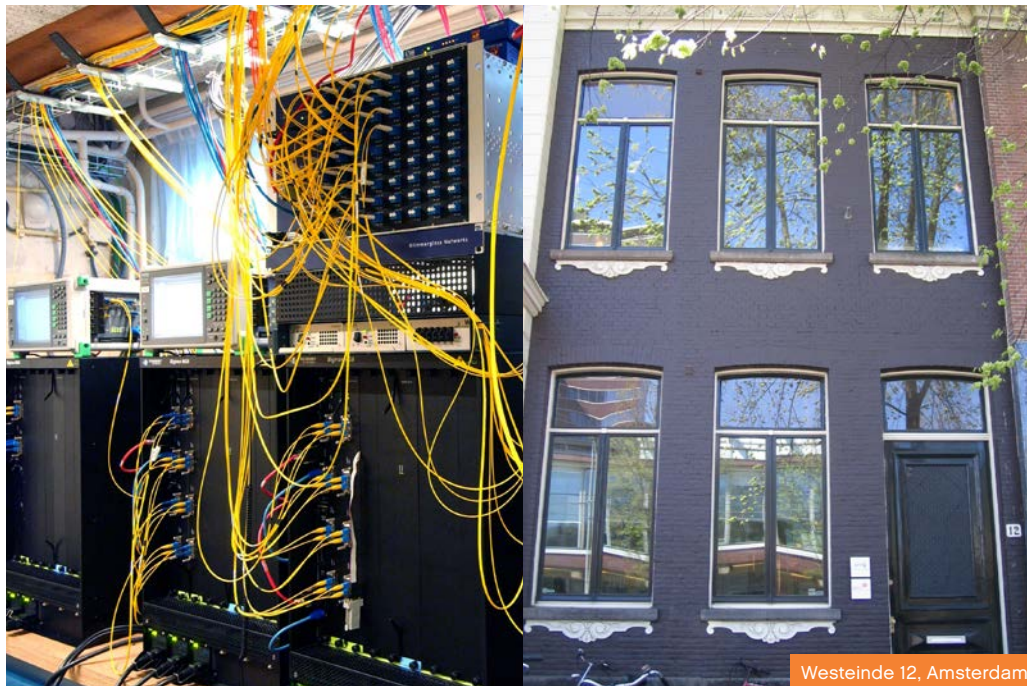
That approach led to some very notable innovations. In 2003, for example, AMS-IX was the first company to use Glimmerglass Networks' Photonic Cross-Connects (PXC) as automated physical patch panels. In 2009, AMS-IX was the first Exchange in the world to migrate from a 'pure' Ethernet to an MPLS/VPLS platform, which allowed L2 connections from anywhere in the world to the AMS-IX platform in Amsterdam. More importantly, it introduced the opportunity to connect to AMS-IX via a reseller. This was a major breakthrough (and not done before on an IX) and set a standard for the whole IXP industry. AMS-IX was also one of the first organizations to experiment with the use of 100 Gigabit ports. The last major upgrade was the introduction of new Extreme Network SLX switches which greatly enhanced the port capacity of the network and reduced the energy usage.

International expansion
AMS-IX expanded its neutral model for Internet Exchanges globally, initiated upon requests from partners and customers.

○

"The last major upgrade was **the introduction of new Extreme Network SLX switches**."

In 2008, the local government of Curaçao asked the help of AMS-IX to set up an Exchange for the Caribbean region (CAR-IX). AMS-IX built and managed the platform, with the intention to eventually hand over operations to local staff. In the end, it proved to be easier to run the Exchange from Amsterdam hence AMS-IX took over the Exchange, renaming it to AMS-IX Caribbean, and listing it as the first AMS-IX Exchange outside of the Netherlands. Another international undertaking followed in 2012, when AMS-IX was approached by HGC Hutchison Telecommunications for setting up an Exchange in Hong Kong.

In 2014, AMS-IX entered the US market, starting with New York, then quickly expanding to Chicago, and the following year to Bay Area. At that time, neutral Exchanges for public peering were not, yet, common in the US (they were either run by data centres or network operators) and it was believed that a neutral Exchange would have a wide appeal. The US turned out to be a tough market however, and eventually, the Exchange in New York was closed down.

The later years
Since the US undertakings, AMS-IX pursues its international ambitions via partners. In 2017, AMS-IX started an Exchange in Mumbai, India, under the wing of Sify. The Strategic partnership proved to be effective and became the preferred approach.

Frederiksplein 42, Amsterdam
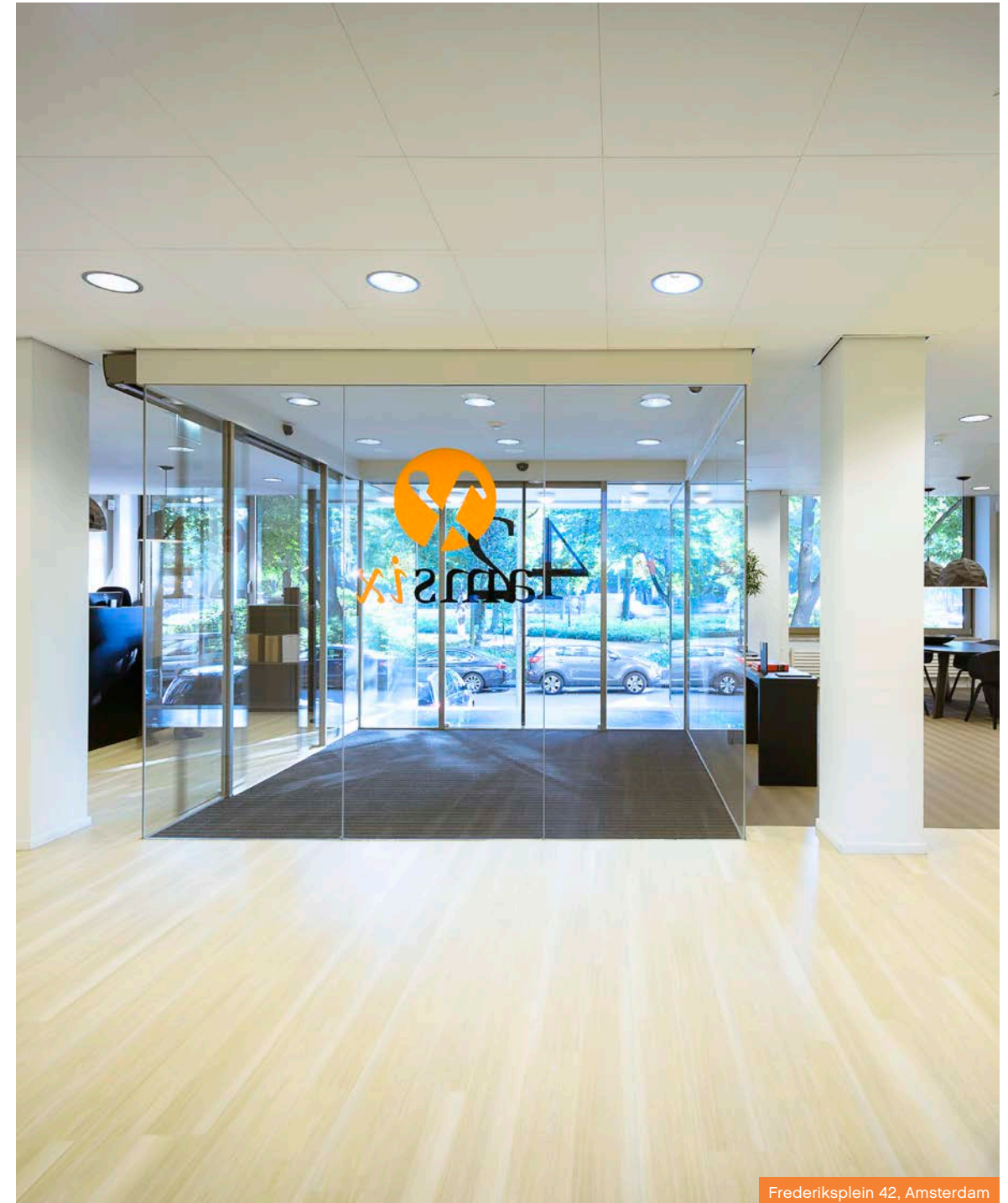
"Next to the international expansion, AMS-IX also **went through several changes in Amsterdam**."

Additionally, in 2019 AMS-IX launched IX-as-a-Service (IXaaS). IXaaS is an appliance-style IXP that can be set up remotely. This service greatly reduces the manual effort of implementing a new Exchange. Batelco was the first company to utilise this service, creating the Manama Internet Exchange in Manama, Bahrain (more information on this topic can be found in the next chapters of this edition).

In 2017, AMS-IX launched EasyAccess, a service that makes it easier for clients to connect to the AMS-IX Amsterdam platform. Companies no longer have to have physical presence in one of the AMS-IX PoPs in Amsterdam but can access AMS-IX Amsterdam from more than 200 locations in Europe.

Next to the international expansion, AMS-IX also went through several changes in Amsterdam. Business models are being digitalised and that means that new types of companies (like e-commerce companies, banks, and other enterprises) are starting to look at the way they connect to the Internet. For AMS-IX this translates into a potential market with a new type of customers, requiring new types of services. Finally, while competition in the interconnection market intensifies, AMS-IX continues to build new value-added services for its members and customers.
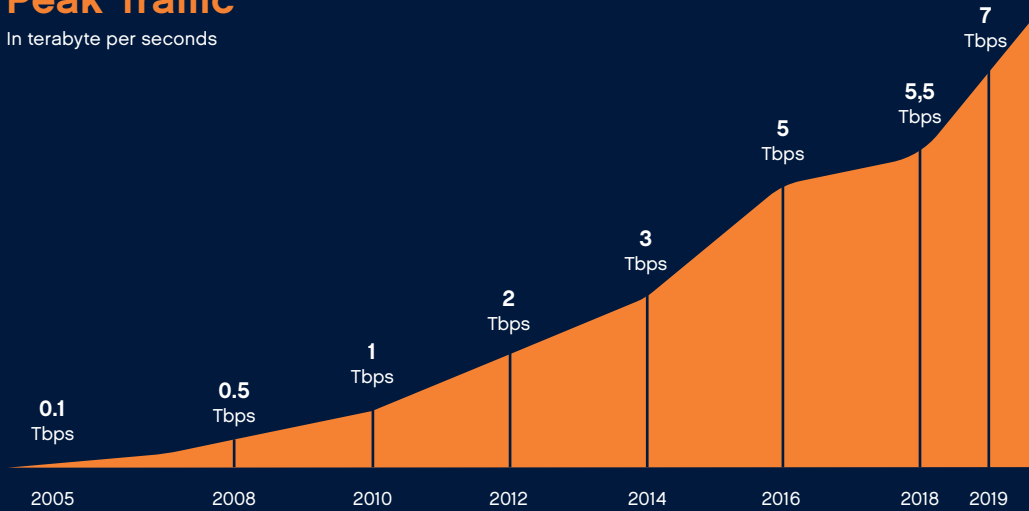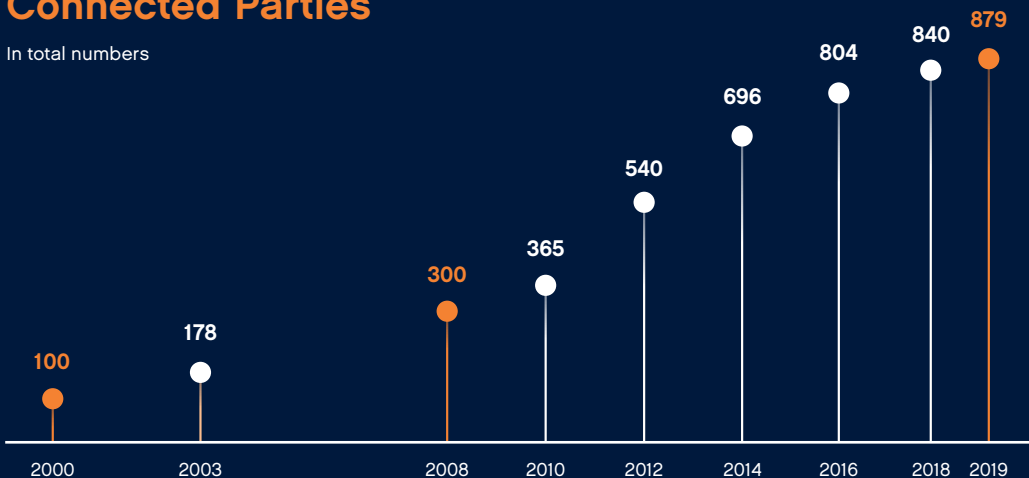
AMS-IX in the
past 25 years

