



# COMCAST INNOVATION FUND

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2017 ANNUAL REPORT





# COMCAST INNOVATION FUND AT-A-GLANCE: 2017 EXECUTIVE SUMMARY

## Background

We know that innovation defines the future of our company, our industry and our connected world. Comcast is committed to fostering a culture of innovation that permeates every level of our business, and we've witnessed firsthand how some of the greatest breakthroughs occur when you simply give smart people the time and resources they need to innovate.

The Comcast Innovation Fund was established to support researchers, technologists, and academics who are committed to the betterment of the Internet and the global technology and policy community.

Grants range from \$3,000 for smaller projects, up to more than \$100,000 for medium-term research efforts. A cross-functional team of technology and business leaders within Comcast reviews grant applications and directs funding where it is most needed and can have the greatest impact.

In 2017, we funded 24 grants from a large pool of worthwhile applications. Since the Fund's inception five years ago, Comcast has supported 111 projects from researchers in 13 countries around the world. We've been inspired by the results of this research and are committed to continuing the program into the future.

## Focus on Impact

Through the innovation fund, we focus on small and midsized projects that may slip between the cracks of traditional research funding sources. The multidisciplinary team of subject matter experts that review applications look for research projects that move technology forward by tackling difficult problems or pioneering new approaches. In 2017, particular weight was given to projects that:

- Address cybersecurity, safety, and privacy threats that face our customers and our services

- Create or advance important open-source projects
- Advance the development and adoption of emerging open Internet standards, as well as the transition from legacy to IP technologies
- Improve the accessibility, operational stability, security, growth, and impact of the Internet
- Improve the technical community's understanding of the Internet, transparency, and the customer experience via better measurement technologies
- Advance and improve the customer experience of our services, and contribute to the creation of better products.

## Grant Categories

The Fund offers two primary types of grant. Some applications fall into both categories and are awarded a grant that spans both purposes.

- Research Grants – These unrestricted grants are given to support researchers, technologists, and academics. They are geared toward supporting research in a range of fields relevant to the Internet and online communication. Research Grants can be either general or targeted. A general research grant provides an unrestricted award of funds to support researchers, usually at colleges and universities. These grants are focused on supporting excellent technical research in a wide variety of fields that are relevant to the broadband industry and/or to Comcast specifically. In contrast, a targeted research grant is more narrowly tailored and typically study more specific issues. In either case, applicants are encouraged to consider grants that may have a cooperative focus, whereby researchers can be matched with a Comcast engineering liaison who will be involved with the research.

## Grant Categories Cont.

- Open Source Development Grants – Comcast is an active and engaged participant in the global open source community. These grants are intended to support the creation and advancement of important open source projects, including those that may not have immediate business value, but which carry the potential for important technological development. Open Source Development Grants are intended to fund new or continued development of open source software in areas of interest to Comcast or of benefit to the Internet and broadband industries. This can fund a range of development, from adding specific features to an existing open source project, to general support of an open source project in which we are interested.

## 2017 Highlights

Projects supported by fund in 2017 included:

- The Future of Privacy Forum’s exploration of how the disability community can be empowered by the Internet of Things (IoT). Their work under this grant brings disability advocates into policy conversations on privacy, data, and technology to explore the range of ways that IoT can be used to help improve the lives of those with disabilities and convenes important privacy-data-technology policy debates related to these communities.
- Novel research at Princeton University that focuses on “cloud to fog” network computing, working to develop a realistic approach that makes networks more efficient. They are working on ways to push network intelligence and processing closer to end users, moving from a binary choice between whether to carry out clients’ tasks using cloud infrastructure or edge devices to a mutually beneficial, inter-dependent model where the cloud, network, and edge devices can work in concert.
- Cutting edge research at the University of Toronto to explore new methods to use complex natural language voice search to find highly specific video content. In particular, they plan to address a scenario where the user describes a movie scene or a news event in natural language, in order to retrieve the relevant clip(s) from a lengthy video. This is one of the holy grails of smart content retrieval, allowing users to easily find their favorite movie scenes, or relevant news events, or big moments in sporting events.
- Important research at the University of Colorado’s Anschutz Medical Campus to explore how to re-design hospital rooms with patient advocates in mind, bringing together student designers from a variety of disciplines including mechanical engineering, pre-med, architecture, electrical engineering, anthropology, and fine arts.
- Groundbreaking work by the Cybercrime Support Network to create a pilot project in Michigan to meet the growing and unsupported needs of U.S.-based cybercrime victims. The pilot program will enable residents to call 211 when affected by cybercrime, connecting them with resources that can help, and more accurately capturing crime data to reveal more accurate crime statistics. The project is focused on making 211 a portal to help for cybercrime that could be as commonplace as calling 911 for emergencies related to health and safety.

