2016-2017
ANNUAL REPORT
Open Source for an Open Internet

Internet Systems Consortium, Inc.

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Letter from the President

The years were very good to ISC. We had increased stability in our core product, BIND 9, and saw the emergence of a viable product in Kea, our new implementation of DHCP. We finished moving away from some difficult and expensive adventures in hosting and networking, and focused on our key strengths: software development and the operation and growth of the F-Root system.

In 2016, we implemented a change in the licensing for BIND 9 to the Mozilla Public License (MPL2) that makes a stronger case for users to pay for support and/or an exception license in order for them to keep a competitive edge. This paid a dividend in 2017 as more and more large commercial organizations began to pay ISC after years of using BIND 9 in their products and services. We believe ISC has done a good job of maintaining the requirements of open source software, while improving the ability to pay for its development, upkeep, and maintenance. Currently, most ISC software is covered by the MPL 2.0 software license.

2016 also saw a hiccup that was very unfortunate. We were in the process of ending a hardware hosting relationship with the US federal government, and failed to get funding after expending all of our efforts for the project upfront. This dramatic loss of revenue resulted in the layoff or reduction of hours of 6½ people. We eventually recovered the funds, with a better level of revenues to expenses, but the loss of staff is never something we intend to do.

The Kea DHCP project gained traction in 2016 with the release of premium “hooks,” which offered special commercial capabilities in an open source project. A grant for $100,000 from Mozilla in 2017 was also a great help to the Kea DHCP project.

We received a grant to renew the aging hardware in the F-Root deployment, and spent much of 2017 deploying it. At the same time, we partnered with Cloudflare to deploy F-Root nodes in Cloudflare’s extremely robust facilities. As a result of these actions, the F-Root is arguably the most widely distributed root server operator with the lowest latency in responses. We are very proud of this achievement.

In 2017, ISC acted as incubator to the Digital Security Exchange as it worked to become a viable organization on its own. We were able to act as a collector of charitable contributions, legal advisor, payroll provider, and health insurance partner as a small organization got off the ground. We enjoyed the process, and continued the relationship through 2017.

It has been a good two years at ISC and we look forward to many more.

Regards,
Jeff Osborn
Revenues
ISC receives revenue primarily from support services for our software products. In 2016, 74% of ISC’s total revenue came from BIND 9, ISC DHCP represented 7%, and Kea DHCP totaled 1%. The remaining 17% of the company’s 2016 revenues came from F-Root, the Internet Domain Survey, Hosted® hosting services, SNS services, training, and donations. Approximately 42% of ISC’s 2016 customers were service providers, demonstrating ISC’s importance to that business segment.
In 2017, 81% of ISC’s total revenue came from BIND 9 (70%), ISC DHCP (7%), and Kea DHCP (4%). Other services, such as F-Root, Hosted®, the Internet Domain Survey, training, and donations, represented the remaining 19% of annual revenues. Once again, service providers represented nearly half of ISC’s revenue. However, in 2016, the Internet Archive terminated its long-term hosting contract with ISC, which led to a decrease in ISC’s total revenue for 2017. In addition, the costly and unprofitable Hosted® and SNS services were discontinued by the end of 2017, as we continued to focus on our core software products.

2017 Revenues by Service

- BIND 9: 70%
- F-Root: 8%
- Kea DHCP: 4%
- ISC DHCP: 7%
- Hosted®: 4%
- Other: 5%
- Donations: 2%
Expenses
ISC’s staff are leaders in their fields and represent the majority of the company’s costs. Other than personnel, ISC’s expenses include bandwidth, facilities, network and equipment depreciation, travel, taxes, utilities, and maintenance — and very little else. We are proud of the efficiency and cost-effectiveness of our operations.

Nearly three-quarters of ISC’s staff are technical personnel in the software engineering, technical support, and network operations areas; the remaining employees fill sales, marketing, and general/administrative roles.

![2016 Expenses by Category](image1.png)

![2017 Expenses by Category](image2.png)
What We Do

Our mission: “Internet Systems Consortium, Inc. (ISC) is dedicated to developing software and offering services in support of the Internet infrastructure.”

Founded in 1994, ISC develops and distributes three open source Internet networking software packages: BIND 9, ISC DHCP, and Kea DHCP. BIND 9, ISC’s Domain Name System (DNS) software program, is widely used on the Internet by enterprises and service providers, offering a robust and stable platform on top of which organizations can build distributed computing systems. ISC DHCP implements the Dynamic Host Configuration Protocol for connection to an IP network, offering a complete solution for implementing DHCP servers, relay agents, and clients. ISC DHCP is a mature program with many features, but it can be cumbersome for operators to maintain. Kea DHCP is ISC’s intended replacement for ISC DHCP, and is designed for dynamic reconfiguration.

All of our open source software is freely available on our website. ISC’s work is supported by the sale of software support contracts, and by donations from users who want to see free open source maintained and extended for everyone.

In addition to our open source software, ISC also operates critical Internet infrastructure, in the form of the F-Root server, and offers DNS hosting services for selected non-profits. In addition, our staff contribute to various Internet governance and community initiatives, and ISC engineers have written or co-authored more than 85 of the technical standards (RFCs) that are essential to interoperability on the Internet.
Why We Do It

According to Paul Vixie, co-founder of ISC, "What ISC does is nothing more or less than the sum total of whatever it takes to keep the Internet running smoothly and the global information economy growing robustly. Somebody has to do this or it won’t get done, done well, and done without capture by commercial or political interests.”

We believe that open source in general, and ISC’s software in particular, protects the Internet from being overtaken by businesses or governments who may not have the world’s interests at heart. In the immortal words of George Bailey, protagonist of the classic film *It’s a Wonderful Life,* “This town needs this measly one-horse institution if only to have some place where people can come without crawling to Potter.” Now, we’re not saying that ISC is a one-horse institution, nor that any of our competitors is as evil as Henry Potter; the point is that it’s essential for individuals and organizations to have options for their critical Internet functions that don’t require them to purchase services from vendors that are looking to profit from their weakness.
What We Did in 2016-2017

BIND 9

In 2016-2017, we began making both our software and our development process smaller, leaner, and faster, and focusing more on new development and less on supporting old software versions. Since BIND 9 has been around since 2000, one of our top priorities is to modernize the code.