Peak Traffic
In terabyte per seconds

0.1 Tbps
0.5 Tbps
1 Tbps
2 Tbps
3 Tbps
5 Tbps
5,5 Tbps
7 Tbps

2005   2008   2010   2012   2014   2016   2018   2019

Connected Parties
In total numbers

100   **178**   **300**   **365**   **540**   **696**   **804**   **840**   **879**

2000   2003   2008   2010   2012   2014   2016   2018   2019

Reach
Connect to AMS-IX anywhere, everywhere

1994   **1999**   **2003**

2013   **2008**

2018

Easy Access 1.0
50 virtual locations
in the Netherlands

Easy Access 2.0
200+ virtual locations
in Europe

2019

AMS-IX POP
(Point-of-Presence)

EasyAccess
no physical presence
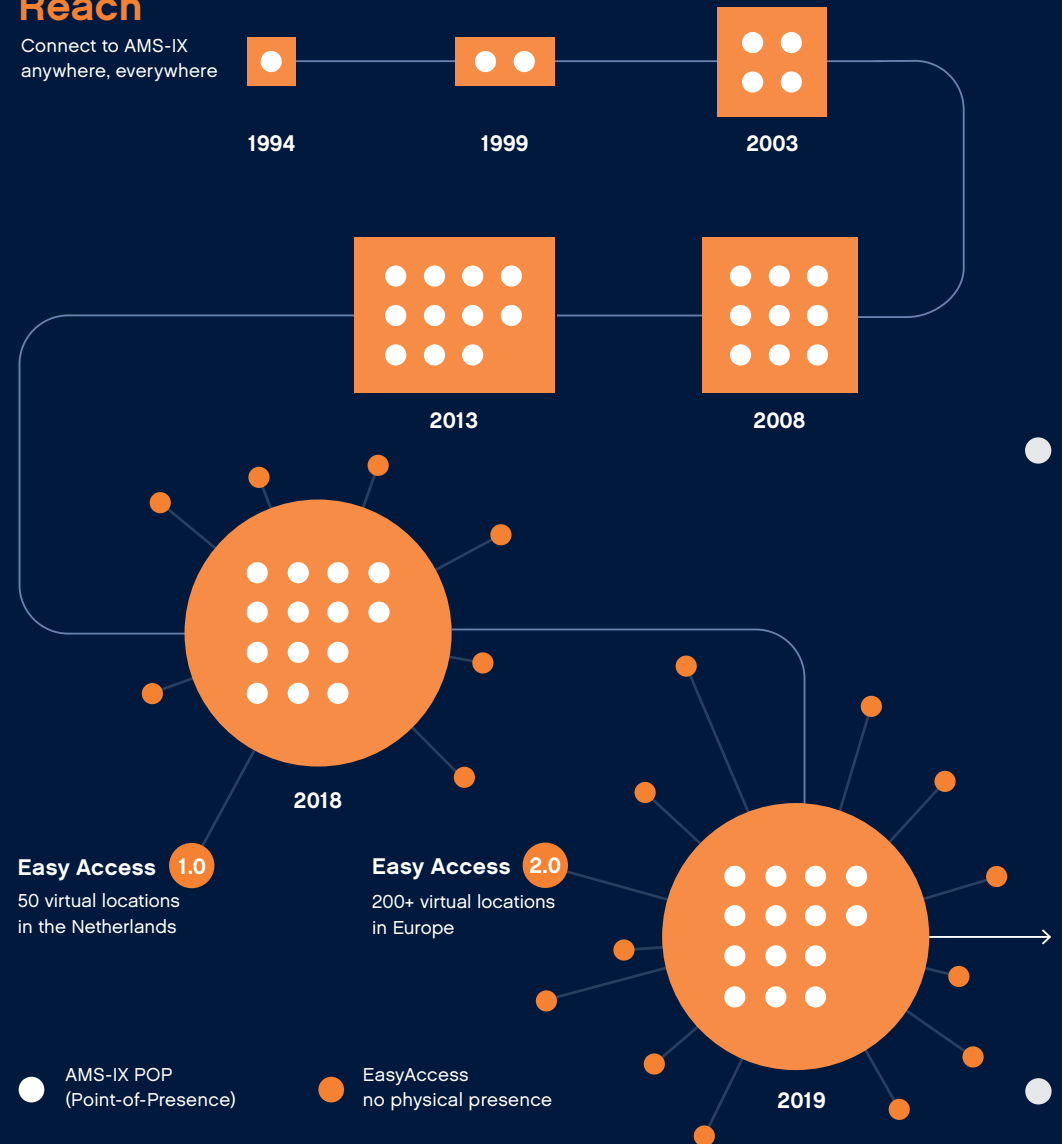
Historical
dates

1994

At the Science Park, in Amsterdam, **a layer-2 shared infrastructure is formed** between (academic) organizations to exchange internet traffic. In February 1994, it is internationalized to exchange traffic with CERN in Switzerland and other ISPs are allowed to connect. **The name AMS-IX is used for the first time.**

1997

Twenty connected ISPs and carriers establish the AMS-IX Association. Founding members are: SURFnet, NLnet, AT&T EMEA, Unisource, BT, KPN Qwest, XS4All, Global One, Euronet, EUnet, Wirehub, Belnet, RIPE NCC, Demon, IXE/PSI, Telecom Finland, IBM GN, A2000, UUnet/ MCI, GTS Europe (Ebone).

1998

The **Multicast VLAN** is implemented for testing purposes, and **the first IPv6 tests** are carried out.

2000

The **AMS-IX Association forms the AMS-IX B.V.** led by CEO Job Witteman. The Association holds all the shares of the company. That same year, **the 100th IP network connected to AMS-IX.**

2001

The **AMS-IX B.V. forms an in-house Operations Department** (the AMS-IX NOC).

2002

In the beginning of the year, **the operational management of the Exchange is transferred to the AMS-IX NOC led by CTO Henk Steenman.** In June, AMS-IX extends the reach of its **platform to two other sites** in Amsterdam: AMS2 (Telecity 2, at that time) and Global Switch.

2003

Closing the year with 178 members, **AMS-IX becomes the IX with the largest number of connections worldwide.** The total aggregated traffic is 22 GB/s.

2004

The platform's network topology is migrated from a ring to a double star. In April, AMS-IX deploys **Glimmerglass Optical Switches**. AMS-IX becomes the world's first IX to deploy photonic switching. Later that year, **the trunked Gigabit and 10 Gigabit Ethernet services are launched**.

2005

AMS-IX hosts **the first European Peering Forum** (EPF) in Frankfurt, Germany, together with DE-CIX and LINX.

2007

Both core switches are upgraded to the MLX32. AMS-IX expands to **a fifth location at euNetworks** and relocates its core switches both to this new location as well as to the location of Global Switch.

2008

AMS-IX expands to its **sixth core location** at the first Equinix data centre in Amsterdam. AMS-IX helps with **the setup of CAR-IX in Curaçao**. CAR-IX is established and is managed by Nico Scheper. According to the 'Amsterdamse ontwikkel-bedrijf', AMS-IX creates – directly and indirectly – **50,000 jobs in Amsterdam**.

2009

AMS-IX expands to its **seventh location Interxion AMS5 in Schiphol-Rijk**. The platform's network topology is migrated from a double star into a MPLS/VPLS (in one night). The new platform aims to increase stability and scalability, and to support the traffic growth in the years to come.

2010

AMS-IX introduces **the AMS-IX Reseller Program**. First AMS-IX location extension realizes at TelecityGroup.
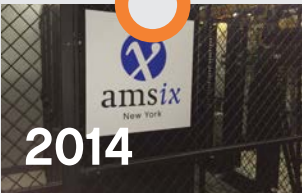
2012

AMS-IX starts **operations in Hong Kong**, in collaboration with HGC Global Communications.

2013

CAR-IX is rebranded to **AMS-IX Caribbean**.

2014

AMS-IX opens **three new Exchanges in the US**, in New York, Bay Area, and Chicago.

2016

AMS-IX goes into **partner-ship with Megaport** for elastic interconnects with Amazon web services, Microsoft Azure and the Google Cloud Platform.

2017

AMS-IX goes into **partner-ship with Sify** in India and establishes **AMS-IX India** in Mumbai. That same year, AMS-IX opens a **Point of Presence with The Datacenter Group** (TDCG) and the data centre tower of Digital Realty.

2018

Peter van Burgel is appointed as the new CEO of the AMS-IX B.V., taking over from his predecessor, Job Witteman. That same year, AMS-IX launches **EasyAccess**, a new service that provides direct connection to AMS-IX in more than 200 locations in Europe.

2019

AMS-IX celebrates its 25th anniversary. AMS-IX Amsterdam breaks through the **7 Terabits per second** (Tbps) barrier on 18 December, around 9PM. This new record underlines the importance of the Amsterdam region as an international hub for internet traffic. That same year, AMS-IX launches **IX-as-a-Service** (IXaaS). The first IXaaS instance is established in Manama, Bahrain, under the name Manama-IX (MN-ix), in partnership with Batelco.

AMS-IX and the Dutch digital mainport

Michiel Steltman,
Managing Director of DINL

Michiel Steltman at MORE-IP 2019

The international connectivity provided by AMS-IX has attracted many companies to the Amsterdam region over the last 25 years. Today, Amsterdam hosts a vibrant ecosystem of digital start-ups and scaleups that deliver their services all over the world. Michiel Steltman, Managing Director of DINL, talks about the position of Amsterdam as the digital gateway to Europe and the founding work of the Digital Infrastructure Association.

