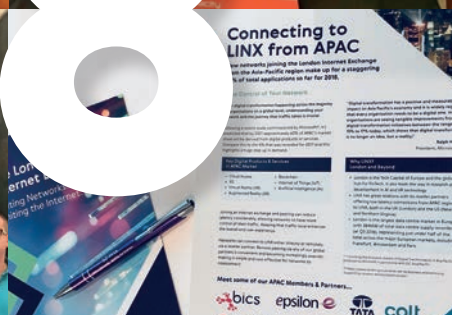# Annual Report 2018

London Internet Exchange

linx

2018

Message from the Board

Letter from LINX Chairman, Simon Woodhead

As this report went to press I had recently taken over as Chair from Murray Steele, who served as our Chair for the past three years. Murray made a strong contribution to LINX, especially by lending his expertise in corporate governance to modernise the Board's structure and working practices. This has made the Board much more effective, both as a guardian of the membership's interests and as a supervisor of the executive team. He also validated our approach of having an appointed Independent Chair, rather than one, like me, appointed from amongst the member-elected Directors.

Whilst recruiting a new Independent Chair is high on my to-do list, I am keen to keep up the momentum and lead further change during my tenure. As this report shows, LINX has had a successful year and I'm excited to be part of shaping its future, building upon the work that has gone before and the fabulous team and culture John Souter has lovingly cultivated within the business over many years.

Simon P Woodhead FCSI
Fellow of the Chartered Securities & Investment Institute

CEO's Report

Adding Value and Creating Opportunities

A landmark year where technical innovation, changes in governance and a focussed marketing strategy combine to enhance our position as a world leading Internet Exchange Point.

2018 was another great year for LINX. We attracted lots of new members, and expanded the number of peering ports across the exchange considerably – and thereby increased the value to our members by providing them with more peering opportunities at greater scale. That is what an Internet exchange should do, and we did!

I'm tempted to stop there, and make it my shortest and simplest annual report ever, but that would not do justice to some other significant achievements during the year. The one that stands out the most is the migration of our London LON2 network to a combination of EdgeCore hardware and IP Infusion EVPN software.

We'll say more about this 'disaggregated model', EVPN and its significance later in this report. But to the great credit of our staff and noting the splendid support of our two suppliers, this network was rebuilt 'in flight', with virtually zero disturbance. This was a remarkable achievement.

We also implemented a significant change in our governance during the year. As the only executive director for so many years, I feel particularly pleased that we have made the transition to having a more balanced Board, having been joined by my fellow executive directors from our senior management team. I feel that this puts LINX in a much stronger position, and that we can now be proud of a governance set-up that reflects the way LINX has evolved over the last 25 years.

LINX Member Conferences

> "I would like to say how proud I am of our staff, and the great commitment that they show to serving a membership organisation such as LINX. They have enthusiastically embraced an agile way of working across almost everything that they do, and I see improvement projects underway in almost every aspect of working life at LINX. Long may it continue!"

John Souter
LINX Chief Executive Officer

LINX member conferences have been the bedrock of LINX community activities since the exchange's inception in 1994. They provide a forum for members to meet, to share expertise and also be updated on the latest technical and regulatory issues. The LINX Annual General Meeting and Board elections are held in May with an Extraordinary General Meeting staged in November to formally approve the following year's budget. In each case members vote on resolutions that directly affect the governance of the exchange.

LINX100 – February
The first membership conference of 2018 saw LINX mark its 100th member meeting. It was a time for reflection with history talks by former Board members Simon Lockhart and Grahame Davies plus a gathering of all the winners of the Conspicuous Contribution to LINX Award. The event also saw LINX launch an updated brand identity and logo which formed the basis of marketing activity for the remainder of the year.

LINX101 & AGM – May
LINX's annual general meeting in May saw the implementation of a new Board election process and timetable. Previously voting was opened and closed on the day of the AGM itself but members had more opportunity to vote in an extended two week voting period. This enabled members to view the footage of the candidates' Q&A session at LINX101 online. Once concluded

Steve Wright and Mike Blanche were duly re-elected for further three year terms of office.