In 2017, we finally opened our BIND and ISC DHCP issue trackers, after much discussion about how to maintain user confidentiality. (The Kea DHCP issue tracker has always been open.) Even after the change, new issues were confidential by default, until they had been triaged by a staff member. We found that this resulted in most issues remaining unpublished because we simply forgot or didn’t have time for the additional step of publishing the bugs. (In early 2018 we switched to GitLab and made all our issues open by default.)

Key initiatives for 2016-2017

- We decided to focus on refactoring after the BIND 9.11 release, primarily to reduce the complexity of some of BIND 9’s functions.
- We resolved to shorten the release cycle to approximately every 12 months after BIND 9.11, and succeeded in bringing out BIND 9.12 approximately a year after releasing 9.11.
- We finally achieved our goal of opening the BIND (and DHCP) bug trackers, which required sponsoring development for our open source bug tracker software, plus upgrading and testing our systems.
- We now test on Debian 7.7, FreeBSD 10.2, FreeBSD 11, OSX 10.11, OpenBSD 5.7, Solaris 10 (Sparc), Ubuntu 13.10, Ubuntu 16.04, and Windows Server 2012. Adding support for Windows in our build farm was a significant effort, spurred by the observation that we have a large number of downloads of the Windows executables from our website.

User trends

- In 2016 we saw a continuation of the pseudo-random subdomain Distributed Denial-of-Service (DDoS) attacks among BIND 9 users.
- In 2017 we saw increased interest in Response Policy Zones (also known as DNS firewalls) and requests for dnstap query logging.
- We completed the sponsored development of EDNS Client Subnet (ECS) in BIND 9 and released it in our non-public Subscription Edition. ECS is controversial because although it is useful for efficient location-aware content delivery, it is also a privacy leak, and a very complex feature.

2016-2017 Releases

In 2016, ISC issued 25 BIND 9 releases, including the new 9.11 branch.

In 2017, we issued 37 BIND 9 releases. This significantly increased number was due to updates and releases in four branches at once (9.9, 9.9-S, 9.10, and 9.11).
**New Feature Development**

New features added in BIND 9.9, 9.9-S, 9.10, and 9.11 included:

- Automatic interface scanning
- Case-sensitive name compression
- Native PKCS#11
- Many DDoS mitigation features
- Many DNSSEC features
- Many EDNS features
- GeoIP support
- Many management features
- Negative answer synthesis (NSEC Aggressive Use)
- nxdomain-redirect option
- Many performance-improvement features
- Many provisioning and resolver features
- Many RNDC and RPZ features
- The following utilities:
  - delv
  - dnssec-importkey
  - dnssec-cds
  - dnssec-checkds
  - dnssec-coverage
  - dnssec-keymgr
  - dnssec-verify
  - dnstap-read
  - rndig
  - named-rrchecker
  - tsig-keygen

**Other Accomplishments**

In BIND 9.10.0 we found an unexpected reduction in throughput capacity that was not discovered until the software was in production use. ISC inaugurated Perflab, our performance monitoring system, to allow us to track performance changes in development. We assigned one BIND 9 developer to specifically look at performance issues, which ultimately did result in an incredible 5X performance improvement for glue-heavy authoritative applications. We open sourced our Perflab test tool in 2017 at https://github.com/isc-projects/perflab. Our developers now can run performance tests on branches in development, as well as release candidates, so we have good information on how our changes are impacting performance.

One of the biggest changes in 2016 was the transition to the Mozilla Public License 2.0 (MPL2) open source license for BIND 9. We asked for and received many comments about the choice of license, and eventually made the change with the BIND 9.11.0 release.

In preparation for the ICANN 2017 root key rollover (which was eventually delayed until 2018), we spent quite a bit of time testing and retesting BIND 9 to ensure our IETF RFC 5011 support was working correctly. We also implemented some additional telemetry that ICANN requested, to monitor availability of the new key across the Internet.
In 2016 and 2017 we made a significant investment in refactoring, re-writing our RPZ support, query_find() and answer_response() functions. All three of these are heavily used areas of the code that were very complex and, therefore, error-prone. The RPZ redesign included disentangling Response Policy Zones from the Red-Black Tree database in BIND 9. It also improved RPZ performance as a welcome side-effect. The query and answer functions were among the most complex in BIND 9, with over a hundred possible code paths through each of them. We were able to reduce this to fewer than 50.

In another effort to reduce our legacy maintenance burden, we ended BIND 9 support for Windows XP and our Light-Weight RESolver daemon (lwresd). We recommended any remaining users of lwresd instead adopt the excellent GetDNS api (https://getdnsapi.net) from our friends at NLnet Labs.

The Internet Assigned Numbers Authority (IANA) officially assigned port 953/tcp for BIND 9’s RNDC protocol.

**Common Vulnerability Exposures (CVEs)**

In 2016 we began to use a “fuzz” program, which generates semi-random input and examines the results, to try to find obvious flaws in our BIND 9 software before its release. There were 11 BIND 9 CVEs in 2016, many of which had been present for years, but which were uncovered by ISC’s internal fuzz testing. The number of newly discovered CVEs fell to only three in 2017. We are fully committed to responsible disclosure of any significant vulnerabilities in our software, while we are also working hard to minimize their occurrence.

This maintainability index, created by ISC engineer Witold Kęcicki, measures the complexity of ISC software. In the past, BIND 9 scored very high on this index, which indicates a greater level of complexity; from 2016 on, we have been working steadily to lower that.
ISC DHCP

ISC DHCP is distributed with most open source operating systems and is incorporated into many commercial DDI/IPAM applications, as well as embedded devices. The software is mature and full-featured, but challenging to maintain. In 2016 and 2017, we began to taper off our work on ISC DHCP and focused more on Kea DHCP, the next-generation DHCP server from ISC.

2016-2017 Releases
We released ISC DHCP 4.4.0, the first release in the 4.4 series, which we expect will be the last branch. Although the software was officially released on January 31, 2018, all the code was written in 2016 and 2017. We also did several maintenance releases in the 4.1 and 4.3 branches.

New Feature Development
The primary areas of focus for ISC DHCP 4.4.0 were dynamic DNS additions, dhclient improvements, and support for dynamic shared libraries.