DINL, the Digital Infrastructure Association, is a coalition of leading Internet sector organizations in the Netherlands. We act as the voice of this industry towards the government, MEP's (Members of EU Parliament) and the general public. The organization was founded in 2015 by AMS-IX, DHPA, ISPConnect, NLnet, Surf, DDA and NLDigital representing data centres, networks, hosting and cloud providers, the academic network and the registrar community. The goal of the initiative is to protect the Netherlands as one of the strongest data hubs in the world.

The third mainport of the Netherlands
First of all, the Dutch data hub creates jobs in the region. Cloud and hosting providers, business networks and data centres employ thousands of people. About 40.000 FTEs, directly and indirectly, work in or for the companies of the Dutch digital mainport. Together they generate more than 4,8 Billion Euro of added value. The large multinational carrier-neutral data centres in the MRA (Metropole Region Amsterdam) are the digital landlords of Facebook, Booking.com, Adyen, Uber, Twitter and other .coms. Google and Microsoft decided to build their own large hyperscale EU data centres in the Netherlands.

The effect of the Dutch digital mainport on a wider scale is far greater. The digital mainport forms a strong basis for the digital ambitions of the Dutch government and further economic growth. Almost every sector of the Dutch economy is transforming due to the introduction of digital tools, technology and services. More than 25 per cent of the Dutch working population currently has a job where they spent more than 50 per cent of their time using ICT. In 2025, this will grow to 2,9 million jobs, 36 per cent of all the professionals.

The Netherlands achieved this position as a result of excellent connectivity, a good investment climate and other favourable conditions. It should be no surprise that they saw AMS-IX as the seed and the fundament. The public peering model was a tipping point that attracted hundreds of national and international connections and data centres, which created the economic 'snowball effect'. In a 2013 report, Deloitte compared it to the two leading logistics hubs: the Rotterdam harbour and Schiphol Airport.

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"DINL is now a strong factor in the public debate and participates in various partnerships in the Netherlands."

The challenges for the future
Strengths and opportunities inevitably go hand in hand with risks and weaknesses, and the Netherlands is no exception to the rule. Early adapters always face the risk of a stall-out. Where other EU countries have now initiated programs to copy the success of the Dutch data hub, the Dutch government has become somewhat complacent with respect to digital infrastructure. The Ministry of Economic Affairs is predominantly occupied with the roll-out of 5G mobile networks but does not pay much attention to the digital infrastructure which also requires extra care.

The Netherlands is lagging with the ipv6 roll-out, a big security concern and a situation that could hamper the growth of the Internet of Things. There is uncertainty about the timely replacement of direct maritime connections to the Netherlands that may go out of service soon. And in the MRA there is a temporary shortage of electricity for the growth of data centres. All these factors could potentially have an impact on the leading Dutch position in this space.

To address these – and many more – issues, DINL acts as the voice of the Dutch Data Hub. Fortunately, DINL has become quite visible and successful. DINL is now a strong factor in the public debate and participates in various partnerships in the Netherlands. It is also a familiar face in the parliament, for ministers, and in national media such as newspapers and radio. Digital Infrastructure: connections, transit, peering, clouds and domains are the fundament of the modern digital economy. The health and openness of that ecosystem is essential for prosperity. DINL's will, with AMS-IX as founding member and as icon of the Dutch digital Hub, continue its work to safeguard the growth and health of the Dutch Data Hub.
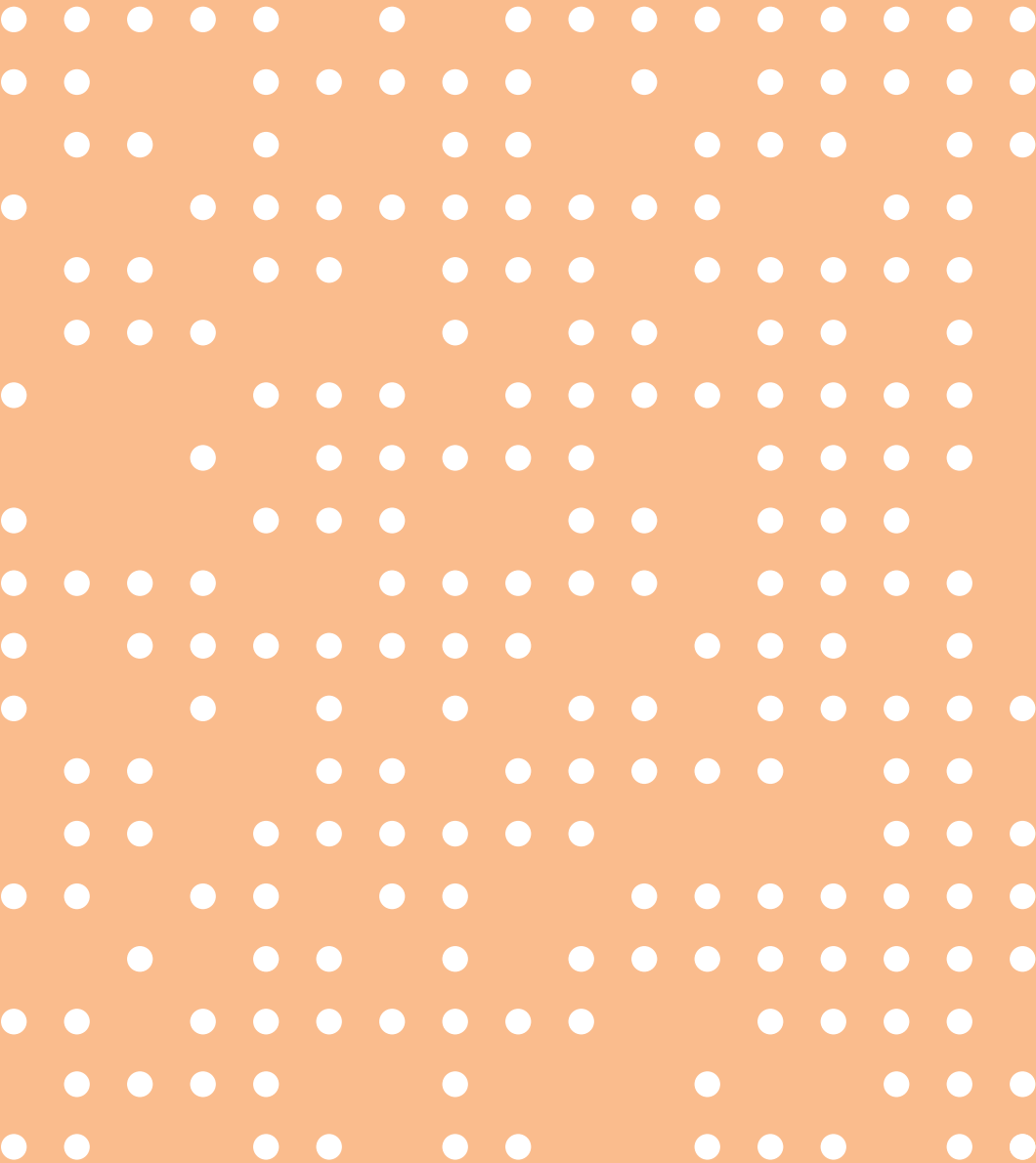
Chapter 2
2019
in Review

Word from the CEO
The year of change

There is a reason why some quotes
and proverbs are popular…
typically, it's because they are true.

To name a few: "The only constant in life is change", "A rolling stone gathers no moss", "There are far, far better things ahead than any we leave behind" and "To improve is to change; to be perfect is to change often". All of these sayings suited AMS-IX in 2019. In the year we celebrated our 25th anniversary we also saw a lot of change both internally and in the market, we operate in. This is why we continue to invest in our long-term strategy: Innovate, Optimise, Grow.

Celebrating a 25th anniversary is also celebrating past success and recognising the things the people of AMS-IX have achieved in those 25 years. The Internet started as an academic network but has grown dramatically into the all-pervasive utility of today's world. AMS-IX managed to secure a world leading position in that rapidly growing market and continues to do so to this day.

Our traditional business (public peering) continues to grow in terms of capacity, connected parties and overall traffic whilst new services like EasyAccess and IX-as-a-Service (IXaaS) are gathering momentum. To support the strategy, new tooling is being deployed that will allow for optimisation of processes and customer interaction. Customer self-service and process automation are two main focus areas. Additionally, we focus on applying the principles of economies of scale in order for efficiency and effectiveness to increase thus further improve the customer experience and the value AMS-IX brings to the market.

Internet traffic is growing at a steady pace providing many opportunities, but the challenges grow, too. Cheap alternatives for interconnectivity put pressure on prices. Growth opportunities for data centres are under pressure due to scarcity of land, power and talent.

Peter van Burgel
Chief Executive Officer

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*"**Amsterdam**
remains the stronghold
of our business"*

On top of that, governments are trying to get a grip on the digital economy with rules and regulations. Typically, this type of pressure in a market leads to consolidation which is already happening in the data centre and connectivity markets.

During 2019, AMS-IX invested a lot in preparing for a time of change. A new way of working was introduced, reshaping the organisation to better support innovation and optimisation, but also to have better reporting, financial insight and control. The "homegrown", monolithic tooling is being replaced by standard tooling, allowing valuable developer resources to focus on innovation. This will continue in 2020 whereby the benefits for the customer will become more visible.

A number of new products and services was launched successfully, however the traditional interconnection business remains strong and continues to grow. The development of new services will continue next year. A healthy pipeline has been developed for IX-as- a-Service (IXaaS) with the first deployments expected to take place in the early 2020. EasyAccess also shows a steady growth with the service being available in over 170 data centres across Europe.

Amsterdam remains the stronghold of our business, with AMS-IX India also showing a significant increase in connected parties and traffic.

The business in Hong Kong, the Caribbean and the USA continue to grow slowly. 2019 also saw the first deployment of IX-as-a-Service with the launch of Manama-IX in Bahrain during the Formula 1 GP, in March. Since the launch, Manama-IX shows steady growth of connected parties and traffic.

Although the results were below budget, a positive financial result before tax is secured due to the pause of the implementation of Saleforce, active monitoring of spend and continued cost savings on infrastructure and fiber investments. Also, the US operations have been restructured according to plan, resolving the negative results while securing the continuation of the AMS-IX brand and services in the USA through an IX as a Service (IXaaS) partnership with Epsilon.

Despite a port price reduction of 20% offered as per January 1, 2019, gross revenues declined by 11% (EUR 2.3 million) compared to 2018.

The decline in revenues from existing business was partially compensated by new products IXaaS and EasyAccess – both contributing EUR 0.2 million to gross revenues in 2019. The new business development was slower than expected but the pipeline for 2020 is already promising.

Lower external operating costs compared to 2018 show AMS-IX's commitment to continuous improvement and efficiency. As such we were able to maintain our profitability in 2019.