## Grants Made by Country in 2017

Canada	1		USA	23
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## Looking Forward

We’ve seen compelling research, promising new open-source code, and creative solutions to challenges large and small that affect Internet users around the world. We’ve already started to award grants for 2018, and still have a lot of opportunity to support good projects. We accept proposals on a rolling basis throughout the year. To apply, visit the Innovation Fund web site at <http://innovationfund.comcast.com/>.

# INDIVIDUAL GRANT INSIGHTS

## Center for Applied Internet Data Analysis (CAIDA) at The University of California San Diego

Grant Type: Research and Open Source Development

*PacketLab*

This grant supports a new approach to developing and maintaining internet measurement infrastructure, by defining a universal endpoint measurement interface called PacketLab. By making the endpoint interface simple, UCSD/CAIDA aims to make it easier to deploy measurement endpoints on any device anywhere, for any period of time the owner chooses. As part of this work, they will develop an endpoint agent that can provide researchers and operators a universal interface for conducting network measurements. Organizations will then be able to deploy lightweight measurement agents at any vantage point. Endpoint owners and operators will have full control over the experiments that run on their endpoints. PacketLab can also be used for internal measurement only, in which case, PacketLab provides an easy-to-deploy, universal interface to an organization's own measurement infrastructure. The design document and code will be available to the public under an open source license.

Status: In Progress

## Center for Applied Internet Data Analysis (CAIDA) at The University of California San Diego

Grant Type: Research and Open Source Development

*Periscope*

Network operators rely on Looking Glasses (LGs) to troubleshoot connectivity and routing issues. However, discovering and querying LGs is still a manual process, making LG usage inefficient, error-prone, and impractical to integrate into machine learning algorithms.

This project will further develop and test the Periscope tool, a platform to unify and automate the discovery and querying of disparate LGs into a standardized, publicly accessible service. The unification of the various LGs under a standardized and language-agnostic API removes the disparities in accessing LGs and facilitates the development of improved network analysis and automation. Improving the practice of using the already deployed measurement tools can address many of the pressing data needs, without investing in entirely new platforms.

Status: In Progress

## Clarkson University

Grant Type: Research and Open Source Development

*Efficient Aggregation, Update Handling and Equivalence Verification on IPv6 Forwarding Tables - Phase 2*

This grant supports the second phase of work that the Innovation Fund initially supported in 2016. As a result of the growth in devices and users connecting to the Internet, increasing reliance upon IPv6 addresses, the size of routing tables in core Internet routers is growing fast and threatens to exceed a size that many such routers can handle. This has the potential to cause router outages and service disruptions. To overcome or mitigate these problems, aggregating the Forwarding Information Base (FIB) may be a potentially effective solution and would not require architecture or hardware changes. This potential solution may be relatively easy to deploy because it is local to individual routers and does not require coordination between routers or network operators. The first phase has shown great promise. The second phase is to design and develop algorithms that are able to maximally aggregate IPv6 FIB entries and incrementally handle route updates. The project will also develop a novel verification algorithm that can efficiently test the forwarding equivalence between any two IPv6 forwarding tables.

Status: Complete

## Cybercrime Support Network

Grant Type: Research

*Michigan Cybercrime Support Network  
Pilot Project*

This grant supports a pilot project in Michigan to meet the unsupported needs of U.S.-based cybercrime victims, by connecting victims to resources and improving crime reporting. The project leverages the "211" phone number, an existing infrastructure of referral specialists that serves 90% of the American public. This project will implement processes to address victim service gaps by: (a) standardizing intake processes at partner agencies to ensure that victims are connected to federal, state or local law enforcement when needed; (b) improving data collection and crime reporting through enhanced collaboration, common reporting tools and shared understanding of goals and objectives; and (c) improving awareness of professional service providers and the general public through effective training and education/outreach materials that are grounded in effective adult learning principals. Status: In Progress