In dynamic DNS improvements, we added three new server configuration parameters which influence DDNS conflict resolution, and the server now honors the update-static-leases parameter for static DHCPv6 hosts.

The dhclient improvements we made include adding three command-line parameters (--prefix-len-hint, --decline-wait-time, and --address-prefix-len), and generating a DHCPv6 DECLINE message when the client script indicates a DAD failure.

In terms of dynamic shared library support, a configure script (configure.ac+lt) which supports libtool is now provided with the source tarball. This script can be used to configure ISC DHCP to build with libtool and thus use dynamic shared libraries.

Other highlights of ISC DHCP 4.4.0 included:

- Server dhcp-cache-threshold support for DHCPv6 operations.
- Server DHCPv6 support address allocation based on EUI-64 DUIDs.
- Experimental support for alternate relay port in both the server and relay for IPv4, IPv6, and 4o6.
Kea DHCP

Kea DHCP is ISC’s next-generation DHCP implementation, which features DHCPv4 and DHCPv6 servers, a dynamic DNS update daemon, and a DHCP performance measurement tool. Kea DHCP is a server only; it does not currently include a client or relay. Kea DHCP is intended to be more easily extended than ISC DHCP, and is designed for dynamic reconfiguration. We are developing a configuration migration tool that will help users switch to Kea DHCP from ISC DHCP with minimum effort.

Two of the biggest changes were the adoption of the Mozilla Public License 2.0 (MPL2) and the release of our first premium hook libraries. We started selling software for the first time, charging $499 for a package of premium Kea DHCP extensions, delivered as source code but with an End-User Licensing Agreement (EULA).

Kea DHCP uses an open-issue database that anyone can review at https://gitlab.isc.org, which includes our requirements and roadmap.

Kea DHCP continuous integration testing is done using Jenkins automation. The current test status is always visible at https://jenkins.isc.org.

Despite the efforts we made to engage with the user community, in 2016-2017 we were still struggling with the financial support model for DHCP open source. In 2016 we had only a single Kea DHCP support customer and we were very concerned about our ability to sustain Kea DHCP long-term without more support. Late in 2016 we received a $100,000 award from the Mozilla Open Source Software program, which funded work on a remote management interface for Kea DHCP in 2017. During 2017 we picked up another five support customers, ending the year with six. This was still not enough to sustain the project, so in 2017 we introduced our first commercial software: premium Kea DHCP libraries that we sold on our website for $499. We sold 14 premium “hooks” libraries in 2017, and we will continue addressing this challenge in 2018 and beyond.

2016-2017 Releases

In 2016 and 2017, ISC issued Kea DHCP 1.1, 1.2, and 1.3. Each of these was a significant feature release. Kea DHCP is still a relatively young product, and as we focused on gaining users we let our early adopters drive much of our roadmap.

The biggest Kea DHCP features developed in 2016 and 2017 were host reservations, overall database support, especially for MySQL and PostgreSQL, and an experimental NoSQL Cassandra database. We also significantly increased the ability to handle complex deployment scenarios, with shared networks and client classification.

New Feature Development

New features added in Kea DHCP 1.1, 1.2, and 1.3 included:

- A Cassandra database backend (initially contributed by Deutsche Telekom)
- Host reservations
- Client classification
• Hook library parameters
• DHCPv4-over-DHCPv6
• Control Agent daemon
• kea-shell tool
• Parser refactoring
• New commands, including config-set, config-get, config-write, list-commands, version-get, and build-report
• Configuration test
• Options in pools
• Flexible Identifier and Host Commands “hooks” libraries for premium subscribers
• Shared networks
• REST interface over HTTPS
• Lease management via REST API
• Subnet management via REST API
• Flexible identifier hook library for leases
• Support for 21 DHCPv4 and 10 DHCPv6 options
• Conditional expressions

**Summary Statistics (2016-2017)**

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Software Support

ISC’s team of dedicated technical support engineers is located in both the US and the UK, and provides support for our core products: BIND 9, ISC DHCP and Kea DHCP. Our support engineers work closely with our software engineering teams and attend and occasionally present at industry conferences, keeping their technical, product, and protocol expertise current and relevant to the needs of today’s system and network administrators and operators.

The support team (senior engineers, overseen by our Director of Operations) also runs our Advance Security Notification service and—along with some of our senior developers—its members support the role of Security Officer, triaging and responding to any reports received directly or discussed on public mailing lists and fora.

The revenues generated from our support services provide most of ISC’s funding, and support all our software maintenance and development operations. Effectively, our support subscribers are funding the ongoing maintenance of our core open source products.

We offer four SLA levels; Basic (which includes only Advance Security Notifications and no other support), Bronze, Silver, and Gold. The “Basic” subscription, which we began offering in November 2014, offers a simple but valuable benefit at our lowest contribution level. The “metals” offer increasingly fast response from our support team, plus escalating amounts of bundled training and consulting. Our customers include OEMs, telcos, Internet service providers, and Internet enterprises that measure their service outages in minutes and millions of dollars.

To support these organizations’ needs, ISC offers rotating on-call coverage and support, with engineering employees in different time zones, to provide 24x7 support for critical issues to customers with subscriptions at Silver level and above.

We are proud of the excellent mix of skill sets and interest within ISC’s support team. All of us together can do everything, but each individual engineer’s specialties add value when handling specific customer issues.

Support Ticketing

As part of ISC’s ongoing program of improvements to our ticketing systems, in the spring of 2016 we updated our customer/user interface to a much cleaner and simpler tickets overview page and enabled a self-service interface for individual password management.

Our internal support ticketing interface now includes improved metadata for enhanced dashboarding and better automation of bulk ticket events (ASNs and -S edition distribution), so we can continue to focus our technical expert attention on our customers’ questions and issues and scale up efficiently as our customer base expands.
Critical ticket alerting has been given greater resilience in the event of Internet outages that affect ISC as well as our customers, by introducing alternate paths to our paging service that are independent of ISC systems.

**Support Trends**

2016 was the year of RPZ-related performance and operational issues (leading to some significant tweaking and refactoring), dnstap, and the take-off of fuzz testing for BIND 9. This improved method of testing led to a flurry of CVEs as we uncovered and addressed several old but critical security issues. We had a slight drop in the number of support customers in 2016 because we discontinued ISC’s Secondary Name Services (SNS) offering.