Other operating costs increased by 4.6% in 2019. This was driven by the costs of implementing Salesforce and the new way of working, as well as the hiring costs of senior staff and investments in new tooling. The new way of working was implemented during 2019 and the implementation of the new tooling will be completed in 2020.

Nevertheless, we were able to close the year with a positive financial result of EUR 1.1 million profit after tax (2018: EUR 0.8 million).

With this result we were able to finance required investments in the ecosystem using cash flow generated in AMS-IX's home market. Our equity ratio increased to 70.1% (2018: 48.6%), which represents a healthy financial position.

Overall the business continues to grow and remains adequately funded. In 2020 our focus is to deliver on our strategy, implementing new services and extending into new markets, but also finish the optimization of our internal processes and implementation of the new ERP system.

At the time of producing the annual accounts 2019, the world is faced with the Covid-19 or Corona crisis which has a strong impact on society and the economy. Being part of vital infrastructure, AMS-IX took additional steps to keep our people safe, whilst ensuring the continuation of the services. We have seen a significant growth of traffic and upgrades on the back of the massive shift to "working from home", signifying the key role of AMS-IX in the Internet eco-system. Although the economic outlook is uncertain, we believe the Internet-market will continue to grow and so remain confident about our future and Long-Term Strategy.

We would like to thank the AMS-IX Supervisory Board and our members for their continuous support over the past year.

"**The business continues to grow** and remains adequately funded"

AMS-IX in 2019

Corporate Governance

AMS-IX places great value on its corporate governance structure. This provides the organisation with a significant degree of independence and neutrality, which contributes to our growth, continuity and global expansion. In this section, the corporate governance structure is explained in greater detail.

Governance Structure

AMS-IX consists of three separate legal entities: the AMS-IX Association, the AMS-IX Limited Company (in Dutch, Besloten Vennootschap or B.V.) and its subsidiary AMS-IX USA Inc. The Association is the single shareholder of the Limited Company and the organisation and its staff are incorporated in the Company. The Executive Board of the Association consists of five people and also acts as the Supervisory Board of the Company.

AMS-IX the Company

The AMS-IX Company is empowered to take the majority of the decisions, within the boundaries set by annual and long-term plans approved by the Association and/or Supervisory Board.
During board meetings, the Supervisory Board validates whether plans are executed according to budget and business plan.

It approves the annual plans and budgets as well as items outside the scope of management control. The Company Management Team reports to the Supervisory Board on a quarterly basis.

Chief Executive Officer of the Company is Peter van Burgel. Mr. van Burgel chairs the Management Team, which further consists of a CTO, a Senior Director Sales & Marketing and Manager Implementation & Operations and a CFO. In addition, the Company consists of technology, commercial and financial departments, as well as human resources and support staff. Next to operating the Internet Exchange in Amsterdam, the AMS-IX Company also operates AMS-IX Caribbean in Curaçao, AMS-IX India in Mumbai and AMS-IX Hong Kong.

During 2019, AMS-IX experienced a higher number of personnel change than usual. Saskia Poelman (former CFO) and Jesse Robbers (former CCO) left AMS-IX and were replaced by Iris Vonk and Mike Baron. Also, a number of long-term employees decided it was time for a new challenge and although it is sad to see experienced colleagues leave, it is quite normal in a time of change.

AMS-IX organisation structure

AMS-IX bodies	Association	Corporation
Meeting acts as	General Assembly	Shareholders meeting
Board acts as	Executive Board	Supervisory Board
Management acts as		Management

Conversely, a number of people stepped up into new roles and the investment in the people continues through training and personal development. In July, Mona Moursy joined in as new Head of HR and took ownership of the HR initiatives around training, management development and the implementation of a new review process.

After the preparatory activities which started in 2018 and the elections that took place in February 2019, the Works Council was formally established in March 2019.

Risk Management

The main risks for AMS-IX are security and finance-related. Based on the ISO27001 certification and Information Security Management System (ISMS), AMS-IX conducts an internal audit and a risk assessment as well as goes through surveillance audits at regular intervals. Potential risks identified during audits are mitigated subsequently, in accordance with the ISO27001 standard and regulations. During 2019, the internal and Surveillance audits were passed successfully with only minor Non-Conformities (mNCs) and several Opportunities for Improvement (OFIs). As to financial risks, please refer to pages 55 – 57 of the annual accounts.

Bart van der Sloot
Chair

Board statement
Shifting gears in 2019

While I write this statement, the world is in turmoil due to outbreak of the COVID-19 virus, which only started impacting the Dutch society about 3 weeks ago.

The impact is huge, not only on those infected and on healthcare staff, but also on people working in markets that have come to a complete standstill. Those in office jobs have moved massively to working from home, like AMS-IX and many of its members and customers. With a solid team and a solid technical infrastructure, the short-term impact on AMS-IX is manageable – the platforms can well handle the increased traffic flows and the management team has implemented a detailed business continuity plan. Forecasting the longer-term impact is more challenging. Will AMS-IX members and customers all stay connected? What is the impact on the team? Will equipment supply chains continue to work? My thoughts are with all members, customers, employees and suppliers in this challenging period. Stay safe!

In 2017, a new strategy was agreed upon, in close cooperation between Members, Management Team, Employees, and Board. The 5 pillars of this strategy were "Create Economies of Scale", "Service Innovation", "Develop New Markets", "Fix the Basics" and "Develop our People".

Whereas 2018 was the first year of execution – with e.g. the launch of EasyAccess –, the year 2019 saw many initiatives and results in all 5 areas. IX-as-a-Service was launched and found its way to new customers in new geographies. The Fix the Basics program was started with the objective to prepare the organization for scaling up and becoming more efficient and innovative – focusing on the team's structure, roles, systems and processes. Many HR initiatives were undertaken, including the deployment of a career framework.

"I'm confident the program **will deliver the full targeted benefits** in the course of 2020"

In parallel, the project to migrate ownership of the activities in the US to Epsilon Telecom was concluded – with AMS-IX continuing to manage these Exchanges under the IX-as-a-Service umbrella, on behalf of Epsilon.

Team changes and challenges
2019 was also a year of many changes in the AMS-IX organization. The former CFO Saskia Poelman, and the former CCO Jesse Robbers left the organization, and Iris Vonk and Mike Baron joined to look after the Financial and Commercial activities. Tim Vriend joined the Management Team, looking after the Delivery and Operations of the technical team. A Works Council was established, which in turn invited the Board for a meeting in December – sharing their observations on organizational developments within AMS-IX and requesting to meet on a more regular basis.

It also became evident that it was a huge challenge to absorb and drive the broad set of initiatives and many changes in the organization, especially in some parts of the Fix the Basics program, which led to the decision to postpone part of the program's implementation for 2020 and more importantly, to ensure alignment among the various teams before proceeding (which I fully support). I'm confident the program will deliver the full targeted benefits in the course of 2020, in spite of the COVID-19 challenges.

Our markets
The promise of AMS-IX, as stated in the strategy documents, is to be the most valued ecosystem and to provide thought leadership in the field of (IP) interconnection. In 2019, these IP interconnection markets continued to go through change, driven by a.o. continued steep price decline in alternative interconnection services (especially IP Transit), consolidation in access networks (where the large networks increasingly tend to avoid IXs) and concentration of content traffic into less than 10 content providers (driving migration from IX services to Private Network Interconnects - PNIs).

These trends provide both threats and opportunities: high-volume traffic streams between large players may move to PNIs, but new players (including enterprises and governmental organizations) arise and see the value of a proven, trusted and neutral Internet Exchange to exchange traffic with their business partners – adding to the "longtail" of connected parties and to the ecosystem.

AMS-IX continues to be a key element in the value of the Netherlands as an international digital hub, where many global players decide to establish their cloud infrastructure.

AMS-IX Chair Bart van der Sloot

Board developments

At the end of 2019, we said farewell to Alex Bik (9 years of Board membership) and Mark Cooper (3 years).
It has been an extremely rewarding experience to work with them and I would like to thank both of them for their contribution to AMS-IX. We continued to count on the experience of Eric Loos (BICS - Treasurer) and Michael Ourabah (BSO Networks) and welcomed new Board members, Bernhard Pusch (Telstra) and Jan Thielemans (Arcadiz Telecom). I'm confident Bernhard and

Jan will be of great help to develop AMS-IX business in new verticals (e.g. enterprise) and geographical markets.

The year 2019 was my third year on the Board and the second year in the Chair position. I have experienced the cooperation within the Board, as well as between Board and Management Team, as very positive.

Looking ahead

I'm very confident about AMS-IX's future. We have a seasoned and energetic Management Team which is well-aligned and has a constructive cooperation with the Executive Board. We have a talented and enthusiastic pool of employees, ambitious strategy and healthy financials – nothing should stop us from reaching our goals. AMS-IX is, and always has been, a reliable, innovative, independent, transparent and collaborative company. We should not underestimate the importance of these values for (prospective) members. This really differentiates AMS-IX from other Exchanges with comparable growth ambitions.

On behalf of the Executive Board of the Association.

"AMS-IX is, and always has been, a reliable, innovative, independent, **transparent and collaborative company**."

Board Report

The Executive Board of the Association manages the Association's business and is also appointed as the Supervisory Board of the AMS-IX Company.

Members of the Executive Board are appointed for a period of three years and can be re-appointed for three times at most. The Supervisory Board supervises and advises the CEO & Management Team whilst also ensuring the AMS-IX Company follows the general course of affairs as set out in the annual and long-term strategic plans.
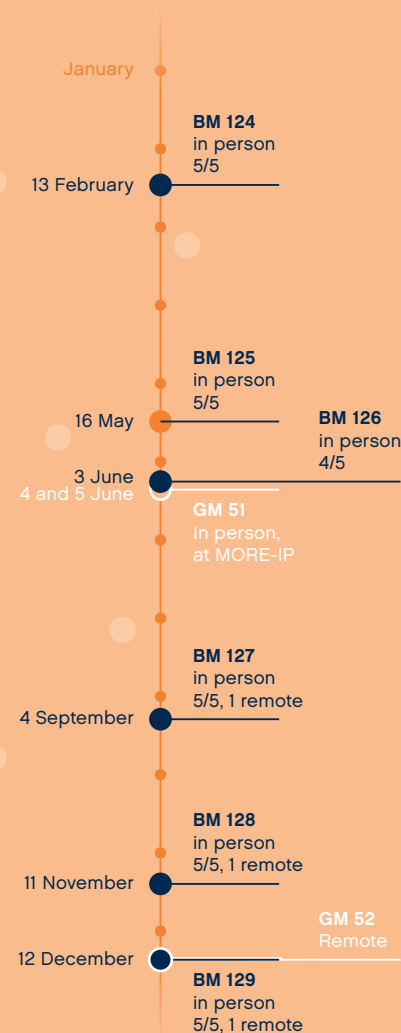

Eric Loos

Michael Ourabah

Bernard Pusch

Bart van der Sloot

Jan Thielemans

Composition of the Board

Name	Organisation	Association Board member since	Next re-election	End term of office as an Executive Board member of the Association	Term of office as a Supervisory Board member* ends no later than:
Alex Bik	BIT	24 Nov 2010	Dec 2019 (stepped down)	N/A	N/A
Mark Cooper	Interxion	20 Dec 2016	Dec 2019 (stepped down)	N/A	N/A
Eric Loos	BICS	20 Dec 2016	Dec 2022	Dec 2028	Dec 2028
Michael Ourabah	BSO Network	14 Dec 2018	Dec 2021	Dec 2030	Dec 2030
Bernhard Pusch	Telstra	12 Dec 2019	Dec 2022	Dec 2031	Dec 2031
Bart van der Sloot	Leaseweb	20 Dec 2016	Dec 2022	Dec 2028	Dec 2028
Jan Thielemans	Arcadiz Telecom	12 Dec 2019	Dec 2022	Dec 2031	Dec 2031

* if appointed as Supervisory Board member at 8 February 2018)

Meetings and Activities of the Board in 2019

● Board Meeting
○ General Meeting

January

BM 124
in person
5/5

13 February

BM 125
in person
5/5

16 May

BM 126
in person
4/5

3 June

4 and 5 June

GM 51
In person,
at MORE-IP

BM 127
in person
5/5, 1 remote

4 September

BM 128
in person
5/5, 1 remote

11 November

GM 52
Remote

12 December

BM 129
in person
5/5, 1 remote

In 2019, the Board held 6 meetings, all in the Amsterdam office. Besides these meetings, the members of the Board and MT members of the Company are in contact regularly to discuss specific topics. The goal of these informal conversations is to ensure the Board remains well informed with regard to the running of the Company's operations.

