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IXP Workshop

ISOC, RIPE NCC, INEX, Euro-IX

Beirut, March 2017

What do we do?

- Two fora per year

- Maintain and develop the website, database and tools

- Annual European IXP Report

- Mentor-IX programme

- Fellowship programme

- Benchmarking Club (BMC)

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Talk to us and each other

- Mailing lists

- Newsletter – Subscribe here:

  - euro-ix.net/news-and-events/newsletter/

- Working Groups

- Social Media

  - Twitter   @euroix

  - Facebook   fb.me/maineuroix

  - YouTube   youtube.com/channel/UCFyucVRAAMzxyJIsxnGwsjw

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Association of IXPs

82 affiliated IXPs:

- 56 IXPs in the Euro-IX Region 49 Countries, operating over 100 Peering LANs

- 26 IXPs from the rest of the world

- Newest Members:

  Global-IX

  DataIX

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Patrons

- **Arista**
- Brocade
- **Ciena**
- **Coriant**
- ECI Telecom
- Equinix | Telecity
- Extreme Networks

- Huawei
- Interxion
- Juniper Networks
- MRV
- Nokia
- Telehouse

Website

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What is an IXP?

What is an IXP?

- *An Internet Exchange Point (IXP) is a network facility that enables the interconnection of more than two independent Autonomous Systems, primarily for the purpose of facilitating the exchange of Internet traffic.*

- *An IXP provides interconnection only for Autonomous Systems.*

- *An IXP does not require the Internet traffic passing between any pair of participating Autonomous Systems to pass through any third Autonomous System, nor does it alter or otherwise interfere with such traffic.*

- *"Autonomous Systems" has the meaning given in BCP6/RFC4271 , "A Border Gateway Protocol BGP4".*

- *"Independent" means Autonomous Systems that are operated by organisational entities with separate legal personality.*

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What is an IXP?

Explanation notes:

1. An Internet Exchange Point is a technical facility. This is distinct from the organisation that provides that facility, which might be termed an IXP operator.

2. An IXP is distinct from an Internet access network or a transit network/carrier.

3. The function of an IXP is to interconnect networks. An IXP does not provide network access or act as a transit provider/carrier. An IXP also does not provide other services unrelated to interconnection (although this does not preclude an IXP operator from also providing unrelated services).

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What is an IXP?

Explanation notes contd.:

4. An IXP exists to interconnect networks that are technically and organisationally separate.

> *a. Without qualification the term "network" is too flexible and fails to identify the degree or kind of separation required. Once interconnected, separate networks are arguably part of the same network: the entire Internet is often considered a network, a network of networks.*

> *b. To resolve this terminological problem we employ the term "Autonomous System", which is the standard technical definition of a technically stand-alone network.*

How do IXPs work?

- A typical IXP consists of one or more router / switch

- To which each of the participating networks can connect to

- The technical and business logistics of the traffic exchange between networks is governed by mutual peering agreements

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Why do we need IXPs?

Why do we need IXPs?

- IXPs enable local traffic to stay local

- This increases efficiency of internet traffic and allows settlement-free peering rather than paying for transit, i.e. reduce cost

- Reduce latency

- Allows and encourages content to be accessed locally

- Reduces dependency on critical nation infrastructure

- Local content business has a higher chance of success

- Greater chance of local businesses to survive

- Can increase knowledge sharing and experience (via IXP meetings and mailing lists)

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Why do we need IXPs?

Traceroute
Kujtesa -> Artmotion

Before

Tracing route to 84.22.48.99 over a maximum of 30 hops

```
1     1 ms     1 ms     1 ms  192.168.1.1
2   132 ms   102 ms    23 ms  10.255.31.254
3   146 ms   100 ms   102 ms  10.20.30.254
4    24 ms    22 ms    21 ms  82.114.64.185
5    25 ms    62 ms    19 ms  79.101.105.229 [Telekom Srbija]
6    23 ms    19 ms    18 ms  212.200.227.225
7    24 ms    19 ms   109 ms  212.200.232.90
8   218 ms    22 ms    24 ms  212.200.17.45
9   103 ms   104 ms   102 ms  79.101.96.130
10  122 ms   102 ms   103 ms  84.22.63.109
11  126 ms   102 ms   106 ms  84.22.63.25
12  114 ms   100 ms   103 ms  84.22.32.198
13  118 ms   102 ms   102 ms  84.22.48.99
```

Trace complete.