In 2017, ISC’s engineers continued rooting out BIND 9 security issues thanks to both internal and external fuzz testing. The last significant features were added to ISC DHCP as we prepared to focus future efforts on our newest software, Kea DHCP. Dual-stack IPv6 took off, as evidenced by the features, tweaks, and bug fixes needed in ISC DHCP; ISC’s support team was also involved in the design of ISC DHCP Dual-Stack Mixed-Mode DDNS ([https://kb.isc.org/docs/aa-01588](https://kb.isc.org/docs/aa-01588)), introduced early in 2018 in ISC DHCP 4.4. DDoS resilience continued to be a frequent topic of importance, although the architecture of attack vectors remains a moving target.

![ISC's Software Support Services](image)

**Knowledgebase**

In 2016, the ISC KB was opened to the public; all pages are now publicly viewable at [https://kb.isc.org](https://kb.isc.org). No login is required to view any content, and no content is reserved for subscription customers.
We added 31 new articles plus many more release notes and operational notices to our KB in 2016 and 2017.

**Other Projects**

Although BIND 9, ISC DHCP, and Kea DHCP are our major activities, ISC’s staff are constantly working to improve the infrastructure and operation of the global Internet. Here are some of our other projects from 2016-2017:

**EDNS compliance checker**

4,500 people visited our online [EDNS compatibility checker](https://isc.org) to test their servers in 2016, and another 3,000 in 2017. In addition to providing the online checker, we also reached out to organizations running the broken domains, when we could identify them. This is an effort to stimulate improved Internet compatibility for advanced DNS features, such as DNSSEC and DNS cookies, that appears to be modestly useful.

**ISC apps**

In 2016, we released a [DIG application](https://isc.org) on the App Store for iPhones and iPads. This is a port of the dig utility from BIND 9, intended as a convenience for experienced users. As a companion, in 2017 we added a [DNS Checker utility](https://isc.org), which checks resolver support for interoperability, including EDNS support. Through the end of 2017, there were 6,318 downloads of the Dig app and 4,154 of the DNS Checker.

![Dig](https://isc.org) ![DNS Checker](https://isc.org)

**Perflab**

In 2017 we published the source code for the Performance Test lab, a tool we built for our own development use. We got many requests to share the tool when we presented our performance test results at conferences, so we packaged it and released it on ISC’s Github account ([https://github.com/isc-projects/perflab](https://github.com/isc-projects/perflab)).

**KSK root key rollover**

We spent a significant amount of time preparing for ICANN’s rollover of the DNS root key, which was planned for October 2017. We wanted to make sure that BIND 9 users would not have a service interruption, but in the end ICANN decided to postpone the event to October 2018, partly because of data ISC provided from some root key telemetry from BIND 9.

**Graphical interface for Kea DHCP server**

One project we undertook in 2017 was a three-month effort to create a graphical front-end for Kea DHCP. This was one of our efforts to generate more financial support for Kea DHCP. Our target was a large service provider’s help desk; when the service provider ultimately decided not to proceed with a trial deployment of Kea DHCP, we shelved the effort after creating a working prototype. The project resulted in a number of improvements to the Kea DHCP management API, and increased our resolve to eventually produce a user-friendly interface for Kea DHCP with wider appeal.
Other ISC Services

**F-Root**

We've operated F-Root, one of the world’s thirteen root name server groups, since 1994. We have long had F-Root service deployed around the world in 50+ locations to offer fast access even in remote areas. During 2016 and 2017 we upgraded F-Root hardware in three locations, while in 2017 we upgraded 22 existing F-Root sites thanks to a generous contribution from an anonymous donor. In 2017, F-Root also added 125 new nodes via an innovative new partnership with Cloudflare, improving response times for some users and further increasing resiliency. To see the latest data on F-Root, see the Root Servers Technical Operations page at [http://www.root-servers.org/](http://www.root-servers.org/).

ISC instrumented F-Root for the new RSSAC02 statistics and began a rolling refresh of the traditional F-Root node hardware, using our new “F single” design. Meanwhile, we continued optimizing ISC’s extensive network to reduce costs, automated more of the F-Root management, and deployed Kea DHCP internally.

F-Root is supported with the help of multi-year contributions, in cash and in kind, from many service providers and other Internet organizations. We partner with many Regional Internet Registries (RIRs), such as LACNIC, APNIC, and AfriNIC, as well as many local sponsors to deploy F-Root all over the globe.

ISC F-Root operations participates each year in the DNS OARC “A Day in the Life” (DITL) data collection project. In 2016, ISC contributed nearly 400 gigabytes of data, consisting of more than 10 billion queries made to F-Root. This represented approximately 10% of all root queries that were reported in the DITL data that year. In 2017, ISC’s contribution of more than 275 GB of data through 6 billion queries represented just under 5% of the total DITL data that year. We also performed additional DITL collections in support of the root key rolls.

**Domain Survey**

ISC’s Internet Domain Survey, which was begun by Network Wizards, is the longest-running survey of the number of computers connected to the Internet. This data provides an in-depth look at the active IPv4 addresses on the Internet. Despite its name, the ISC Domain Survey is not a survey of domains; it is a survey of IPv4 addresses that have a domain name attached to them. ISC has been sponsoring the Domain Survey since it was founded, although the process by which the information is gathered has evolved since then.

The Domain Survey attempts to discover every IPv4 host on the Internet by doing a complete search of the allocated address space and following PTR links to published domain names. Survey data is collected and a summary is published quarterly. The complete set of data is available for purchase from ISC. In a recent survey, we found more than 1 billion hosts. Therefore, the corresponding datasets, especially for the .com, .net, edu, and .org TLDs, are quite large. For example, the .com file is more than 170MB zipped. The Domain Survey is approximately revenue-neutral. This is a program we run for the benefit of those doing teaching and research on the growth of the Internet.
**AS112 Server**
ISC operates an AS112 server. The global collection of AS112 servers absorbs leaked advertisements for what are supposed to be private RFC1918 addresses, reducing the load on the rest of the DNS infrastructure.