During Board meetings, the members of the Board reviewed and discussed matters concerning AMS-IX's activities, business results, plans and strategy. Among other activities, the Board focused on reviewing the long-term annual plans and partner agreements as well offering advice on how to react to a changing peering and inter-connection market.

In 2019 special attention was given to the execution of the strategy, especially in the areas of growth and transforming the processes, systems and organization structure.

Attendance
All Board members attended almost every Board meeting in 2019 (with only one Board member missing one meeting). All Board members made sufficient time available for AMS-IX-related matters.

Remuneration
Participation on the Board is voluntary. There is no remuneration or compensation for this service. Only travel and hotel expenses are covered by the Company.

The Board would like to thank the Management Team and employees for their contributions in 2019.

Amsterdam, January 10, 2020.

Bart van der Sloot
Chair Supervisory Board

2019 in Numbers

in Amsterdam

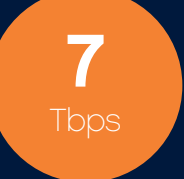## Connected networks

875+

Total capacity

34.6 Tbps

Peak Traffic

7 Tbps

7 Terabit per second corresponds to the simultaneous transmission of up to 280.000 videos in 4k HD quality.

Internet traffic volume

Total

16.9 EB
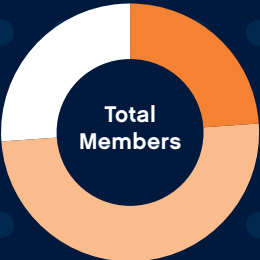
↑ +17 %

17 % more than 2018

Monthly average

1.4 EB

GRX Peak Traffic

155.5 Gbps

Location of connected members & customers

New Members

38 % Netherlands

15 % Europe (excl. NL)

47 % Outside Europe

62% outside NL

Total Members

24 % Netherlands

50 % Europe (excl. NL)

26 % Outside Europe

76% outside NL

Connection method of new connected parties

37 % direct   **63 % via reseller**

Total active 100G ports

258

↑ +19 %   19 % more than 2018

Number of POPs

in Amsterdam Metro

14

Financial
Statements

Despite pressure on gross revenues and investments made in the company's people, systems and equipment, 2019 financials show a net profit of EUR 1.1 million.

Gross revenue declined by EUR 2.3 million (11%) to EUR 19.2 million. The reduction in port prices by 20% – per 1 January, 2019 – was partially compensated by increased volumes in ports sold and new business income.

External operating costs declined by 5% to EUR 2.0 million (2018: EUR 2.1 million). This was mainly driven by lower customer discounts and infrastructure cost savings.

Personnel cost increased by 14% (EUR 0.8 million) to EUR 6.8 million. The rise is mainly due to the increase in FTEs, recruitment costs incurred for senior staff, and increased spending on employees' training.

In addition, the implementation of the new way of working and of SalesForce resulted in a higher need for temporary outsourced personnel.

AMS-IX's number of employees (heads) at the end of 2019, grew to 61.5 full-time equivalent staff (2018: 54.8).

In 2019, total investments in fixed assets amounted to EUR 1.9 million – mainly comprising of switches and equipment.

The depreciation cost amounted to EUR 5.3 million, a decrease of EUR 0.7 million compared to 2018. The decrease is driven by fully depreciated equipment from 2014 (investments in 2014: EUR 12.2 million), which was depreciated in 5 years.

Iris Vonk
Chief Financial Officer

Other operational costs increased by EUR 0.5 million (2018: EUR 3.0 million), following additional consultancy fees incurred for the new way of working programme and the implementation of SalesForce, as well as due to investments made in software licenses.

Financial results (EUR 0.2 million) include interest on lease contracts and exchange rate losses. In 2018, an unplanned waiver of financial lease agreements resulted in additional income of EUR 0.9 million.

As in 2018, for the calculation of the tax charge, cumulative losses in AMS-IX Inc. have not been taken into consideration. The principle of prudency is applied until we are able to determine that compensation of losses is likely.

Company balance sheet

As at 31 December (x Euro, after result appropriation)

Assets	2019	2018
Property, plant and equipment		
Equipment	7.445.948	11.760.810
Other assets	1.192.687	507.736
Financial Fixed Assets		
Group Companies	–	–
Fixed Assets	8.638.635	12.268.546
Current assets		
Accounts receivable	1.373.844	755.439
Taxes receivable	2.808	–
Other receivables and prepaid expenses	1.921.472	209.752
Cash and cash equivalents	2.328.695	5.105.631
Current Assets	5.626.819	6.070.822
Total Assets	**14.265.454**	**18.339.368**
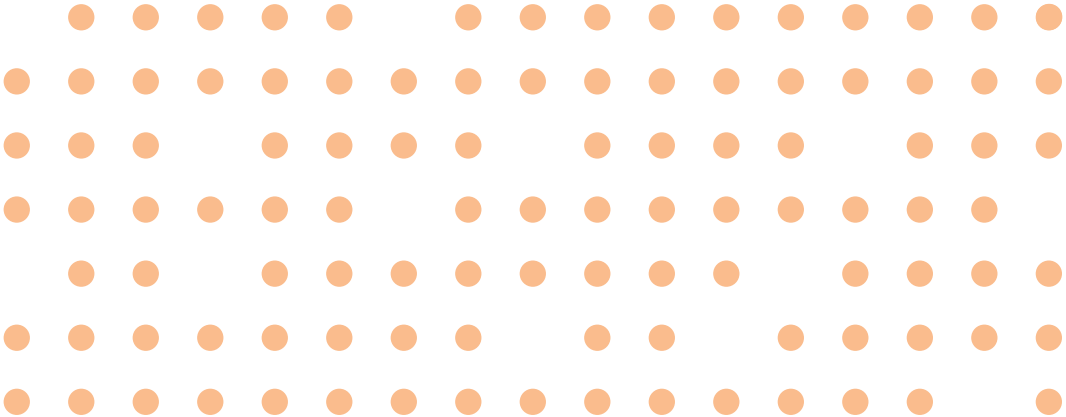
Equity and liabilities

As at 31 December (x Euro, after result appropriation)

	2019	2018
Shareholder's equity	9.997.185	8.907.390
Provisions		
Other provisions	–	117.225
Group Companies	81.123	929.490
Long-term liabilities		
Financial Lease liabilities	51.968	952.393
Non-current liabilities	133.091	1.999.108
Current liabilities		
Accounts payable	1.556.781	1.197.290
Taxes and social premiums	316.762	771.102
Other payables	2.261.635	5.464.478
Current liabilities	4.135.178	7.432.870
Total Equity and liabilities	**14.265.454**	**18.339.368**

Company Income statement

	2019	2018
Revenues		
Gross revenues	19.232.235	21.530.431
External operating costs	1.995.758 -	2.102.427 -
Net revenues	17.236.477	19.428.004
Other operating costs		
Personnel costs	6.834.351	5.982.681
Depreciation property, plant and equipment	5.315.713	6.015.591
Other operational costs	3.556.392	3.012.994
Total other operating costs	15.706.456	15.011.266
Net operating income	**1.530.021**	**4.416.738**
Financial results	206.531 -	881.673
Result before taxes	**1.323.490**	**5.298.411**
Corporate income tax	318.873 -	1.321.557 -
Earnings after tax	**1.004.617**	**3.976.854**
Income from subsidiaries	137.395	3.153.679 -
Net result	**1.142.012**	**823.175**

Independent Auditor's Report
on the Summary of Accounts

The accompanying Summary of Accounts (Financial developments 2019, Company Balance Sheet, Equity and liabilities, Company Income Statement), as presented on page 51 to page 55 of this report is taken from the financial statements for the year ending December 31st, 2019 of Amsterdam Internet Exchange B.V. in Amsterdam in accordance with Part 9 of Book 2 of the Dutch Civil Code. We have issued an unqualified independent auditor's report dated May 12th, 2020 on these financial statements.

The Summary of Accounts does not contain all the disclosures required for full annual accounts according to Part 9 of Book 2 of the Dutch Civil Code. Therefore, reading the Summary of Accounts is not a substitute for reading the audited financial statements.

Management's Responsibility
Management is responsible for the preparation and fair presentation of the Summary of Accounts in accordance with the applied criteria.

Auditor's Responsibility
Our responsibility is to express an opinion on the Summary of Accounts based on our audit. We conducted our audit in accordance with applicable law, including the Standard 810 on 'Engagements to report on summary financial information'.

**Opinion with Respect to the Summary of Accounts**
In our opinion, the Summary of Accounts in all material aspects is consistent with the financial statements for the year ending December 31st, 2019 of Amsterdam Internet Exchange B.V. in Amsterdam, on which we have issued an unqualified independent auditor's report dated May 12th, 2020.