LINX102 – August
LINX's summer conference was held in Manchester. Among the topics covered were the Global Resurgence of Subsea Cables by Vinay Nagpal of Interglobix, the Delivery of the World Cup in HD and UHD online by the BBC's Richard Cooper and BGP Hijacks by Dr Richard Clayton. In addition there was a talk on member exchanges vs. commercial exchanges from Ian Cleary of Google. This event also saw the introduction of an online meeting tool for delegates to arrange peering meetings with fellow attendees.

LINX103 & EGM – November
The final meeting of the year had a broad range of regulatory and technical content including presentations on network automation and LINX's plans for its LON1 platform. There was also a fascinating talk by Richard Tang, founder of Rochdale-based broadband and telecoms provider Zen Internet, who gave a personal account of the rise of the Internet over the past two decades or more.

The Year Ahead

Port Growth and New Products

The shift to a common use of 10GE ports has been clear for some time and in the coming year we expect more and more new members will join with 10GE ports instead of 1GE ports.

For some time we have observed an increase in interest from segments that traditionally have neither managed their own traffic nor peered at Internet Exchanges. Pioneers from the financial services, FinTech, and enterprise sectors have joined LINX, and professed delight at successfully participating in our community.

These new market segments come to Internet interconnection to establish direct connections with the networks that service their end-users, with the primary aim of ensuring service quality and boosting resilience. However, our experience is that they have slightly different needs than our more traditional members, who mainly comprise access networks and content providers.

These needs bring new requirements on LINX's services and staff, so we are working on ensuring that our service offerings meet their expectations. We are therefore planning to launch some additional services during 2019 which have a focus on these new market segments. These range from reporting tools to technical services such as the private VLAN service that we launched at the end of 2018.

Following on the relaunch of our ConneXions program in 2018, we are also planning several new efforts together with both the ConneXions partners and our datacentre partners in targeting the new segments.

We are constantly working to ensure that we can manage growth and that we can do this at scale. During the past year we focused a lot on scaling our internal systems as well as launching the first version of our membership portal. During 2019 we expect to launch several new tools on the member portal which will make our members' interaction with LINX easier, and allow members to directly manage their account and orders with LINX. This will not only allow us to scale further without a corresponding increase in costs, but will also allow for faster and more efficient processing of orders.

Last, towards the end of 2018 LINX and Saudi Telecom announced that LINX had won the contract to build and operate the JEDIX Internet Exchange in Jeddah. We very much look forward to establishing a successful Internet Exchange in a region that has previously been underserved when it comes to peering.

"Establishing JEDIX and working with our members in the Gulf region as well as our other members from all over the world will be an exciting challenge for us."

Kurtis Lindqvist
LINX Chief Marketing Officer

LINX Technology

Disaggregation, Migration & Automation

2018 saw the launch of the disaggregated LON2 network infrastructure with all members migrated seamlessly. LINX's automated network configuration platform also went live.

"In 2018, operationally we realised the benefits from two significant technology development efforts we'd been working on for some time. These were the successful introduction of the LINX-built, network configuration automation (NCA) platform, initially launched in October 2017, and the production release and migration of members to the new disaggregated London peering LAN, LON2, in the middle of the year."

Richard Petrie
LINX Chief Technical Officer

Looking at these two initiatives in more detail, they bring significant benefits to members and LINX. The NCA platform saw us fully automate the fulfilment needs in delivering member services to LON1. It also gave us the core system to extend automation to other vendor equipment such as the new IP Infusion network operation system (NOS) software at the heart of LON2. The validation of this full end-to-end automation is also a key enabler for when we add additional overlay services in the future, such as IXP reseller services, private VLAN connectivity and the wider marketplace services we are considering.

Following on from the NCA platform success, we spent the first five months of 2018 bringing together the disaggregated network solution for the LON2 network. The new infrastructure used the lab tested IP Infusion network operating system, and the tried and tested Edgecore Ethernet switches.