**Discontinued Services**

*Hosted@
We have historically provided free or subsidized hosting for non-profit projects, but economic realities required us to close down the Hosted@ program. By the end of 2016 almost all of the Hosted@ servers were moved or decommissioned. The labor and utility costs had become prohibitive and there are now numerous commercial hosting services available at prices acceptable to any organization that can afford to buy a server.

*SNS*
We ended our commercial SNS service for reasons similar to the Hosted@ closure. Experience has shown the world that only huge DNS clusters can survive Denial-of-Service attacks, and we could not afford the capital or operating expenses of a huge DNS service. We referred our commercial SNS customers to Afilias. We still run a small public-benefit SNS service for ccTLDs and charitable organizations, but it cannot be defended against large DoS attacks.

*DLV*
ISC had operated the DNSSEC Look-aside Validation Registry (DLV) since the very early days of DNSSEC. This was always intended as a transitional service, to help early adopters anchor their DNSSEC chain of trust before their parent domain was signed. After announcing our intention to discontinue this service, we finally emptied the DLV of records in September 2017, ending that “temporary” service after nine years.

*Above:* ISC’s DNSSEC Look-aside Validation Registry, transitioning to shutdown and the shutdown itself at the DNS-OARC conference in September 2017. *Below:* Dan Mahoney after pulling the plug on the DLV.
IETF Standards and Drafts Authored by ISC in 2016-2017
ISC developers participate vigorously in the creation and evolution of the Internet standards. In 2016 and 2017, nine of the drafts ISC staff authored or co-authored reached RFC status:

**RFC 7766:** DNS Transport over TCP - Implementation Requirements
J. Dickinson, S. Dickinson, R. Bellis, A. Mankin, D. Wessels

**RFC 7793:** Adding 100.64.0.0/10 Prefixes to the IPv4 Locally-Served DNS Zones Registry
M. Andrews

**RFC 7819:** Privacy Considerations for DHCP
S. Jiang, S. Krishnan, T. Mrugalski

**RFC 7824:** Privacy Considerations for DHCPv6
S. Jiang, S. Krishnan, T. Mrugalski

**RFC 7828:** The edns-tcp-keepalive EDNS0 Option
P. Wouters, J. Abley, S. Dickinson, R. Bellis

**RFC 7844:** Anonymity Profiles for DHCP Clients
C. Huitema, S. Krishnan, T. Mrugalski

**RFC 7873:** Domain Name System (DNS) Cookies
D. Eastlake 3rd, M. Andrews

**RFC 7969:** Customizing DHCP Configuration on the Basis of Network Topology
T. Lemon, T. Mrugalski

**RFC 8156:** DHCPv6 Failover Protocol
T. Mrugalski, K. Kinnear

ISC staff reviewed and contributed to many other drafts and standards that we did not author.

**Public Presentations**
ISC staff made 11 public presentations at conferences in 2016 and seven in 2017, and put on six webinars during the period. All of these are archived on the [ISC website](http://isc.org).

_Eddy Winstead speaks about EDNS (in)compatibility at the APRICOT February 2016 conference in Auckland._
What’s Next

We are encouraged by our BIND 9 refactoring thus far and plan to continue that work. In 2018, we will work on the design for a BIND 9 “hooks” interface to enable extension modules. We migrated our working BIND repository to GitLab after we released 9.12, to make community collaboration easier and more transparent. We are changing the BIND 9 release model in 2018, including adding rapid-development releases off of our working master branch.

ISC’s DHCP programs continue to operate at a loss, but we trust that our persistence will be rewarded in 2018, as we have had a surge of interest from users deploying Kea DHCP. The team has already added a high-availability mode and a supported Cassandra backend to Kea DHCP and is planning a Kea DHCP 1.5 release in 2018 that will add support for Netconf and a DHCPv4 YANG model. The Kea program, which was already developing in the open, will also migrate to GitLab in 2018.

In response to many requests from users, we are planning to start building our own packages for both BIND 9 and Kea DHCP, and to look into providing more management utilities, including possibly a graphical user interface.
Who We Are

Internet Systems Consortium, Inc. is a US nonprofit 501(c)(3) corporation. ISC Inc. has Public Charity status 509(a)(1) and 170(b)(1) (A)(vi), which means that contributions to ISC can be deducted from US income taxes. Our US Federal EIN is 20-0141248.

Board of Directors

ISC’s Board of Directors is currently made up of four members, each with a long and important history of involvement with the Internet: Rick Adams (Chairman of the Board), Fred Baker (Director), David J. Farber (Director), and Stephen Wolff (Director).

Management

ISC is currently managed by Jeff Osborn (President), Ondřej Surý (Director of DNS Development), Tomek Mrugalski (Director of DHCP Development), Stephen Morris (Senior Director of Research & QA), Brian Reid (Director of Operations), Vicky Risk (Director of Marketing and Product Marketing), and T. Marc Jones (Director of Sales).

There were some changes in the management team during 2016 and 2017. In 2016 Brian Reid took over management of network operations from Jim Martin, who departed ISC. Brian Reid is also the senior manager for our Technical Support team. Stephen Morris was Director of Development through 2016 and into 2017, when Ondřej Surý joined ISC and Tomek Mrugalski was promoted.

Professional Affiliations

ISC staff contribute in a number of technical fora. The list below describes some of our more substantial commitments.

APNIC – Asia-Pacific Network Information Centre (APNIC) is the Regional Internet Registry (RIR) responsible for the Asia-Pacific region. They are an active supporter of our F-Root projects, and a research partner.
**DNS-OARC** – ISC was instrumental in setting up the DNS Operations, Analysis, and Research Center (DNS-OARC) and is a “Silver” member. In 2016 ISC ceased hosting DNS-OARC and managing its accounting operations and transitioned to “regular” membership. ISC staff attend the DNS-OARC meetings and participate in their mailing list discussions. In addition, we contribute annually to the Day In the Life data project, providing the raw data for continuing research into the growth and changes of the global DNS. Ray Bellis, ISC Research Fellow, served on the Program Committee for DNS-OARC in 2016 and 2017, becoming chair; Ondřej Surý is a DNS-OARC board member.