Zaandam, May 12th, 2020
CPAccountants B.V.
– Cees van Prooijen RA
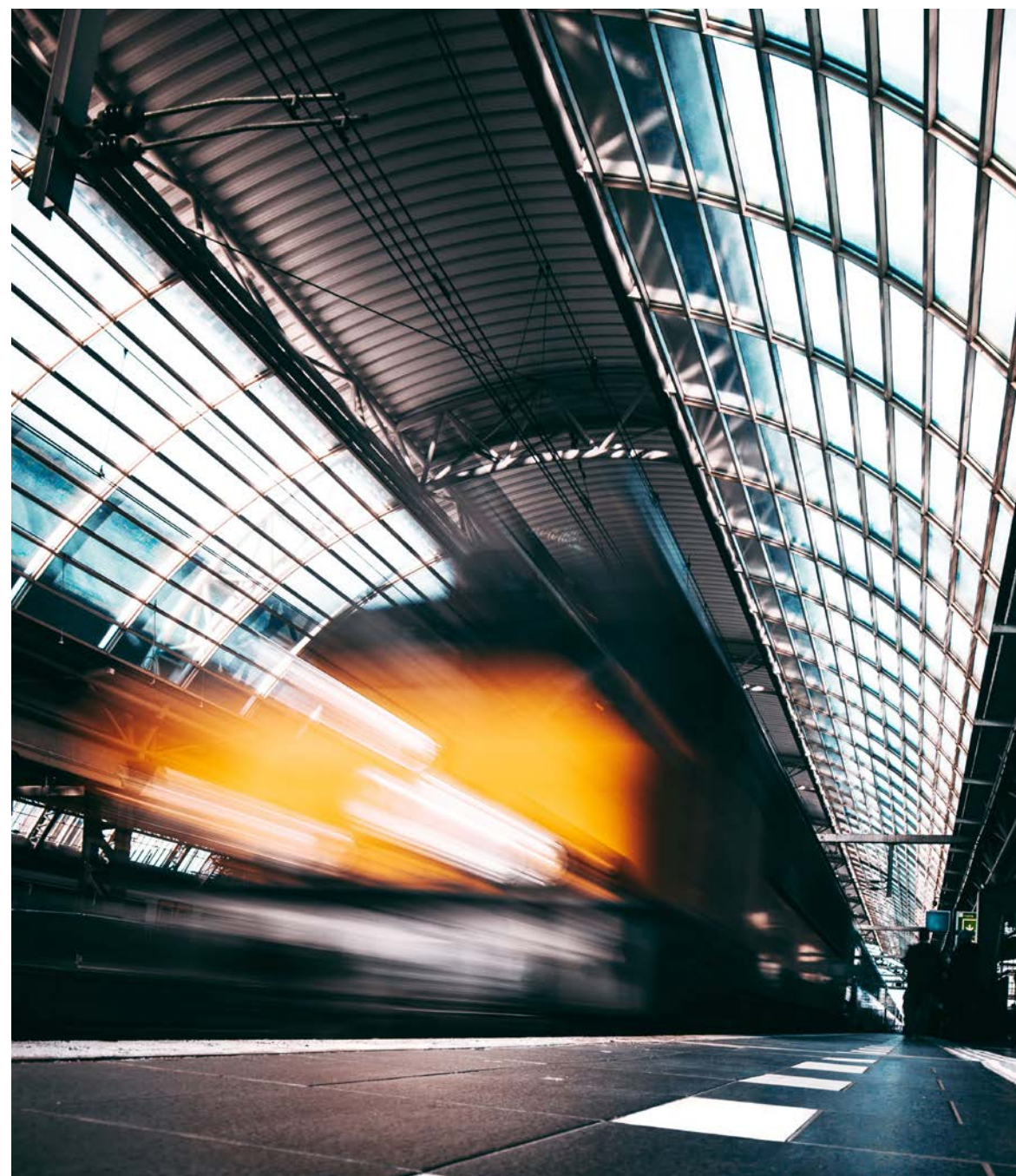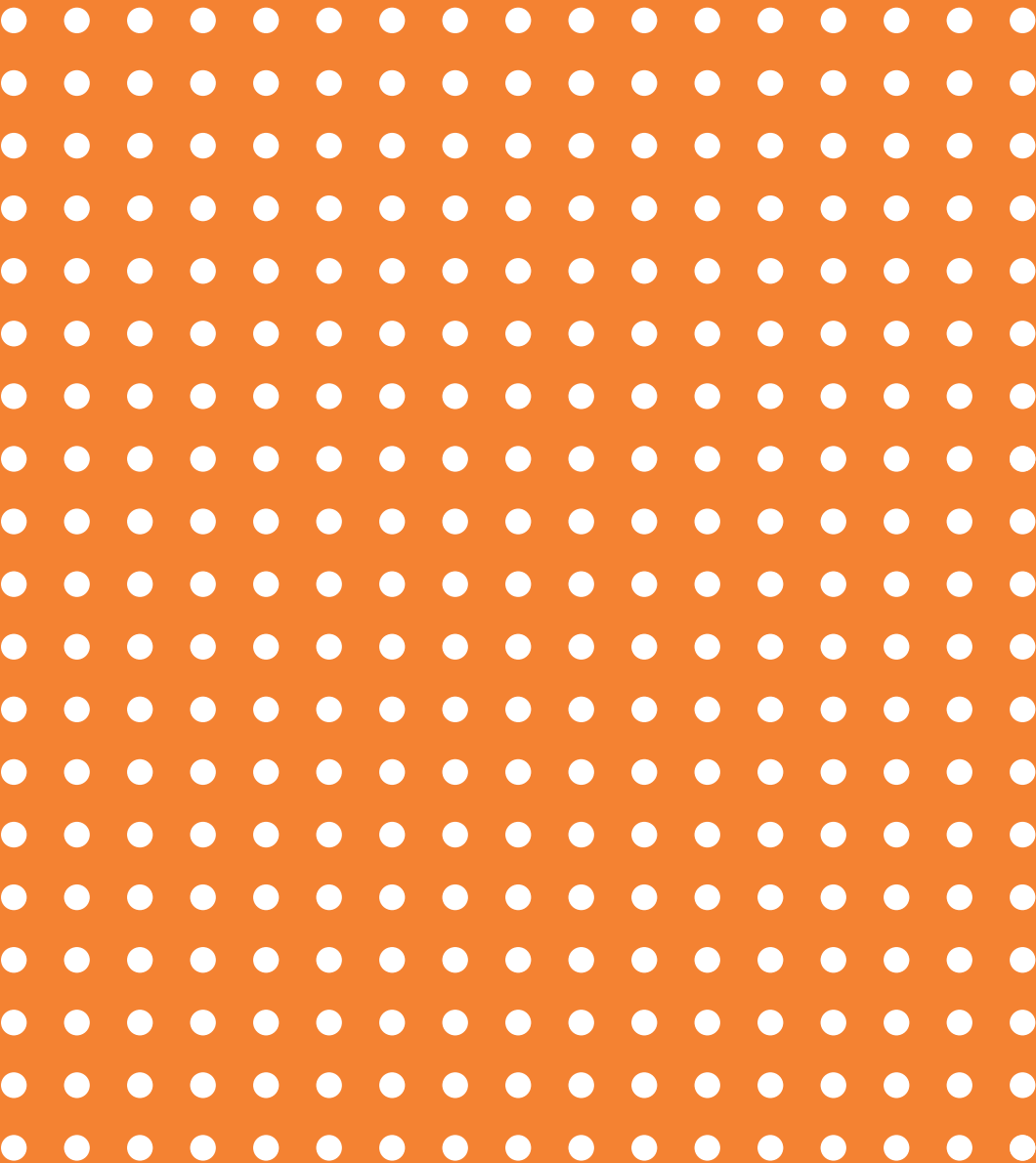
Chapter 3

Tech projects and future of AMS-IX

History   2019   **Future**

Henk Steenman
Chief Technology Officer

Word from the CTO
The Internet has major flaws. What can AMS-IX do to overcome them?'

The Internet is definitely one of humanity's greatest inventions, but it also has some very unsettling shortcomings that need to be addressed. AMS-IX commits itself to overcoming some of these imperfections in the years to come.

The fact that the Internet has some major flaws, is obvious. Just take a look at the papers. Every day there are major hacks and data breaches. A kid with access to a credit card can order DDoS attacks and destabilise the banking sector of a country, accounting for millions in damage. Traffic is rerouted due to malpractice or errors and privacy seems to be a thing of the past. Companies can track and trace everything you do online.

We are so used to this that we don't realize any more how bizarre this situation actually is. When you drink water from the tap (at least in the Netherlands), you know for sure that the water is clean and not contaminated. But, when we go on the Internet, we think it is normal that there are people checking our data, and that there is a good chance that someone is stealing it or that we are being framed.

"AMS-IX is positioned to **help, initiate and build** these new networking communities."

It makes one wonder: is it possible to reengineer the Internet in order to address some of these security and privacy issues?

Some of the problems the Internet is currently facing
It would be wrong to state that the Internet was badly designed, because there wasn't a design in the first place, at least not for what the Internet has become. The foundation was laid by academic groups in the 70s and early 80s (IP and TCP protocol definitions stem from 1973). It was only in the late 80s and early 90s that commercial ISPs were established and started offering services based on TCP/IP. There was an atmosphere of trust and cooperation amongst these first internet pioneers and the way the network is built reflects this mindset. The internet protocols were originally designed for intercomputer communication in an academic environment.

But as we have seen, the Internet has organically grown into a huge, global, communication network.

Currently, the Internet has many shortcomings, such as spoofing of host addresses, DDoS attacks, forged TLS certificates by compromised trust roots, and many more. At AMS-IX we experience, for example, problems with interdomain routing with the use of Border Gateway Protocol (BGP). BGP is a globally distributed protocol exchanging reachability information for their respective ASs (Autonomous Systems). As there is no hierarchy between the BGP speaking routers, updates by a single BGP speaker can impact routing information in the entire Internet. This allows for example, for prefix hijacking and while often these are caused by erroneous configuration, there are well-known cases where this has, and is, been caused by adversaries with criminal or political intentions. Related to this, is prefix 'redirect', where traffic in the end finds its destination, but on its path there it is intercepted for eavesdropping purposes.

Building new internets
It is impossible to re-engineer the existing Internet. Too many companies are relying on the Internet Protocol and it still adds value for the common user to make all the security and privacy risks worthwhile.

We can see this for example, in the way companies handle the problem of address space. The Internet originally used 32-bit addresses, which means that there is a limited amount of address space. This problem was already flagged at the end of the 90s, and it was addressed with the introduction of new 128-bit IPv6 addresses. However, most of the internet organizations have not, or are still in the progress of, migrating to IPv6. With the exhaustion of IPv4 address space all kind of issues start to occur, one of which is the barrier it creates to new service providers on the Internet.

One way to go about this, is to build internets that operate parallel to the current Internet. These new networks connect companies with similar or common goals. They use the networks for specific applications. And, most importantly, they make and abide to their own set of networking rules. This way they can ensure security and trust within their community.

The idea of building new networks that operate next to the current Internet is not as revolutionary as it sounds. In many areas, companies and organizations are working along similar lines. The Dutch government for example, has its own Diginetwork that operates next to the Internet. It is basically a collection of interconnected governmental networks operating under their own rules for privacy and security.

Another example can be found with the GRX, AMS-IX's interconnection platform for exchange of roaming GPRS traffic between mobile operators. The traffic is based on guidelines set by the GSMA.

But there are a lot of possibilities. A great use case for building such a network can be done in the financial sector, especially when it comes to the communication between banks and their users. Momentarily, banks deliver all their services as IP traffic on their network. As a result, if the customer portal of the bank is hit by a DDoS attack, users can be blocked out. It is, however, also possible that the banks organize their network traffic with their users via a separate network thus ensuring the continuity of their services.