After

Tracing route to 84.22.48.99 over a maximum of 30 hops

```
1    1 ms     1 ms     1 ms  192.168.1.1
2   40 ms    84 ms    22 ms  10.255.31.254
3   44 ms    17 ms    10 ms  10.20.30.254
4   12 ms    23 ms    24 ms  82.114.64.185 [Kujtesa]
5   22 ms    16 ms    12 ms  192.168.100.12 [KOSIX]
6   31 ms    24 ms    12 ms  84.22.32.198 [Artmotion]
7   27 ms    11 ms    21 ms  84.22.48.99
```

Trace complete.

Improvement:
- Drop from 13 to 7 hops
- Average 3-packet delay drop from 75ms to 22ms

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Why do we need IXPs?

Ping
Kujtesa -> Artmotion

Before

Pinging 84.22.48.99 with 32 bytes of data:
Reply from 84.22.48.99: bytes=32 time=131ms TTL=245
Reply from 84.22.48.99: bytes=32 time=143ms TTL=245
Reply from 84.22.48.99: bytes=32 time=181ms TTL=245
Reply from 84.22.48.99: bytes=32 time=199ms TTL=245

Ping statistics for 84.22.48.99:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 131ms, Maximum = 199ms, **Average = 163ms**

After

Pinging 84.22.48.99 with 32 bytes of data:
Reply from 84.22.48.99: bytes=32 time=16ms TTL=249
Reply from 84.22.48.99: bytes=32 time=14ms TTL=249
Reply from 84.22.48.99: bytes=32 time=14ms TTL=249
Reply from 84.22.48.99: bytes=32 time=13ms TTL=249

Ping statistics for 84.22.48.99:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 13ms, Maximum = 16ms, **Average = 14ms**

Improvement :
Average RTT drop from 163 ms to 14 ms

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IXP Hosting

Hosting IXPs

- Location is Key

- Should be **Neutral** (not competing with customers)

- Should have enough space, environment control, security, power, access to terrestrial infrastructure, cabling, support

- IXPs generally abstain from carrying out any activity that may compete with member business activities or opportunities.

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IXP Hosting

- The Important Point is that the ownership and management of the IXP should always remain netural

- Many IXPs begin with donations of equipment, rack space, labour, and other assistance. This is part of the cooperative nature of most start-up IXPs.

- Neutrality can be at stake if one member owns parts of the IXP.

- Therefore the IXP should always maintain ownership and responsibility of its assets.

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IXP Models

IXP Models

Free IXP

- The IXP location is donated or paid for by a willing sponsor

- No membership, joining or paid for by willing sponsor

- Members contribute (donate) equipment, money, human resources and time to the IXP based on their ability and needs

- Examples, UIXP (Uganda), SIX (Seattle)

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IXP Hosting

Subsidized Business Model

- Certain aspects and operational costs of the IXP are met by a sponsor for a sustained period of time

- In most cases the Government through development fund subsidize the IXP operating costs

- The IXP meets some of the operating costs by charging members a nominal fee

- Examples, IXPN (Nigeria), MYIX (Malaysia)

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IXP Models

Independent Business Model

- All aspects of operational expenses are met by the IXP

- The IXP generates revenue by charging fees for the service

- Additional revenue from value added services

- Examples, KIXP (Kenya), JINX (South Africa) and most EU IXPs

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Getting Started

Getting started

Netnod – Swedish Internet Exchange

- First peering agreement between SUNET (Swedish University Network) and Swipnet in 1990 – this was the first step to forming an IXP

- In 1991/1992 Ebone is formed to handle EU traffic

- In 1995 the idea of forming a distributed global internet exchange D-GIXes – would connect to Paris and Washington

- In 1996 it grew from 20 operators connected to 40 for a cost of 2000 USD a year

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Getting started

Netnod – Swedish Internet Exchange

- In 1996 the Swedish government ran a study on critical infrastructure and identified –
  - .se
  - And internet exchanges

- Proposal was to build 5 IXPs, one per 1M population

- That was the beginning of Netnod – the Swedish IXP

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Getting started

FICIX – Finnish Internet Exchange

- 1993 – initial agreement between Telecom Finalnd, Helsinki telephone company and Eunet to interconnect forming the IXP

- Initially exchanged traffic on 10Mpbs Ethernet hub

- 1996, upgraded to a 155-ATM switch

- 1999, Upgraded to 622-ATM switch

- 2001, association founded, 11 founding members

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Getting started

FICIX – Finnish Internet Exchange

- 2002, upgraded to Gige technology

- 2004, first 10Gige ports delivered

- 2013, upgraded to 100Gige Technology

- Adding value
  - Developing membership services further
  - Extended services to enable VoIP transport between telco's
  - Taking part in regulatory and security work as CIP organisation

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Getting started

LINX – London Internet Exchange

- In November 1994, using a donated piece of equipment 5 ISPs in the UK linked their networks in order to exchange data and avoid paying astronomical transatlantic bandwidth costs

- The goal was to keep traffic local

- Switching the first data through the Telehouse hub was a momentous event that was accomplished by primarily technical specialists who were unconcerned about the formalities of legal contracts.