**ICANN** – As part of our ongoing participation in root server policy, ISC participates in the Internet Corporation for Assigned Names and Numbers (ICANN) Root Server System Advisory Committee (RSSAC). Ondřej Surý is one of the seven Recovery Key Share Holders for Root Zone DNSSEC Keys, a member of The Registry Services Technical Evaluation Panel (RSTEP), and a member of the RSSAC. Brian Reid, Fred Baker, and Jeff Osborn represented F-Root on the RSSAC during the 2016-2017 period. Ray Bellis, Mukund Sivaraman, and Evan Hunt were also members of the RSSAC Caucus.

**IETF** – ISC sends four or five developers to every Internet Engineering Task Force (IETF) meeting and our engineers participate vigorously in the development of new standards. ISC’s association with the DNSOP working group continued in 2016-2017. Tomek Mrugalski, the lead developer on our Kea DHCP server, continued serving as co-chair of the IETF DHC working group in 2016 and 2017. Ondřej Surý was a co-chair of the IETF DANE Working Group, while Ray Bellis was a co-chair of the IETF Homenet Working Group.
The Internet Society promotes the open development, evolution, and use of the Internet for the benefit of all people throughout the world. The work is mainly focused on influencing policy and education. ISOC is the umbrella organization for the IETF. In 2015, Jeff Osborn became the ISC delegate to the Advisory Council and continues in that role; David Farber, one of ISC’s Directors, is a current trustee of the Internet Society.


Members of ISC technical staff participate regularly in meetings of the Polish Network Operators Group (PLNOG).

Réseaux IP Européens (RIPE, French for “European IP Networks”) is the RIR responsible for Europe and the Middle East. They also host a network operators’ meeting twice a year that brings together much of the European networking community. ISC is a paying member of RIPE, to get addressing needed for F-Root. We also participate in various RIPE projects such as ATLAS, hosting equipment in Palo Alto. RIPE is also a Root System Operators peer, as they operate K-Root. ISC technical staff participate in the RIPE community meetings and Ondřej Surý is a RIPE Program Committee Member.

Stephen Morris of ISC sits on the Advisory Committee and Cathy Almond, our Lead Technical Support Engineer, is a vice chair of the Programme Committee for the UK Network Operators Forum (UKNOF).

ISC headquarters is in Redwood City, CA, but most staff work remotely from throughout the US and around the world. At the end of 2016, ISC had 29 employees and consultants; at the end of 2017, our staff totaled 31. Staff members collaborate primarily via video conference, email, and instant messaging. We have an annual all-hands meeting in person, and meet face-to-face at conferences as well.
In 2016-2017, we hired a new BIND 9 developer, Michał Kępień, who came to us from Naukowa i Akademicka Sieć Komputerowa (NASK) in Poland, and Ondřej Sury, from CZ.NIC in Czechia, who became our Director of DNS Development. Tomek Mrugalski was promoted to Director of DHCP Development, responsible for both Kea DHCP and ISC DHCP. As of the end of 2017, Stephen Morris was leading Quality Assurance and DNS research. Fred Baker, a member of ISC’s board of directors for many years, became a part-time contractor and has taken on the role of ISC’s liaison to RSSAC.

Włodek Wencel doesn’t even need a chair to get his work done at the 2017 IETF meeting in Prague.

Evan Hunt takes the mike at the 2017 IETF meeting in Chicago.

Amanda Swain of CIRA, Melissa Muth of the University of Pennsylvania, Vicky Risk, Allison Mankin of Salesforce, Jing Qiao of .NZ, Sue Graves of DNS-OARC, Cathy Almond, and Sara Dickinson of Sinodun IT rock the Netgrrrls table at the 2017 DNS-OARC meeting in San Jose.
Thank You

We are extremely grateful to the companies, organizations, and individuals who support our open source work each year, both financially and technically. You are the reason that ISC exists, and we are here to serve you.

We are thankful for our many long-time support subscribers, who include some of the best network operators in the world, and who provide us with a stable funding base to maintain and evolve our open source.

To all those who sent us patches or reported issues to us, we really value these contributions and we love hearing from you. Our top submitters for 2017 were Tony Finch for BIND 9 (he submitted an incredible 22 patches, which we reviewed and resolved), Jiri Popelka for ISC DHCP, and Andrei Pavel for Kea DHCP. Please accept our apologies for any contributions we have failed to mention!

BIND 9 Technical Contributions

Adam Tkac, Petr Spacek, Jiri Kuncar, and Martin Nagy of Red Hat contributed the dyndb feature in BIND 9.11.

Armin Pech helped with a dnssec-keymgr issue where domain names in policy files could fail to match due to trailing dots.

Bill Parker submitted static analyzer issues.

Bluecat submitted a patch to GSS-TSIG buffer sizes.

Daniel Stirnimann made changes to “pkcs11-list” so it now displays the extractability attribute of private or secret keys stored in an HSM as either “true”, “false”, or “never”.

Farsight contributed the RPZ Service Interface in BIND 9.12.

John Worley added dig +ednsopt to BIND 9.12.

Lamont Jones corrected a bug in the MIPS implementation of isc_atomic_xadd().

Niall O’Reilly contributed dnssec-checkds -s to BIND 9.12.

Nis Wechselberg contributed to a fix for a dnssec-keymgr issue, where expired/deleted keys were not always excluded.

Petr Spacek contributed the new-zones-directory option in BIND 9.12.

Robert Edmonds contributed to BIND 9’s dnstap implementation.

Sebastián Castro of .NZ worked on the new dnssec-keymgr utility at a Hackathon.

T Hozza, formerly of Red Hat, reported many issues over the years that we are continuing to fix.

Timothe Litt improved BIND statistics reporting in 9.11.

Tony Finch, among other things, contributed the minimal ANY response in BIND 9.11 and the DNS-CDS feature in BIND 9.12.

Xoze Vazquez Perez added missing IPv6 address 2001:500:84::b for B.ROOT-SERVERS.NET.