## Domain Name System Operations, Analysis and Research Center (DNS-OARC)

Grant Type: Open Source Development *"dnsjit"*  
*DNS replay functionality improvements*

In 2016, we made a grant to fund an open source development project called "dnsjit", a new tool to help technologists capture, parse, and replay DNS data in order to better understand and respond to distributed denial of service (DDoS) attacks and perform other analysis. This second grant funded the next phase of development, to improve the performance and add functionality to process and analyze the DNS responses. DNS-OARC expects that this will enable the tool to be used on the world's largest DNS platforms. They are also focused on revealing more statistical information about what is being replayed, such as the number of responses and if they are valid DNS responses. Status: In Progress

## Drexel University

Grant Type: Research and Open Source Development

*Exploration of the Content Naming and Address Schemes Proposed by the Glass to Glass Internet Ecosystem (GGIE) - Phase 3*

Previous GGIE work developed a prototype that permitted live experimentation using CDNs on the public internet to validate the benefits of bridging named media segments, as used in media player manifests, with IPv6 network addresses in order to demonstrate potentially better ways to transport streamed video. With the core elements of GGIE developed and tested, this phase of the project focuses on evaluating transport protocols and their interaction with GGIE, how IPv6 Segment Routing (SR) enhances GGIE caching, and establishing an open infrastructure for broader GGIE experimentation. Given projections that video will soon make up 80 percent of all Internet traffic, leaders of the project believe work like this is essential to meet consumer quality expectations and find ways of more efficiently leveraging the network for creation, publication, and delivery of video and advancing the associated technology and standards.

Status: In Progress

## Drexel University

Grant Type: Research and Open Source Development

*IPv6 Segment Routing*

This research will explore IPv6 Segment Routing, which enables programming of IPv6 packets instead of programming routers, to facilitate the movement of IPv6 traffic in modern IP networks. The work supports efforts to standardize Segment Routing, develop a Linux implementation, develop reference of applications, and develop an abstraction layer (API) that will facilitate, ease, and accelerate the development of IPv6 Segment Routing-based applications and services.

Status: In Progress

## Future Of Privacy Forum (FPF)

Grant Type: Research

*Convening IoT-Related Discussions with Disability Experts*

This grant will support an outreach and research effort to promote understanding of the range of ways Internet of Things (IoT) technologies are being used to empower those with disabilities and bring disability advocates into privacy-data-technology policy debates. The Future of Privacy Forum will convene disability leaders and experts, researchers, public interest advocates, and innovators for a series of roundtable discussions on topics related to assistive technologies and applications, and IoT issues related to privacy, security, equality, and access. This series of discussions will be part of the Future of Privacy Forum's Consumer-Business Dialogue, which facilitates robust technology and policy conversations in a friendly atmosphere conducive to honest, constructive dialogue.

Status: In Progress

## Indiana University

Grant Type: Research

*Empowering Consumers in the IoT*

This grant will explore ways to provide better tools and information for consumers to determine the quality and security of Internet of Things (IoT) devices. This research project aims to develop and test a consumer-friendly IoT rating system. The research will evaluate the system with controlled experiments and statistical analyses with the goal of creating a reliable information source for consumers to use in evaluating IoT technologies. The researchers goal is to provide an interaction and set of standards that consumers can use to rate the security impact of IoT devices on their home networks.

Status: In Progress

## Internet Systems Consortium (ISC)

Grant Type: Open Source Development

*Kea DHCP Server Version 1.3 with Shared Subnets*

This grant will support the further development of ISC's open source Kea DHCP software. Kea is a modern open source DHCPv4 and DHCPv6 server that runs on Unix and Linux systems.

This new work supported development of support for shared subnets that enables the server to assign multiple addresses from different IP subnets to devices connected to the same physical network. This is particularly important for networks that have run out of addresses from the assigned IPv4 subnet and need to add another IPv4 subnet on top of existing one. Similarly, IPv6 deployments that want to modify their addressing scheme may need to support both old and new IPv6 subnets. Furthermore, the popularity of using virtual machines for application deployment is driving new requirements to assign multiple addresses per physical device, and when subnets are used to group related applications together, (e.g. in lieu of a VLAN), that also requires shared subnets. In addition, with the explosion in IoT and other consumer devices, shared subnets may also be used to group devices by type.