This was the first disaggregated networking solution at a large scale Internet exchange and successfully runs using Ethernet-VPN (EVPN). The deployment phase ran through March, with April and May seeing member migrations. As of the 5th June, we had all services moved over to the new peering platform and the old Extreme Networks LAN shut down. The LON2 network has proved robust, resilient, and reliable ever since.
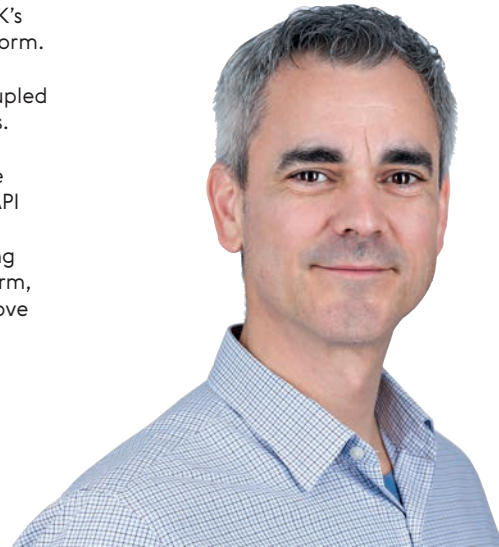
Whilst we continue to explore our options on LON1 and the evolution of the Juniper based network, our efforts in 2018 remained mainly in the lab and in performing proof of concept trials with Juniper, focused around their MX-10K platform.

In general, network capacity and core traffic continued to rise across the major exchange LANs. We reached 25Tb/s of connected capacity overall and peaked at over 4.4 Tb/s of traffic passing across the exchange. By the end of 2018 we had reached 150 member 100GE ports. In addition, our regional peering points continued to flourish, with Manchester, where we added a number of 100GE services, and with Scotland which grew with the introduction of a second PoP in Airdrie, near Glasgow.

Looking ahead to 2019 our focus is on LON1, network insight, and external API development. This will help open up the peering platforms to programmable interfaces, partners for reselling, and digital platforms to consume LINX services. The lab work from 2018 on LON1 will see us move to a summer deployment, replacing the PTX5K's with the newer, higher capacity MX-10K platform. The insight project builds on the telemetry developments in the networking industry, coupled with a plan to streamline our monitoring tools. This will allow us the opportunity to buy or build network intelligence systems to improve network insight, health, and availability. The API development will help LINX work closer with members and partners, to open up the peering platform as a market place technology platform, and to enrich the membership portal to improve the tooling and user experience.

"In LON2, the engineering, software and operations teams at LINX have worked tirelessly to bring together this major transformational project. It truly shows success comes from both technical invention as well as dedicated work from highly skilled and talented engineers."

Richard Petrie
LINX Chief Technical Officer

UK Exchanges

Keeping Network Traffic Local

Building regional exchanges provides for an alternative to the centralisation of infrastructure in London, which allows for localisation of traffic and improved services.

"LINX are able to nurture and support UK regional exchanges as the infrastructure used for the two London LANS can easily be extended to deliver and maintain smaller regional exchanges with very little additional cost."

Jo Fereday
LINX Product
Manager

LINX Manchester

LINX Manchester continues to grow and passed the major milestone of 100 connected members in 2018. This is a very positive outcome of the LINX regional peering strategy, and compares very favourably with second city exchanges in other European countries. Further growth is expected in Manchester, supported by the local data centre scene, which is much larger than most UK cities outside of London. This exchange is also the first and so far only exchange within the LINX group to offer Bi-Directional optical transceivers, which give members a cost effective connection method. We saw members starting to use this technology for the first time in 2018.

LINX supported the local Manchester networking community and held a local LINX Manchester event in conjunction with UKNOF in April. This provided a social networking opportunity for local members (or locally based staff). In December LINX sponsored a successful local network training event which was free for members to attend. This was delivered by our long term partner, Systems and Network Training Ltd.

LINX Scotland

The Scottish government took a strong and supportive interest in this exchange, and allocated some grant funding to encourage local peering to ensure that more traffic stays local in Scotland. This was used to boost membership at the exchange, and to extend it to a second site, at Datavita in Airdrie. Traffic is continues to grow, and there are now more than 30 networks connected, including some of our largest content provider members.

LINX NoVA

2018 was the year our LINX NoVA exchange began to come of age. There are so many ways to measure success, but an overall growth in ASNs, port capacity, traffic and revenue contribution, saw the exchange track well against forecasts for the year.

Traffic levels hit a record 32.39Gbps, some new exciting networks joined the exchange and revenue contribution increased from 2017.

Feedback from our members at LINX NoVA reflects this progress also with an increase in satisfaction at the exchange coming from the most recent membership satisfaction survey (52% of NoVA members responded).

The Future

Those members who have been following the progress of LINX NoVA will know that my secondment to the USA finishes in 2019, so we are busy putting in place handover plans to ensure continued support for our US based members and team.