The following individuals reported significant bugs and/or suggested fixes:

Alan Clegg                  Bill Parker
Alan Egerton               Brad Smith
Anand Buddhdev             Carl Byington
Christopher Nord
Craig Campbell
Don Henry
Feng Yu
Georg Sluyterman
Hanno Bock
Holger Zuleger
Hugo Koji Kobayashi

John Barnitz
Julian Ospald
Loganaden Velvindron
Maria Iano
Ondrej Holas
Rick Puckett
Rob Riepel

ISC DHCP Technical Contributions
Alessandro Gherardi reported an issue we fixed in 4.4.0.
Antoine Beaupré submitted a patch for contrib/dhcp-lease-list.pl.
Bill Parker reported two memory allocation failures.
Bill Shirley and dgutier-at-cern-dot-ch requested support for update-static-leases.
Cameron Paine added updates to contrib/dhcp-lease-list.pl.
David Zych reported an requirement to allow client identifiers in more than one subnet and Norm Proffitt
suggested a solution. David Zych also worked with us to solve another problem, resulting in abandon-
lease-time.
Denis Taranushin supplied a patch making ISC DHCP’s IPv6 code work better with LDAP.
Fernando Soto reported several bugs that we fixed in DHCP 4.4.0 and defined the requirement for
release-on-roam.
Indy, of the FireballISO open source project, and H. Peter Anvin suggested a change to prefix length hints
in the dhclient.
Jarkko Torppa sent in a patch updating the Solaris configure script.
Jay Ford reported a server crash, fixed in ISC DHCP 4.4.0.
Jiri Popelka was a prolific patch contributor. Among many other contributions, he submitted the patch
that was the foundation for a change in client behavior after a DAD failure, as well as a patch to
modify the dhclient (-6) when it has only expired address associations. He also provided a patch fixing
an issue with Linux packet filter code and VLAN IDs.
Marius Tomaschewski at SUSE and Wei Kong at Novell both submitted patches to the Linux interface
discovery code.
Mark Nejedlo reported a problem with prefix assignment that was fixed in ISC DHCP 4.4.0.
Martin Pitt provided a dhclient patch which came to us via Andrew Pollock.
Michael Vincent reported and helped us verify and fix a problem with dhcp-cache-threshold.
Naiming Shen and Enke Chen added experimental support for relay port (draft-ietf-dhc-relay-port-10.txt)
in ISC DHCP 4.4.0.
Nathan Neulinger requested some debugging enhancements we made.
Pavel Kankovsky requested decline-wait-time in dhclient.
Pavel Polacek and Jan Evangelista reported a problem when leases were reassigned and some information
was not scrubbed from the lease.
Pavel Zhukov at Red Hat found a memory leak in OMAPI and suggested a fix.
Peter Lewis submitted requests for some new options added to ISC DHCP 4.4.0.
Pierre Clerissi identified a client crash.
Rodney Beede reported a DDNS issue, addressed in ISC DHCP 4.4.0.
Sebastian Poehn contributed a patch updating bounds checking when receiving a packet.
Sumant Gupta pointed out a problem with FQDN and dhcpv6 vendor options.
Tim Dean found a problem preventing IPv6 addresses from being added to interfaces in NetBSD and OpenBSD.
Tim DeNike of Lightspeed Communications showed us the error of our ways.
Timothe Litt pointed out some problems with lease file use across platforms with different byte-ordering.

Kea DHCP Technical Contributions
Andreas Rammhold made Kea DHCP build fixes for gcc 6, which uses C++14 by default.
Andrei Pavel contributed the initial Cassandra backend as well as more than 50 other fixes and additions.
Angelo Failla added two enhancements to perfdhcp: optionally using MAC addresses from a file in new DHCP transactions, and generation of DHCPv6 relayed messages.
Bartłomiej Piotrowski fixed a build problem with the Boost library.
Jiri Popelka of Red Hat added several fixes.
Josh Soref and Vincent Legout helped fix many spelling errors.
Juan Settecase helped identify a bug causing illegal memory access while retrieving server hostname and boot file name fields from the host reservation database.
Kalmus implemented IPv6 address/prefix reservations in MySQL.
Marv Cool made changes so kea-admin supports -h (and --host) parameters that can specify MySQL or PostgreSQL database locations other than the default localhost.
Michal Humpula submitted a patch for an issue where DHCPINFORM was generally sent to port 68, rather than port 67.
Olivier Clavel made improvements in the tools/tests_in_valgrind.sh script.
Parisoa updated DHCPv4 and DHCPv6 parsers to accept a database port parameter.
Patrik Lundin provided fixes in the occasionally failing LFC unit test.
Razvan Becheriu helped with more than 40 contributions.
Walt Steverson added a missing header for the PD-exclude DHCPv6 option and compilation fixes for Alpine Linux.
Yusef Shaban fixed syntax errors in dhcpdb_create.mysql.

Financial Support
ISC is grateful to the following people and organizations for their donations in 2016 and/or 2017. ISC thanks you, and the entire open source community thanks you for supporting open source software.

2016 Major Sponsors
JANET
Mozilla
Anonymous

2016 Supporters
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Best Binary Brokers
cPanel.com
Digerati - Michel Machado
Discontrue
Excel Easy
Intuix, LLC
Promocodewatch.com
THE ETERNITY ROSE
Tobi
Travel Ticker
Triplex Trading OU
Tularosa Basin Telephone Company
2016 Donors
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Alan Maitland         Kamil Mastej
Anders Bergman        Keith Steward
Andreas Vogele        Kiryll Batushkov
Anthony Hoffmann      Leo Bicknell
Byron Tuggle          Mark Waring
Chen Jonson           Martin Seeger
Christof Chen         Melina Cohen
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Dave Taht             Nashville Marketing
David Hoffman         Nick Adams
DeluxeMaid            OpenBSD
Donald Richards       OS MEDIA
Drew Rothstein        Richard Doty
Electrim Technologies Corp. Robin Cornelio Thomas
Forex Solo Ads        Roy Althaus
Garrett Christophson  Shengyu Wu
Gavin Montague / John Daniels Simon Blampied
Geert Jan de Groot    Solar Panels Ontario
Gregory Boyce         Steven Arntzen
Hakan Lindqvist       Tanase Liviu
Hosted.nl B.V.        The Commerce Company
Ian West              Tore Stelzner
Jan Helge Stokmo      Trent Hein
Jay Ford              U5comCo Ltd
Jeffrey Reasoner      Ulrich Philipp
Jeffrey Robinson      Volker Janzen
John Folkerts         Winfried Pohl IT-Services
Jose Paulo Santos