Status: Complete

## Johns Hopkins University, School for Advanced International Studies (SAIS) Center for Transatlantic Relations

Grant Type: Research

*Democracy, The Internet, and Transatlantic Relations*

This grant supports a proposal entitled "Democracy, The Internet, and Transatlantic Relations" and will help enable the SAIS Center to convene a variety of different discussion forums with high-level policy, political, and opinion leaders from Europe and the United States, including government and elected officials. The grant will help enable the SAIS Center to convene discussions with policy leaders and other key stakeholders to explore a number of key issues affecting the Internet on both sides of the Atlantic, including freedom of speech, privacy and public safety.

Status: In Progress

## Let's Encrypt

Grant Type: Open Source Development

*General Support for Let's Encrypt*

This grant will support the continuation of the Let's Encrypt mission and general scaling up to handle growth.

Let's Encrypt is a free, automated, user-friendly, and open certificate authority (CA), run for the public's benefit. They have helped over 50 million web sites worldwide to enable HTTPS (SSL/TLS), thereby helping to create a more secure and privacy-respecting Web. In addition, Let's Encrypt is also exploring whether they might play a role in helping to find a way to securely issue certificates that may help solve robo-calling issues.

Status: In Progress

### **Networks, Electronic Commerce and Telecommunications (NET) Institute, New York University, Stern School of Business**

Grant Type: Research

*General Support for the NET Institute*

This grant will support research on the economics of the internet, networks, platforms, multi-sided markets and other areas. The NET Institute functions as a world-wide focal point for research and open exchange and dissemination of ideas in these areas.

Status: In Progress

### **Northeastern University**

Grant Type: Research and Open Source Development

*Revealing and Controlling Home Network Privacy Leaks*

This grant supports research that explores how to potentially reveal and control home network privacy leaks. The project will conduct research into techniques for improving privacy transparency and control by analyzing network traffic as it traverses the home network, with the goal of identifying and stopping leaks before they happen. By focusing on home network traffic, this project will enable simpler and more effective privacy controls that could potentially be deployed to operating systems, home network gear, VPN software, and/or cloud systems. One potential outcome could be the development of free, open-source privacy tools.

Status: In Progress

### **New York University, Tandon School of Engineering**

Grant Type: Research

*Understanding & Undermining the Business of Copyright Infringing Media*

This research will work to better understand the business of streaming of copyright infringing media. The project will focus on investigating businesses of delivering copyright infringing streaming to understand the economics of the ecosystem. The expected output of the project is a survey of business models for profiting from copyright infringing media, with associated papers or presentations at industry conferences.

Status: In Progress

### **Oakland University**

Grant Type: Research and Open Source Development

*Developing Context-Aware Strategies to Minimize Network Impact on an Internet of Things Home Network*

This research will explore methods to minimize the overall impact that IoT devices can have on a network, using a model that is self-adaptive (i.e., able to reconfigure at run time) and multi-agent (i.e., each device is autonomous). Anticipated network adaptations include reconfiguring individual devices to minimize network traffic and/or power draw, and anticipated agents can comprise consumer devices, monitoring agents, and testing agents. If successful, ISPs, IoT service providers, IoT device manufacturers, software developers, and others may be able to leverage this work to improve the security, network efficiency, and performance of current or future IoT devices and services.

Status: In Progress



## Princeton University

Grant Type: Research and Open Source Development

### *Cloud to Fog*

This grant will support research into “Cloud to Fog” networking, which is an architectural approach that seeks to make networks more efficient by pushing network intelligence and processing capabilities closer to end users.

In the fog networking paradigm, whether to carry out clients' tasks using cloud infrastructure or edge devices/things near the users is not a binary choice. Instead, cloud and edge form a mutually beneficial, inter-dependent continuum. This research project focuses on the labor and timescale division functionality of the Cloud-to-Fog interface in the areas of storage, communication and management. The research also seeks to advance the understanding of fog networking by: (1) bridging the centralized cloud infrastructure and the distributed edge architecture; (2) providing motivations, incentives and service quality assurances to the users; (3) proposing practical solution schemes for labor division and tasks assignment.

Status: In Progress

## Seton Hall University

Grant Type: Research

### *Collaborative Scripting Environment for Network Analysis Education*

This research aims to improve how students learn about good network analysis, in order to grow the next generation of networking experts. The continued robust expansion of the internet depends on the improvements the efficiency and effectiveness network-related training and education. The approach being investigated promises not only to adapt readily to integration of domain-specific technologies but also to improve the collaborative enterprise itself. Strengthening the ability to share knowledge both in real-time and among users divided by time and space enhances the potency of these important knowledge transfers.