"As I write this, it is only three short years since I first arrived in the USA (January 2016) and we have learned so much about what it means to look after our members' interests in a very different marketplace to the UK."

Ben Hedges
CEO LINX America

LINX Cardiff

2018 was a year of reflection and review for LINX Cardiff, following a fairly disappointing 2017. The review revealed that whilst the exchange was not growing as much as we had hoped, there are still networks that are interested in joining - although in most cases this is likely to take some time.

The Welsh government showed their continuing strong support by encouraging the local government network (PSBA) to join in 2018. This network brings substantial access capacity to the exchange, and it is expected that this and other initiatives will provide an incentive to content providers and other networks to fulfil their pledges to join. We expect to be able to report better progress in 2019.

Exchange Growth

Performance and Resilience Key Factors for Network Development

"2018 saw us connecting 82 new members. While not a record we are still very happy to see the continued growth of the LINX membership."

Kurtis Lindqvist
LINX Chief Marketing Officer

LINX added 141 new 10GE ports and 40 new 100GE ports across all the LINX exchanges during 2018. One of these 100GE ports was the second such port to go live in Manchester, which is very encouraging and a sign of the growth we have seen across all our networks.

As stated in our UK Exchanges section we now have over a hundred networks connected in Manchester. We have also established a second site for LINX Scotland at Datavita in Airdrie, and saw a number of content providers join LINX Scotland as well. The continued growth at the regional exchanges is a good sign for the UK Internet, as the whole country benefits from less centralisation as well as improved performance and resilience across the UK.

This focus on performance and resilience is very much in line with LINX's vision for our regional exchange program. During 2018 LINX also relaunched its partnership and reseller program, ConneXions, with a clearer charging and tier structure for the partners. LINX also saw a rise in activity through the reseller channels with 40% of new members connecting this way, compared to 27% in 2017.

We are really pleased to report this continuing growth at LINX, which shows that we are fulfilling our core mission, and reinforces the continued importance of Internet Exchanges as a component of the Internet interconnect eco-system.

818 LINX Members

868 Member ASNs

81 Member Countries

95 New applications in 2018

4.34 Terabits per second peak traffic on the public exchange

1926 Connected member ports

980 Member-facing 10GigE ports

154 Member-facing 100GigE ports

25.673 Terrabits of connected capacity

613563 Routes peered at LINX (maximal)

726239 Global routing table routes

84.42% Percentage of global routes available at LINX

Products and Services by end of 2018

LINX Products

- **Public Peering**
  Network traffic exchange over a shared network

- **Private Interconnect**
  Member point-to-point connections

- **ConneXions Partners**
  LINX connection via vLAN

- **ConneXions Access Points**
  - Data centres with a LINX PoP
  - Data centres with LINX transmission equipment
  - Data Centres with access to LINX via an approved Layer 2 carrier

- **Member Rack space**
  Rack space at PoPs available directly through LINX

- **IXP Reseller**
  LINX connection from an existing (mutual or non-profit) Internet exchange

- **Bi-Directional Optical Transceivers**
  Bi-Di transceivers allow the transmitting and receiving of data on a single fibre

- **Private VLAN NEW!**
  New product launched in 2018 to allow members to connect to other members from LINX over a single port

LINX Local Exchanges

- **LINX Manchester**
  Peering LAN in North West England

- **LINX NoVA**
  Peering LAN in Northern Virginia, USA

- **LINX Scotland**
  Peering LAN in Edinburgh and Glasgow in central Scotland

- **LINX Cardiff**
  Peering LAN in Cardiff, Wales

LINX Services

- **Public Affairs**
  Membership representation on matters of public policy

- **Route Servers**
  Free peering service of member advertised routes

- **Time Servers**
  LINX time servers distribute high accuracy time

The introduction of PVLAN in 2018 provides a platform for LINX to be able to offer members an even greater range of services across the exchange

Public Policy

Brexit Debate Overshadows Internet Policy Development in 2018

Arguments over Brexit sucked the life out of any other policy development in the UK in 2018. Would the campaign to overturn the referendum and stay in the EU with a second referendum succeed? If not, would the UK take control of its own policymaking, or would a "deal" be struck that would bind the UK to follow the EU's policy directions in perpetuity?