The road ahead
AMS-IX is positioned to help, initiate and build these new networking communities. We have been operating at the core of the Internet for more than 25 years. Our interconnection platform in Amsterdam connects more than 875 networks and it is neutral ground for all these organisations. We already have a lot of experience with measures to secure the Internet's routing infrastructure, like the use of RPKI (Resource Public Key Infrastructure) and the implementation of MANRS (Mutually Agreed Norms for Routing Security).

"**Quality standards need to be developed** around internet technology."

We operate with no commercial goals and for the good of all internet companies, which puts us in the position to address some of the general problems of the Internet. Next to that, we have excellent ties with academic organisations, universities and other associations like RIPE, NLnet Lab and ISOC, some of which have initiatives of their own addressing some of the problems of the functioning of the Internet.

AMS-IX can, first and foremost, assist in the development of new technical standards that can help building these new networks. In its most simple form, it means playing a role as neutral intermediary in the development of these new networking communities, facilitating rules on which the networks are to operate. Additionally, it can also mean participating in the development of new alternatives for the Internet Protocols like RINA, SCION and NDN. AMS-IX is already participating in the 2STiC program, a joint research program, where AMS-IX together with NLnet Labs, SIDN Labs, SURFnet, TU Delft, the University of Amsterdam and the University of Twente, aim to test some of these new protocols. But there are fields of technological testing and engineering where AMS-IX can play a role as well, like testing and developing new encryption technologies to be used in a networking environment.

AMS-IX can also play a role in safe-guarding the neutrality of infrastructure to be used for the common good. An interesting use case could be the 5G roll-out in the Netherlands. Many enterprises want to operate their own 5G networks that operate next to networks of telecom operators. AMS-IX can be used as a neutral Exchange point and facilitator of interconnection.

Of course, there is also a lot that needs to be done outside the scope of AMS-IX. Governments for example, need to adapt their legislation so that it is more suited to the current workings of the Internet. The GDPR is an excellent first step to give civilians more control over their personal data. Next to that, quality standards need to be developed around internet technology. For example, currently, poorly secured IoT devices can be sold without any restrictions. A new CE marking for IoT devices would be very welcome.

For 25 years, AMS-IX is playing a leading role in developing and growing the Internet. It brought much good, but we can now clearly see that the Internet also has some flaws which should be the focus of our attention in the future.

AMS-IX launches IX-as-a-Service
with Batelco as a first customer

Aleksandar Mitrov
Head of Products and Services

In the summer of 2019, AMS-IX helped Batelco start an Internet Exchange (IX) in Manama, Bahrain. The new 'Powered by AMS-IX' Exchange runs on IX-as-a-Service (IXaaS), a newly developed solution for building, maintaining, and growing an IX.

Peter van Burgel (AMS-IX) and Adel Al-Daylami (Batelco) sign the IX-as-a-Service contract

The development of IXaaS started already a few years ago, when AMS-IX noticed a rising demand for Internet Exchanges, especially in countries with non-existent IXP presence. The presence of an IX in a specific region not only allows internet end-users to profit from fast, stable, and cost-effective online experiences, but it also accelerates the economic growth and innovation in the respective county and surrounding areas (the influence of AMS-IX on the economy of the city of Amsterdam is a good example of this).

Subsequently, in many countries, the local governments are stimulating telecommunications incumbents to telecommunications companies. A good example of such a case is the Kingdom of Bahrain.

The Kingdom
The Kingdom of Bahrain aims to turn their capital Manama into a key digital hub for the Middle East region. The government made great strides to accomplish this by implementing legislative changes, making it easier for digital businesses to open their doors in Bahrain.

Next to that, The Kingdom also created the Global Zone, a carrier neutral digital business platform based on a highly secured Tier III Data Centre. Furthermore, they also enticed Batelco into setting up a neutral Internet Exchange in Manama.

In 2018, AMS-IX was approached by Batelco. AMS-IX has a great deal of experience in setting up Exchanges outside the Netherlands, by running Exchanges in Hong Kong, Chicago, Bay Area, Mumbai, and on the island of Curaçao, already for years. AMS-IX prefers to start these type of foreign activities (projects) with the help of local partners, due to their knowledge of the respective markets.

Therefore, Batelco's plans fitted AMS-IX's preferred approach. This led to both parties signing a contract during the 2019 Bahrain F1 Grand Prix in Manama.

IX-as-a-Service (IXaaS)
In the past, AMS-IX always pursued its international activities as unique, one-off projects. However, the growing interest in the use of IX technology prompted AMS-IX to develop a new and less labour-intensive way of rolling out an Internet Exchange. This new service was named IX-as-a-Service (IXaaS) and Batelco was the first partner that utilised it. With IXaaS, AMS-IX has bundled all its operational, technical and commercial knowledge into a single service.

The idea is simple: AMS-IX builds an enclosure with pre-patched hardware equipment, software and wiring, scaled to the client's needs. When the enclosure is ready, it is then shipped to the new IX location where it can be set up by local engineers using instructions provided by AMS-IX. Configuring and managing the IX is done remotely by the AMS-IX engineers. The benefit of this approach is that it greatly reduces the amount of work for setting up an Exchange. For the client, the whole process is a plug-and-play. The new Manama IX went live in September of 2019. Since then, eight customers have connected to the new IX, and amongst them are some of the biggest content providers and local ISPs in the world: Viva, ITC, Batelco, Amazon, Microsoft, Ooredoo, Tata and Zain. MN-IX registered a peak traffic of 15,8 GE and the total port capacity is 270 GE.

In November 2019, Batelco renewed their established partnership with Gulf Bridge International hence strengthening the connectivity between Bahrain and Europe. More customers are expected to connect in the coming year, as the Exchange will steadily progress into a connectivity hub for the region. AMS-IX not only considers this project a commercial success, but foremost as a technical triumph. For IX-as-a-Service to work, the AMS-IX development team had to build new provisioning software and new portal software. The construction of IX-as-a-Service enhanced the ability to execute.

Supported features of IX-as-a-Service

- Cutting-edge IX Platform with all the necessary switching infrastructure to set up a professional and scalable Internet Exchange (from one to multiple sites)

- Software-defined provisioning and monitoring software allowing rapid provisioning of connections

- Secure route server with filtering based on RRDB objects, as well as on predefined BGP communities, compliant with the latest routing security norms

- Customer portal with self-service functionalities and traffic and sFlow statistics

- First and/or second-line technical support by highly trained professionals, available 24/7

- Next generation firewalls, providing enterprise-grade security

Over the next years, AMS-IX will focus on their efforts for setting up new Exchanges in multiple regions around the world. At the same time, the AMS-IX development team will develop the IXaaS offering further in order to reduce the footprint and associated costs.

International
Presence

Amsterdam

879 Connected parties

POPs	14
Total ports	1268
Peak	7.025 Tbps
Capacity	34.6 Tbps

Chicago

29 Connected parties

POPs	2
Total ports	31
Peak	127.09 Gbps
Capacity	670 Gbps

Bay Area

25 Connected parties

POPs	3
Total ports	14
Peak	31.43 Gbps
Capacity	154 Gbps

Hong Kong

55 Connected parties

POPs	1
Total ports	27
Peak	53.43 Gbps
Capacity	424 Gbps

Caribbean

12 Connected parties

POPs	2
Total ports	14
Peak	22.32 Gbps
Capacity	105 Gbps

Mumbai

48 Connected parties

POPs	2
Total ports	44
Peak	60.77 Gbps
Capacity	409 Gbps

Upgrading to
SLX switches

Konstantinos Prantzos,
Manager Operations

Konstantinos Prantzos

In 2019, we completed a major upgrade of our interconnection platform in Amsterdam, with new Extreme SLX switches. Although there is still some work to be done, the benefits are already visible: a significant increase in our port capacity and 30% less energy consumption.

AMS-IX is always in line with the latest technology and this project was no exception. In 2017, several AMS-IX locations were running low on ports, and the need for an upgrade was imminent. At the time, Extreme Networks had just launched its new, high capacity switching platform. Implementing these new switches would enable us to work with the latest technology available, but the implementation required a lot of work from our side. The new SLX switches would offer far more ports, as they could support the use of 400 Gigabit line cards, and require approximately half the physical rack space than the previously used MLXs.

Presentation of the SLX-9850 switch during MORE-IP Chicago

Challenges

We started off by replacing the core switches. This action enabled us to continue growing our backbone capacity, in order to meet the continuous requirements of our platform. The next step was the replacement of the customer-facing switches. In 2018, we were focused on optimizing and stabilizing the rollout and implementation plan. At the same time, we performed a few additional migrations, by replacing four additional switches, in four different locations. By the end of the year, we had completed the migration at 6, out of our 14, locations.

In the first half of 2019, we completed a major chunk of the project. We migrated the secondary customer-facing switches in all the already SLX-enabled sites. Although unforeseen issues were less likely to appear, we still faced a few challenges. On top of the time-sensitive and extensive physical work that was required, there were also various systems that needed to be updated, and many dependencies were involved.

For instance, the 'super-site', i.e Interxion IX9 and Nikhef interconnection, required special attention due to its uniqueness. At the same time, we were handling day-to-day operations, but in the end, everyone did a fantastic job, and we managed to complete everything as planned.

Benefits and next steps

The SLX migrations offer significant advantages to AMS-IX —the main one being scalability. We are once again able to scale up and meet our growth expectations. Additionally, in 2019, we upgraded the backbone capacity several times, without facing hardware limitations, the number of platform switches dropped due to consolidation and we are able to cut back on power consumption by 30%, from 300 Kwh to 230 Kwh.

2020 will be a busy year for NOC and Engineering. There are still sites that make use of MLX switches, some of which, we are planning to migrate to SLXs. Also, we are still using MLX switches in our SLX-enabled sites in order to support our reseller program. By now, we have almost completed the software feature tests and are getting ready to roll out the new SLX feature that is meant to facilitate the support of our reseller connections. In a nutshell, there is never a dull moment for our teams, and the future is looking bright.

The AMS-IX Information Security and System Operations team. Thomas Manolis (at the back), Enrique Gil Palau (left) and Miguel Regalado Querol (right)

AMS-IX public domains are **DNSSEC**-enabled

AMS-IX Information Security and System Operations team

As of the 29th of August 2019, AMS-IX is the first Internet Exchange to have DNS Security Extensions (DNSSECs) enabled for all the public (forward) domains it hosts.

Security is a fundamental principle for us, and we continuously strive to keep offering a trustworthy Internet to our customers, hence last year, a complete redefinition of our Domain Name System (DNS) infrastructure was a priority. This implementation was a joint effort between our Information Security Officer and our System Operators.

Brief description
The Domain Name System Security Extensions (DNSSECs) is a suite of Internet Engineering Task Force (IETF) specifications. It is used for securing certain kinds of information provided by the Domain Name Server (DNS).