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Getting started

LINX – London Internet Exchange

- From the beginning it was agreed that LINX would be a non-profit organisation run for the benefit of members and governed by them collectively through regular member meetings, a practice which continues to this day.

- In summer 1996 LINX became the first Internet exchange in the world to deploy a 100-megabit switch - a Cisco Catalyst 5000.

- In January 1999 it pioneered the implementation of a Metropolitan Area Network (MAN) running over gigabit Ethernet connections.

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Getting started

LINX – London Internet Exchange

- LINX membership reached 200 in mid-2006.

- In 2012, the first 100G member port went live (for BT), just before the start of the London Olympic Games.

- 2012 saw the launch of the ConneXions reseller programme.

- IXScotland went live in November 2013.

- In 2014 LINX opened an IXP in the USA

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Website – Top Improvements!

1. ASN Automation

2. Switch Database

3. Route Server Database

4. Peering matrix, service matrix and ASN

5. Database quality improvements

6. Edit your organisation and team members

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IXP Database

Organization Profile

Internet Neutral Exchange Association

General | Introduction | Contacts | IXPs | Users

Location:	Ireland
Established:	1996-09-01
Affiliation:	Member
Board Contact:	
Email:	barry.rhodes@inex.ie
Website:	https://www.inex.ie/

Edit

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IXP Database

Organization Profile

Amsterdam Internet Exchange B.V.

General   Introduction   Contacts   **IXPs**   Users

NAME	COUNTRY
AMS-IX Bay Area	United States of America
AMS-IX Caribbean	Netherlands Antilles
AMS-IX Chicago	United States of America
AMS-IX Hong Kong	China
AMS-IX India	India
AMS-IX New York	United States of America
Amsterdam Internet Exchange	Netherlands

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IXP Database

IXP Database

ASN Database

Stats Search Recent Common

IXP PARTICIPANTS	IPV6	UNIQUE ASNS
EURO-IX		
8715	5488	4478
APIX		
1513	447	929
AF-IX		
335	64	296
LAC-IX		
1883	1258	1385
NORTH AMERICA		
2195	538	1086
GLOBAL		
14641	7795	7755

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IXP Database

ASN Database

Stats   Search   Recent   **Common**

AS#	COMPANY	PRESENT AT	IPV6
6939	HE	80	Ⓨ
20940	Akamai		
15169	Google		
3856	Packet Clearing House		
42	WoodyNet		
8075	Microsoft		
22822	Limelight Networks, Inc.		
10310	Yahoo Inc. (B)		
13335	CloudFlare		
16509	Amazon		
26415	VeriSign Netherlands BV		
15133	Edgecast		

IXPs

AMS-IX
AMS-IX Bay Area
AMS-IX Chicago
AMS-IX Hong Kong
AMS-IX New York
BBIX - Tokyo
BCIX
BIX.BG
BiX
Big APE
CATNIX
CoreSite - Any2 Denver / RMIX Denver
CoreSite - Any2 Los Angeles
DE-CIX Frankfurt
DE-CIX Hamburg
DE-CIX Marseille
DE-CIX Munich
DE-CIX New York
DIX - Lyngby
ECIX Berlin