Status: In Progress

## Teklibre

Grant Type: Research and Open Source Development

### *Diagnosing/Diluting Wi-Fi Multicast Effects*

This project builds upon an earlier grant called "Make WiFi Fast", which sped up Wi-Fi unicast traffic under load, while also reducing latency by a factor of five, and was folded into Linux 4.11. This new project tackles one of the largest remaining problems in WiFi: the negative side effects of multicast and power save queues, both of which are essentially infinite. As a result, some applications and unicast traffic can be adversely affected when the multicast and/or power save queues are over-used. Applications such as Multicast DNS (mDNS), Universal Plug and Play (UPnP), IPv6 Neighbor Discovery (IPv6 ND) or Router Advertisement (IPv6 RA), Dynamic Host Configuration Protocol (DHCP and DHCPv6), can all have negative effects on normal web, voice, and video streaming traffic. The project aims to make WiFi scale to more devices, with lower latency and jitter, combined with improved reliability and throughput. The work will develop tests, develop fixes which can be integrated into the Linux kernel, and write papers to explain and quantify the benefits.

Status: In Progress

## University of Colorado, Anschutz Medical Campus - Inworks

Grant Type: Research

### *Hospital Room Redesign with Patient Advocates in Mind*

The project involves student designers from a variety of disciplines including mechanical engineering, pre-med, architecture, electrical engineering, anthropology, and fine arts. Students leverage their expertise in those fields to focus on the inpatient hospital room experience - specifically how to enable a stronger connection between patient advocates (including loved ones and family members) and patients as a means of enriching care.



Hospital rooms traditionally do not provide patient advocates with a good experience and usually lack comfortable furniture, accessories to accommodate a range of functions(i.e. clothing storage, food storage, surfaces on which to work and eat, access to entertainment options and allowing for close physical proximity to the patient (despite research that supports the inherent worth in physical touch for calming and healing).

Status: In Progress

## University of Connecticut

Grant Type: Research

*Neurodiversity Fellowship Program*

This research will explore how students with Attention Deficit Hyperactivity Disorder (ADHD) may more successfully pursue engineering education and careers. It can be challenging for people with ADHD seeking to complete an undergraduate engineering program within traditional academic approaches. This work will leverage prior work that has established that many students with ADHD have high creative potential, and that engaging undergraduate students with ADHD in hands-on engineering research significantly increases their interest in both engineering and pursuing further graduate studies.

Status: In Progress

## University of Pennsylvania, Wharton School of Business

Grant Type: Research and Open Source Development

*After the Digital Tornado*

This grant supported a policy conference called “After the Digital Tornado” that follows up on the FCC’s “Digital Tornado” working paper from 20 years ago, which explored transformative potential of the internet. The conference explored questions about power, freedom, fairness, and human agency in the digital age. Proceedings of the event will be published.

Status: Complete

## University of Toronto

Grant Type: Research

*Deep Learning for Video Content Retrieval using Natural Language Queries*

This grant will support research into deep learning for video content retrieval using natural language queries. It tackles the problem of finding and retrieving videos such as where a user describes a movie scene or a news event in natural language, in order to retrieve the relevant clip(s) from a lengthy video. The issue is challenging, including the need to semantically parse videos, and match them to textual queries, while also representing content in a way that is memory and space efficient. Standard deep learning approaches that rely on storing large feature files obtained from neural networks may not be practical in this scenario.

As a result, this research will explore a new way of representing video content in the form of semantic graphs, which may enable much more efficient methods to find relevant video content. If this project is successful, the research will result in development of a new method for querying videos via graphs.

Status: In Progress

## Zerzura Advisors

Grant Type: Research

*Handling Secrets in Open Source Places*

This grant will support research to create and publish best practices for using open source tools while protecting secrets. The current research builds on work that was funded by the Department of Homeland Security. These best practices will help development teams to manage open source code development that involves access control mechanisms, such as passwords, certificates, and cryptographic keys, that must be kept secret, while the source code and system configuration files that use these secrets are themselves made public. This will also explore source code workflow processes that present issues with management of secrets, guidance on the process for recovering in cases where secrets were leaked, and several models for reducing risk when dealing with secrets in parallel with code in an open source code repository.

Status: In Progress