Government conversation in 2018 was largely spent debating these issues, futilely, as they would be decided by the Prime Minister and her closest civil service aides and ratified, or not, in Parliament. Officials investigated industry's preparation for Brexit, and especially a "No Deal Brexit", collecting evidence for official briefings on the catastrophic consequences of "crashing out".

In consequence, few concrete policy conclusions of substance were reached in the UK in 2018, and the Parliamentary timetable was almost entirely dominated with Brexit legislation and political manoeuvring to support or undermine the UK's negotiating position.

That is not to say that there was nothing of consequence for Internet policy. The UK government has become steadily more concerned about technical security, and stepped up measures to examine more closely the cybersecurity of both network operators, and also LINX, as the UK's largest IXP. An investigation was begun into the resilience of the telecoms supply chain, and a debate erupted within the UK government about whether to change the UK's permissive approach to the use of certain Chinese suppliers for critical network components.

Driven in part by claims that the UK's vote for Brexit had been driven by "Russian meddling online", and in part by worries about the aggressive and intemperate nature of social media debate on this subject, the political climate turned decisively in favour of tighter regulation of online speech. "Foreign disinformation", "trolling", and "harmful content" were all examples of the ill-defined targets identified by political figures including the Prime Minister.

The Department for Digital, Culture, Media and Sport committed to publish a white paper setting out new policies to make social media platforms "take responsibility" for online content, backed by "tough regulation" and fines based on global revenues.

Brexit wasn't the only driver for greater regulation of Internet content. In Brussels it is known as "techlash", a backlash against American technology companies who are perceived as arrogantly ignoring European standards, laws, and taxes. Looking forward, there will be a new Commission and Parliament in 2019, and the new regime may well build on the "duty of care" concept as a basis for its own regulatory agenda. In the UK, the duty of care will probably also feature in the UK's forthcoming White Paper. 2018's legislative hiatus is unlikely to last.

"For Internet companies the difficulty is that as there is no definition of what satisfies the "duty of care", whether they have done enough to escape liability will be largely at the whim of the essentially political expectations of Commission prosecutors and the courts, and the goalposts will almost certainly move periodically."

Malcolm Hutty
LINX Head of Public Affairs

Financial Report

Statement of Income and Retained Earnings	2018 (£)	2017 (£)
Turnover	15,827,050	15,739,668
Distribution costs	(1,757,323)	(1,727,022)
Administrative expenses	(14,141,676)	(14,062,411)
Other operating income	195,607	191,958
Operating surplus	123,658	142,193
Interest receivable	19,240	2,073
Surplus / (deficit) before taxation	142,898	144,266
Tax on surplus from non-core activities	(5,632)	(11,210)
Surplus/ (deficit) after taxation	137,266	133,056
Retained earnings at beginning of year	11,834,525	11,701,469
Retained earnings at end of year	11,971,791	11,834,525

Balance Sheet	2018 (£)	2017 (£)
Fixed assets	4,704,820	7,491,247
Current assets	8,853,752	6,666,225
Current liabilities	(1,586,781)	(2,322,947)
Net assets	11,971,791	11,834,525

Income and Retained Earnings Overview

As referenced in last year's annual report, we continued the recent trend of price cuts at the beginning of 2018 and, at that time, expected deficit for the year. In the event, our service volume growth offset our reduction of income from the price cuts and we only narrowly missed our revenue targets by a small 3% variance. We also managed to hold our expenditure to be a greater 8% amount under target. This overall effect was a very satisfactory result of achieving a small surplus for the year.

We again have made further price cuts in January 2019, this time at a higher level, and consequently we are forecasting a deficit for 2019. In implementing the latest significant price cuts the Board took into account our financial reserves and our ability to still maintain a strong financial status after the cuts. Membership grew by 6%, connected capacity by 19%, and our high capacity 100GE ports by 37% . These good results support our pricing decisions and, with our network reliability continuing to be very high, we have achieved both our financial and operational objectives.

Balance Sheet Summary

Our balance sheet remains strong with our net assets increasing by a small amount and our current assets including a significant and increased level of liquid funds.

Our capital expenditure programme has, similar to last year, been at a much lower level than earlier years and the consequential depreciation charges, related to the past, continue to outpace our current expenditure levels. The net book value of our fixed assets has consequently fallen but we still maintain in excess of £20m invested in our current operational networks.