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IXP Database

Peering Matrix

CSV Download

	Total listed ASNs	ASNs that don't peer at other IXPs	% of ASNs that don't peer at other IXPs	ASNs that peer at other IXPs	% of ASNs that peer at other IXPs	ALB-IX	AMS-IX	AMS-IX Caribbean	ARMIX	Angonix	BBIX - Hong Kong	BBIX - Tokyo	BCIX	BIX.BG	BNIX	BiX	CATNIX	CHN-IX	CIX	CIX
AMS-IX	79.77	0				796	2	0	0	0	2	37	22	19	17	11	0	4	19	
AMS-IX Caribbean	30.77	0				2	13	0	0	0	1	1	1	0	0	1	0	1	0	
ARMIX	0.00	0				0	0	10	0	0	0	0	0	0	0	0	0	0	0	
Angonix	50.00	0				0	0	0	2	0	0	0	0	0	0	0	0	0	0	
BBIX - Tokyo	62.50	0				2	1	0	0	0	8	2	2	0	1	1	0	0	0	
BCIX	70.89	0				37	1	0	0	0	2	79	8	3	4	4	0	2	2	
BIX.BG	58.33	0				22	1	0	0	0	2	8	72	1	4	3	0	3	0	
BNIX	53.33	0				19	0	0	0	0	0	3	1	45	4	2	0	0	3	
BiX	42.86	0				17	0	0	0	0	1	4	4	4	49	2	0	1	1	
CATNIX	37.50	0				11	1	0	0	0	1	4	3	2	2	32	0	3	1	
CIX	37.50	0				4	1	0	0	0	2	3	0	1	3	0	32	0		
CIXP	75.00	0				19	0	0	0	0	2	0	3	1	1	0	0	36		
DE-CIX Frankfurt	72.48	0				385	1	0	1	0	2	46	26	17	17	8	0	5	15	
DIX - Lyngby	59.09	0				22	1	0	0	0	2	5	2	4	2	2	0	0	3	
ECIX Berlin	83.67	0				24	1	0	0	0	2	22	5	1	3	1	0	1	0	
Equinix Paris	83.38	0				131	1	0	0	0	2	19	10	8	5	6	0	2	7	
Equinix Zurich	98.95	0				69	1	0	0	0	2	10	7	4	2	3	0	1	2	
FICIX - Helsinki	56.67	0				9	0	0	0	0	2	1	2	2	1	0	1	1		
FVG-IX	75.00	0				3	0	0	0	0	1	1	1	0	0	0	0	0		
France-IX Paris	89.80	0				113	1	0	0	0	2	17	8	12	7	6	0	2	5	

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IXP Database

IXP Service Matrix

CSV Download

IXP	Location	ASN	RS ASN	# of customers	# IPv6 ready	% IPv6 ready	# of Sites	
AMS-IX	Amsterdam							
AMS-IX Bay Area	San Francisco			23	17	73.91	0	
AMS-IX Caribbean	Willemstad, Curacao	28017		14	6	42.86	1	
AMS-IX Chicago	Chicago			21	17	80.95	0	
AMS-IX Hong Kong	Hong Kong	58516		32	25	78.12	1	
AMS-IX India	Mumbai					0.0	0	
AMS-IX New York	New York	62981		18	17	94.44	4	
ARMIX	Yerevan	51225		10	8	80.00	1	
Angonix	Luanda	327788		2	2	100.00	0	
Aracaju (SE)	Aracaju					0.0	0	
BBIX - Hong Kong	Hong Kong					0.0	0	
BBIX - Tokyo	Tokyo	23640		8	1	12.50	7	
BCIX	Berlin	16374		83	72	86.75	6	
BIX Bergen	Bergen	0		4	2	50.00	0	
BIX.BG	Sofia	15669		77	36	46.75	8	
BNIX	Brussels	5406		45	14	31.11	3	
Belo Horizonte (MG)	Belo Horizonte			29	13	44.83	0	
Belm (BEL)	Belém			15	6	40.00	1	
BiX	Budapest	5507		49	37	75.51	3	
Braslia (DF)	Brasilia			32	21	65.62	0	
CATNIX	Barcelona	49638		35	22	62.86	3	
CHN-IX	Beijing					0.0	0	
CIX	Zagreb	51702		32	11	34.38	2	
CIXP	Geneva	57859		36	7	19.44	3	

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IXP Database

IXP Database

Switch Database

Browse | Recent | For Sale | My IXP Switches | Add Switch

NAME	VENDOR	MODEL	IXP	SOFTWARE VERSION	CREATED
Cremat	Arista	7280SE-72	CATNIX	4.15.3F	Sept. 28, 2016
Sucre	Arista	7280SE-72	CATNIX	4.15.3F	Sept. 28, 2016
CIX2	Force10	S4810	CIX	9.10(0.0)	Sept. 23, 2016
mlx-zh4	Brocade	MLXe-16	SwissIX	5.7.0dT163	Aug. 02, 2016
mlx-rue	Brocade	MLXe-16	SwissIX	5.7.0dT163	Aug. 02, 2016

NAME	VENDOR	MODEL	IXP	SOFTWARE VERSION	UPDATED
switch26	Extreme	X480-24x(10G4X)	LINX LON2	15.4.1.3	Oct. 23, 2016

Route Servers

Browse | Recent | My Route Servers | Add Route Server

IXP	AT IXP	NAME	IN USE	DAEMON	VERSION	OS	CREATED
DE-CIX Frankfurt	Y	rsbh.fra.de-cix.net	Y	BIRD	1.6.3	Debian	Jan. 28, 2017
ECIX Munich	N	rs1.muc.ecix.net	Y	bird		CentOS	Jan. 27, 2017
InterLAN	Y	RS02-INTERLAN	Y	BIRD	1.3.11	CentOS	Nov. 11, 2016
InterLAN	Y	RS01-INTERLAN	Y	BIRD	1.3.11	CentOS	Nov. 11, 2016
SAIX	Y	saix-rs1	Y	BIRD	1.4.5	Debian	Nov. 11, 2016