2017 Major Sponsors
Alibaba Cloud
APNIC sponsored the NSEC aggressive use feature in BIND 9.12.
Comcast Innovation Fund helped underwrite the Kea DHCP 1.3 release.
ICANN helped sustain F-Root operations with a data-sharing agreement.
Mozilla Open Source contributed to Kea DHCP development.
SWITCH.ch – “SWITCH relies heavily on BIND and we appreciate the hard work you put into it!”
Anonymous

2017 Supporters
99bitcoins             Bestvpnrrating.com
Aftonbladet Rabattkoder – “As geeks we appreciate your work daily. Thanks for all your great work.”
Best Gaming Headset   Cannabis-Education.org
Casino Experts        Casinofeber.se
Contactcustomerserviceuk.co.uk
2017 Donors
Aime Munanka
Andre Nathan
Antonio Augusto De Cintra Batista
Cool Bison
Fred Templeton – For Kea!
Jan-Henk Gerritsen
Jay Ford
Mahmoud Misah El-Idrissi
Mark Beyer
May Digital Julien Josset
Micah Arthur
Patrik Kernstock

Intuix
Kampanjjakten.se
Radboud Universiteit Nijmegen
Twin.com Online Casino

Phil Benchoff
Rupert Summerskill
Stefan Knoblich
The Commerce Company – “Thanks, as always, for keeping DNS safe and reliable.”
Anonymous – “I’m just glad you folks are keeping this up. I will say, ISC has the most reliable distributions I have ever seen. I never have issues; and with something the size of BIND, that says a lot. You guys rock.”

Your donations really are important to us!
ISC 2016-2017 Financial Information

Overall, ISC is in its strongest financial shape in years.

Software development revenue dropped from 2016 to 2017; this is actually a good thing, as that number refers to directed or bespoke development. We prefer to focus our development resources on projects that benefit our entire user base. We took a contract to develop EDNS Client-Subnet identifier in 2016, which was a significant custom development job we did not repeat in 2017.

From 2016 to 2017, ISC’s Services/Training/Consulting revenue dropped significantly. This came as a result of our decision to discontinue our Secondary Name Service (SNS) and hosting service Hosted@. Both of these are services that are more economical to run at a much larger scale. Hosted@ was a money-losing business we exited in 2016. It took quite a while to reduce the associated expenses (rented UPSs, cooling, facilities) associated with that business, but eventually those reductions led to in a drop in our program expenses in 2017 as compared to 2016. The drop in revenue from Hosted@ was largely offset with a one-time 2017 grant of $500,000 for an F-Root hardware refresh, which has been completed. We transitioned our remaining commercial SNS accounts in 2017 and closed that service.

Another noticeable difference between 2016 and 2017 is the larger amount of “other income” in 2017. That came from serving as an incubator to the Digital Security Exchange, mentioned in the Letter from the President at the beginning of this report.

The following pages show ISC’s unaudited financial data for the years 2016 and 2017.
# Combined Statements of Financial Position

**December 31, 2017 and 2016**

**UNAUDITED**

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASSETS</strong></td>
<td></td>
<td></td>
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<tr>
<td>Current assets:</td>
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<td></td>
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<tr>
<td>Cash and Cash Equivalents</td>
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<td>$1,156,529</td>
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<tr>
<td>Accounts Receivable</td>
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<td>Prepaid Expenses and other current assets</td>
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<td>53,568</td>
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<td><strong>Total current assets</strong></td>
<td><strong>1,963,007</strong></td>
<td><strong>2,069,202</strong></td>
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<tr>
<td>Property and equipment net</td>
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<td>82,445</td>
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<tr>
<td><strong>Property and equipment net</strong></td>
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<td><strong>2,151,647</strong></td>
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<tbody>
<tr>
<td><strong>LIABILITIES</strong></td>
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<tr>
<td>Current liabilities:</td>
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<td></td>
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<tr>
<td>Accounts payable and other accruals</td>
<td>$37,123</td>
<td>$22,213</td>
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<tr>
<td>Accrued payroll liabilities</td>
<td>377,174</td>
<td>390,505</td>
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<tr>
<td>Deferred revenue</td>
<td>1,941,363</td>
<td>1,866,540</td>
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<tr>
<td><strong>Total current liabilities</strong></td>
<td><strong>2,355,660</strong></td>
<td><strong>2,279,258</strong></td>
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<tr>
<td>Net assets:</td>
<td></td>
<td></td>
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<tr>
<td>Unrestricted</td>
<td>(244,589)</td>
<td>(127,610)</td>
</tr>
<tr>
<td><strong>Total net assets</strong></td>
<td><strong>(244,589)</strong></td>
<td><strong>(127,610)</strong></td>
</tr>
</tbody>
</table>
# INTERNET SYSTEMS CONSORTIUM

## Combined Statements of Activities

Years Ended December 31, 2017 and 2016

**UNAUDITED**

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue and Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subscriptions</td>
<td>$3,724,559</td>
<td>$3,744,194</td>
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<tr>
<td>Software Support</td>
<td>21,487</td>
<td>15,000</td>
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<tr>
<td>Software Development</td>
<td>167,859</td>
<td>325,000</td>
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<tr>
<td>Services/Training/Consulting</td>
<td>253,683</td>
<td>716,613</td>
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<tr>
<td>F-Root</td>
<td>559,416</td>
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<tr>
<td>Donations and Grants</td>
<td>114,897</td>
<td>68,956</td>
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<tr>
<td>Other Income</td>
<td>235,216</td>
<td>52,324</td>
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<tr>
<td><strong>Total revenue and support</strong></td>
<td>$5,077,117</td>
<td>$5,119,855</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2016</th>
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<tbody>
<tr>
<td><strong>Operating expenses:</strong></td>
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</tr>
<tr>
<td>Program</td>
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<td>4,509,342</td>
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<tr>
<td>General and administrative</td>
<td>665,371</td>
<td>661,242</td>
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<tr>
<td>Fundraising</td>
<td>385,356</td>
<td>447,570</td>
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<tr>
<td><strong>Total operating expenses</strong></td>
<td>4,905,432</td>
<td>5,618,154</td>
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