Cash Flow

	2018 (£)	2017 (£)
Operating surplus/(deficit) for the year	137,266	133,056
Add-back depreciation charge	3,662,302	3,695,761
Add-back movement in debtors/creditors	(1,717,496)	610,570
Taxation paid	(2,632)	(7,268)
Cash flow from operating activities	**2,079,440**	**4,432,119**
Purchase of fixed assets	(875,874)	(2,658,692)
Foreign exchange movement on fixed assets	0	6,878
Interest receivable	19,240	2,073
Overall cash flow for the year	**1,222,806**	**1,782,378**
Cash and equivalents at beginning of year	**4,881,183**	**3,098,805**
Cash and equivalents at end of year	**6,103,989**	**4,881,183**

Purchase of Fixed Assets

	2018 (£)	2017 (£)
Network assets	**812,307**	**2,550,570**
Leashold property improvements	**2,697**	**10,310**
Computer equipment	**60,870**	**97,813**
Total fixed assets purchased	**875,874**	**2,658,693**

Summary of Fixed Assets

The 2018 capital expenditure budget was set at a lower level and such reflects the lower demand for new services, and therefore equipment, than experienced a few years ago.

Additionally, with an extended testing period for some of our new equipment, a significant amount of CAPEX has been deferred into future periods.

Cash Flow Analysis

Our better than expected financial results, together with the lower level of capital expenditure, made significant contributions to our level of liquid funds. These increased by £1.2m compared to the end of 2017.

"Despite cuts to the prices of our services, we managed to maintain our revenue levels and contain expenditure growth which resulted in the reporting of a small surplus."

Malcolm Holt
LINX Chief Finance Officer

LINX in the Wider World
Partners, Associates
and Supporting Organisations

LINX has enjoyed a supportive and collaborative relationship with its community partners over many years.

It is through these relationships within the Internet community that LINX is able to provide members representation at a global level, the opportunity to benchmark performance, and offer a role in helping make the Internet a safer and more trusted space. There is also the opportunity for members to influence policies and procedures in the UK and overseas.

Euro-IX

Euro-IX, the European Internet Exchange Association, currently has 80 member IXPs from around the world. LINX is a founding member of Euro-IX. LINX CMO Kurtis Lindqvist continues to serve as the chairman of the board. LINX regularly meets with the IXP community at Euro-IX conferences to discuss and share ideas and experiences for the mutual advantage of the membership. This is done via technical meetings, mailing lists and online resources. Euro-IX also gathers information on regulatory issues affecting member exchanges that could potentially impact the membership from within the European region, and other jurisdictions, in the future.
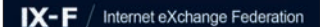
EuroISPA

A key partner for LINX is EuroISPA, the pan-European association for organisations representing the ISP industry. Working with EuroISPA allows us to influence policy and legislation at the EU level, which it has done efficiently and effectively for many years. Malcolm Hutty, LINX's Head of Public Affairs, served as President of the association for five years. He is currently chair of the Intermediary Liability Committee.

Internet Exchange Federation

IX-F, the Internet Exchange Federation, is a global platform for associated Internet Exchange Point Associations, including Euro-IX. Its goal is for exchanges to collaborate "to build a global IXP community and help the development of IXPs throughout the world". LINX CEO John Souter served on the board until he stepped down from the board of Euro-IX.

Internet Watch Foundation

LINX played a pivotal role in the creation and start-up of the Internet Watch Foundation (IWF). One of the roles of the organisation is to assist hosting providers identify and remove child abuse images hosted on their servers. In 2016 the IWF celebrated its 20th anniversary. In 1996, the UK hosted 18% of the world's known online child sexual abuse material. Today, it hosts just 0.2%.

Internet Society

The policy and international engagement activities of the Internet Society (ISOC) are rooted in the organisation's fundamental belief that the Internet is for everyone and should be available to people everywhere. ISOC works with governments, national and international bodies, civil society organisations, the private sector, and other stakeholders to reach decisions about the Internet that conform to its core values.

ISOC's mission to preserve and protect the open, collaborative, distributed, multi stakeholder model is strongly supported by LINX and its stance has defined the successful development of the Internet for many years. As an "Organisational Member" of the Internet Society, membership enables LINX to influence Internet policy on a global stage, through international forums such as the IGF, the ITU and ICANN.

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