IXP	AT IXP	NAME	IN USE	DAEMON	VERSION	OS	UPDATED
TOP-IX	Y	rs2.top-ix.org	Y	BIRD	1.6.2	Ubuntu	Feb. 21, 2017
TOP-IX	Y	rs1.top-ix.org	Y	BIRD	1.6.2	Ubuntu	Feb. 21, 2017
DE-CIX Frankfurt	Y	rs2.fra.de-cix.net	Y	BIRD	1.6.3	Debian	Jan. 28, 2017
DE-CIX Frankfurt	Y	rs1.fra.de-cix.net	Y	BIRD	1.5.0	Debian	Jan. 28, 2017
DE-CIX Frankfurt	Y	rsbh.fra.de-cix.net	Y	BIRD	1.6.3	Debian	Jan. 28, 2017

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IXP Database – where are we?

- Database schema is in place for IXPs to record their information about themselves and the operators they serve

- IXP API is live - https://db.ix-f.net/api/ixp

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IXP Database – What's next?

- Extend and internationalise the admin interface for all IXPAs (APIX, LAC-IX and AF-IX)

- Create bespoke maintained APIs

- Future revisions to the database schema to capture more data

IXP Database – use case

Thanks to Andy Davidson for the example

"who am I not peering with at LONAP?"

- You have a script which load direct adjacencies into an array

- You need a complete and canonical list of peers to compare differences

IXP Database – use case

Using the IXP API

https://db.ix-f.net/api/ixp

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IXP Database – use case

```
{
    "ixp_info": {
        "status": "active",
        "updated": "2014-02-17T10:07:51Z",
        "name": "London Network Access Point",
        "created": "2011-08-16T13:26:26Z",
        "shortname": "LONAP",
        "ixp_id": "IX-F#18"
    },
    "timestamp": "2015-09-16T08:17:31.116Z",
    "version": "2014110401",
    "member_list": [
        {
            "asnum": 20915,
            "name": "100 Percent"
        },
        {
            "url": "http://www.2connectbahrain.com/",
            "asnum": 51406,
            "name": "2Connect"
        },
        {
            "url": "http://www.34sp.com",
            "asnum": 41357,
            "name": "34SP.com Ltd"
        },
        {
            "url": "http://4d-dc.com/",
            "asnum": 31463,
            "name": "4D Data Centres"
        },
        {
            "url": "http://www.afilias.info",
            "asnum": 12041,
            "name": "Afilias"
        },
        {
            "url": "http://www.akamai.com",
            "asnum": 20940,
            "name": "Akamai Technologies"
        },
        {
            "url": "http://www.alentus.com",
            "asnum": 21321,
            "name": "Alentus UK Ltd"
        },
```

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IXP Database – use case

```python
import urllib, json

url = "http://db.ix-f.net/api/ixp/18/member-list"
response = urllib.urlopen(url)

ixpdata = json.loads(response.read())

my_peers = [8916,20940,20915, 51406, 41357, 31463, 12041, 21321, 12536, 16509, 20712, 33920, 4

for member in ixpdata["member_list"]:
    if member["asnum"] not in my_peers:
        print "Get some peering with " + str(member["asnum"]) + " (" + member["name"] + ")"
```

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IXP Database – use case

IXP Database – IXP JSON Schema

- Contains both IXP data & IXP participant data

    - ASN (member list), locations, switch, RS, etc etc

- Open, consistent & an atomic design

- Currently 24 IXP independent implementations

(API includes data from euro-ix portal entered manually or via .csv)

- Open source implementation in IXP Manager

- Source available on GitHub;

    https://github.com/euro-ix/json-schemas

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IXP Database – use case

Why not just use the IXPs own data?

- This gives you a single API for many IXPs

- Get the same format for all IXPs, its standard – wohoo!

- Data is fed from the IXP – IXPs have accurate data, they own it.

- Portable, supportable and scale-able!

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IXP Database

In search of accurate information

- Peering networks can go to two sources of data to guarantee accuracy

- Tools and portal available on the Euro-IX website, future development for APIX, LAC-IX and AF-IX

- IXPAs have regional reach to local IXPs

- The data is complementary to database services that the RIR/NIRs & PeeringDB provide

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Thank You!

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