The DNS can be considered as the internet's 'phone book'. It maintains a directory of domain names and translates them into IP addresses. DNS has almost 300 Requests for Comments (RFCs) making a total of more than 2000 pages, most of which are security-related. DNSSEC is one of them and provides vital functions.

Internet criminals can exploit weaknesses and are capable of creating false DNS records. These fake records can 'trick' users into visiting fake websites, downloading malicious software, or worse.
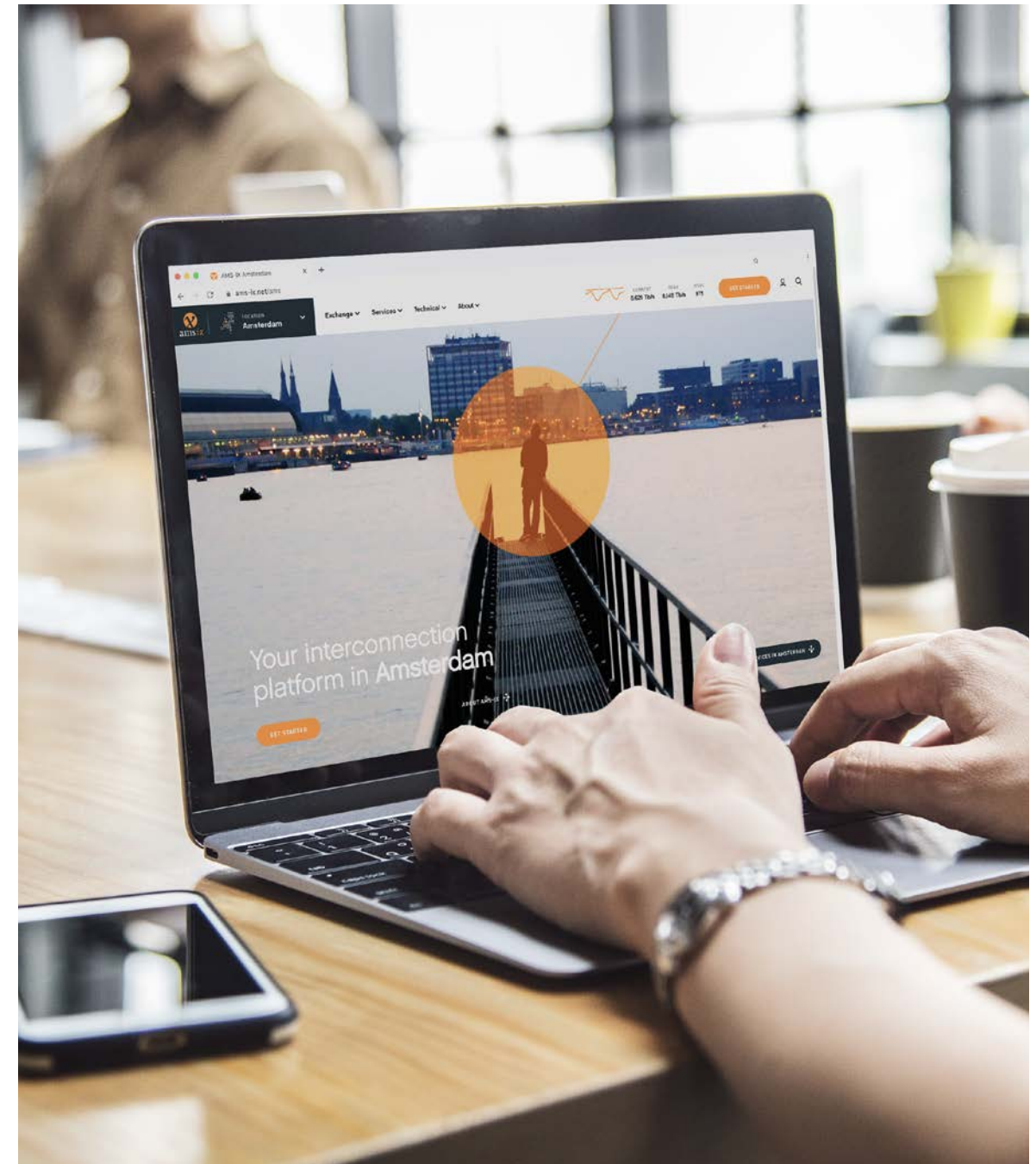
AMS-IX public domains

The public domains we are hosting and are now DNSSEC-enabled are:

- ams-ix-caribbean.com
- ams-ix-caribbean.net
- ams-ix-caribbean.org
- ams-ix.net
- amsix.net
- ixaas.net
- more-ip-event.net
- ams-ix.nl
- peering-forum.eu
- digitale-infrastructuur.nl

DNSSEC was created to save the day, by providing a level of additional security where the web browser can check to make sure that the DNS information is correct and was not modified. Additionally, DNSSEC is not only intended for the web, but can also be used by any other Internet service or protocol.

Implementation
A crucial factor that led to the enablement of DNNSEC, apart from security reasons, was manageability and integration with our my.ams-ix.net customer portal. Luckily, the implementation was not complicated. The difficulties we faced were mostly related to the migration of our legacy DNS infrastructure to a newer one, so the project had —since the very beginning— a few, well-defined milestones: creating new DNS resolvers, new authoritative DNSs, new master DNS, a split horizon configuration with other extra configurations, and lastly, our developers getting used to working with a new product.

The CTO's of AMS-IX, DE-CIX and LINX
on stage during the launch of IX-API

IX-API one API to provision them all

Petros Papadopoulos
Software developer

Last year, AMS-IX together with DE-CIX and LINX, announced the development of a single API that can be consumed for provisioning services in a standardized way at all three Interconnection platforms. The project is not only a success because it created a new industry standard, but it also shows that three competitors can work together very well on one common goal.

The API was presented to the world in September 2019, during the 14th European Peering Forum (EPF) in Tallinn but the project started much earlier. In the summer of 2018, the CTOs of all three Exchanges gathered with a number of relevant technical experts and decided to go forward with this project.

Since then, the development teams of AMS-IX, DE-CIX and LINX come together every six weeks in Amsterdam, London or Frankfurt, in a rotational manner. In between these sessions, the respective development teams stay up to date via weekly and bi-weekly conference calls.

A new industry standard

IX-API stands for Internet Exchange Application Programming Interface. It is a technical communication protocol which can be used to interface and provision connections on all three Exchanges. The big advantage of the IX-API is that it enables customers to interface with any IX, in a standardized way. This results in fast, efficient and less error- prone provisioning of connections.

The first release of the API supports applications that can be consumed by a customer portal of, for example, a reseller. The API will automate the ordering process for customers of the resellers that want to connect to one of the IXs.

The intention is that the API will become an industry standard. Next to DE-CIX, LINX and AMS-IX, multiple other exchanges have shown their intention to implement the API.

If things go according to plan, the new API will increase competition which will drive down prices. In the end, the whole industry will benefit from it.

Resellers

From very early on in the development of the project, we worked together with our testing partners, Epsilon and Interxion, who indicated that they would be interested in consuming the API allowing for their customers to order directly on the IXs. Their input was vital in making the API a success.

The first phase of the project was focused on resellers and has been finalized for all three Exchanges. Any reseller with preconfigured physical reseller port(s) and a pre-created, reseller's API-user can now provision services via the API. Going further, the IX-API will be available to a broader range of IX users, like Internet Service Providers, Content Delivery Networks, carriers, and other IXs.

The project is not only significant because of its technical challenges, but also shows that the three Exchanges can collaborate very well. It is possible that the development teams of AMS-IX, DE-CIX and LINX will work together in other projects as well. The future looks very promising!

Petros Papadopoulos

Supported features of IX-API

- Authentication in the API
- Overview of customer contracts
- Option to create a new customer contract and add customer contact information to it
- Overview of enabled physical ports
- Option to create a new MAC address under a customer contract
- Overview of all VLANs available at AMS-IX, DE-CIX and LINX
- Option to create a new virtual link for customers and add a previously created MAC to it
- Overview of customers' virtual links
- Provision a newly-created virtual link
- Overview of all available route servers at AMS-IX, DE-CIX and LINX
- Enable route server peering for a provisioned virtual link

2STiC making the Internet safe, secure, and transparent

Stavros Konstantaras
Senior NOC Engineer

At the end of 2019, AMS-IX joined a coalition, consisting of several universities and not-for-profit organizations, for testing and developing new internet architectures. The goal of the project? Experiment with a new type of internet, one without some of its major flaws.

Stavros Konstantaras

2STiC (pronounced "to-stick') stands for Security, Stability and Transparency in inter-network communication. The name gives away some of the problems we want to address with this initiative. For years, academics and engineers looked for ways to tackle some of the major design flaws of the Internet, independently. 2STiC is the program where they all team up. It is a joint research program comprised by AMS-IX, NLnet Labs, SIDN Labs, SURFnet, TU Delft, the University of Amsterdam and the University of Twente. Together, we aim to make academic ideas more concrete and experiment with feasible internet architectures. If the project meets its goals, it will allow us to build alternative versions of the Internet to date, which will be safer and more stable.

TCP/IP

The problems that the Internet is currently facing have resulted from its initial strength: the TCP/IP protocol. The protocol dictates that packages are sent over a network without defining a route, which has the advantage that traffic automatically flows via another route when a connection suddenly breaks. This makes the network resilient and it allows senders and receivers to make use of a network without the need to go into much technical details for setting up a connection. The success of the protocol is the Internet we see today: a gigantic network connecting billions of people all over the planet.

The TCP/IP protocol, however, was not designed to accommodate such a network. Consequently, the protocol has some flaws. TCP/IP is basically built on trust. Nobody knows how traffic comes from A to B, making it very susceptible to hackers or other malicious users who want to control traffic. People can send huge amounts of traffic from A to B with a DDoS attack, without the risk of getting caught. Next to that, the TCP/IP protocol gives networks very little control over their traffic route. Traffic routing can only go as far as sending traffic from your node to the next node. After that, the traffic is out of sight again.

SCION

The 2STiC research group wants to experiment with some of the new internet architectures that have been

developed by academia, like SCION, NDN and RINA. All three network designs are major alternatives for TCP/IP networks. 2STiC comprises of several working groups and AMS-IX is present in two (every organization brings in two representatives). The first one aims to gather network specs from enterprises. The second group is involved in building a test network. Other groups will work on preparing the architecture designs for practical use.

The first architecture that is going to be tested in 2020 is SCION. It is a path-based architecture that allows end-hosts to learn about available network path segments and combine them into end-to-end paths that are carried out in packet headers. Thanks to embedded cryptographic mechanisms, path construction is constrained to the route policies of ISPs and receivers, offering path choice to all the parties: senders, receivers, and ISPs.

2STiC can go on as long as new architectures are there to be considered. If a particular architecture presents itself as a safe, secure and transparent alternative for the TCP/IP-based Internet, it will allow us to start building a community of trusted partners and parties to make use of this alternative architecture. One that will co-exist next to the 'normal' Internet but can be used by communities like financial institutions or the government. The question will then be: what kind of Internet do you want?

Colophon

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