

Arnaud Legout

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Citizenship: French
Date of birth: June, 10th 1973

EXPERIENCE

Oct 2004-today **Research Scientist, INRIA, France**

Current research projects

- *ElectroSmart: Understanding background electromagnetic radiations.*

With the stunning adoption of mobile devices in the last 10 years, the exposition to high frequency background electromagnetic radiations dramatically increased. Indeed, all modern radio communication technologies such as 2G, 3G, 4G, 5G, WiFi and Bluetooth use high frequency radio (from hundreds of MHz to GHz), which represent most of the high frequency background electromagnetic radiations. However, little is known about the actual exposition of human beings.

The goal of this project is to uncover the exposition to radio frequency background electromagnetic radiations using smartphones as a measurement device. As smartphones are carry on devices, always on and connected, equipped with a GPS, and able to measure most radio communication technologies, they are the perfect measurement device to uncover the exposition of human beings during their daily life. We developed an Android application to make periodic measurements in the background and collect the measurements. We intend to build the largest worldwide database on radio frequency background electromagnetic radiations and to scientifically exploit it to answer, for instance, the complex optimization problem of regulation authorities or cellular operators who want to both minimize the exposition and improve coverage. The page of this project is: <http://electrosmart.app>

- *Greasy: Which traces do you leave on the Web?*

Privacy on the Web is an extraordinary complex and poorly understood issue: extraordinary complex because the Web is at the root of the entire advertisement industry on the internet, a huge ecosystem generating trillions of dollar revenues spread among numerous actors each playing a key role on profiling users and selecting advertisements; poorly understood because most people believe, mainly due to cookie banners enforced by the GDPR, that, on the one hand, third party cookies are responsible for their profiling and, on the other hand, they can easily be blocked, giving a false sense of protection.

The goal of this project is to evaluate how greasy cookies are, that is which traces remain despite efforts to clean them up. Said in other words, if you block or clean cookies, can you still be tracked? We show that not only you can still be tracked, but that the advertisement industry is already using sophisticated tracking techniques that work around the yet to be deployed deprecation of third party cookies by Web browsers. The page of this project is: <http://www-sop.inria.fr/members/Arnaud.Legout/Projects/greasy.html>

Dec 2000-Oct 2004

Architect, Castify Networks, France

Castify Networks is a startup founded in 2000 that develops a software platform for Content Delivery Networks (CDNs).

Technical work

This work was on the design of major components of the Castify products and was the object of two European patents. Achievements are:

- A content lookup and meta-content lookup mechanism, which enables finding the best content (according to the meta-content rules) in few memory lookups for millions of end-users, millions of contents, and thousands of servers. All the data structures fit in the memory of a standard PC.
- An authentication protocol, which preserves from link hi-jacking, enforces a predefined path of server to get a content, but does not require any communication among the servers during the authentication process. Therefore, it is highly scalable.
- A data distribution platform, which enables content delivery on unicast, multicast, and satellite networks in a scalable and transparent way.
- An encryption protocol in a one way delivery environment, which enables secure data distribution in any number of subgroups and perfect forward secrecy without feedback channel.
- A feedback suppression protocol in a one way delivery environment, which enables scalable feedback suppression without multicast connectivity among the receivers and without complex timer computation.

Management work

This work was on the QA strategy at Castify. My effort was oriented toward the test, the development process, and the communication strategy. Achievements are:

- The creation and management of a development workflow. This workflow covered all the process from the early implementation to the delivery of a release.
- The creation and management of a testbed. I defined a process to use the testbed and created tools to improve its management and usability.
- The creation and management of a weekly department meeting. I created and was in charge of a periodic meeting where technical and organizational issues were addressed.
- The creation of a project management tool based on an extension of scarab an open source leading issue tracking system.

Nov 1997-Nov 2000

Research Assistant, Institut Eurecom, France

The Institut Eurecom is an engineering school and a research center in communications systems created in 1991 in Sophia Antipolis that is part of the GET (Groupement des écoles de télécommunications).

Research achievements

This work was on multicast congestion control for best effort networks. Achievements are:

- The design of a theoretical framework for the conception of optimal congestion control protocols.
- The design and implementation (in ns) of a new congestion control protocol called PLM for multicast transmissions. This protocol outperformed all the existing multicast congestion control protocols. This protocol was a validation of the theoretical framework.
- The design of a bandwidth allocation policy for multicast transmissions that improves the user satisfaction without a significant decrease in fairness.
- The study of popular congestion control protocols (RLM and RLC) that exhibited for the first time major pathological behaviors.

RELEVANT PUBLICATIONS

Go to my [Google scholar profile](#)

- 2022 [Longitudinal study of exposure to radio frequencies at population scale.](#) Yanis Boussad, Xi (Leslie) Chen, Arnaud Legout, Augustin Chaintreau, Walid Dabbous. *Environment International*, Volume 162, April 2022, 107144, ISSN 0160-4120, doi: 10.1016/j.envint.2022.107144.
- [My Cookie is a phoenix: detection, measurement, and lawfulness of cookie respawning with browser fingerprinting.](#) Imane Fouad, Cristiana Santos, Arnaud Legout, Nataliia Bielova. *In Proc. of Privacy Enhancing Technologies Symposium (PETS 2022)*, July 11–15, 2022. Sydney, Australia.
- 2021 [In-Depth Technical and Legal Analysis of Tracking on Health Related Websites with ERNIE Extension.](#) Vera Wesselkamp, Imane Fouad, Cristiana Santos, Yanis Boussad, Nataliia Bielova, Arnaud Legout. *In Proc. of WPES'21*, November 15, 2021. Seoul, South Korea. The ERNIE extension is available [here](#) or on [github](#).
- [Evaluating Smartphone Accuracy for RSSI Measurements.](#) Yanis Boussad, M. Naoufal Mahfoudi, Arnaud Legout, Leonardo Lizzi, Fabien Ferrero, Walid Dabbous. *IEEE Transactions on Instrumentation & Measurement (TIM)*, vol. 70, pp. 1-12, 2021, Art no. 5501012, doi: 10.1109/TIM.2020.3048776.
- 2020 [Missed by Filter Lists: Detecting Unknown Third-Party Trackers with Invisible Pixels.](#) Imane Fouad, Nataliia Bielova, Arnaud Legout, Natasa Sarafijanovic-Djukic. *In Proc. of Privacy Enhancing Technologies Symposium (PETS 2020)*, July 14–18, 2020, Montréal, Canada.
- [Open-Source 4G Experimental Setup.](#) Yanis Boussad, Mohamed Naoufal Mahfoudi, Arnaud Legout, Fabien Ferrero, Leonardo Lizzi, Walid Dabbous. *In Proc. of IEEE International Symposium on Antennas and Propagation (AP-S)*, July 5–10 2020, Montréal, Canada.
- 2016 [ReCon: Revealing and Controlling PII Leaks in Mobile Network Traffic.](#) Jingjing Ren, Ashwin Rao, Martina Lindorfer, Arnaud Legout, David Choffnes. *In Proc. of ACM MobiSys 2016*, June 26–30, 2016, Singapore.
- [Social Clicks: What and Who Gets Read on Twitter?](#) Maksym Gabielkov, Arthi Ramachandran, Arnaud Legout, Augustin Chaintreau. *In Proc. of ACM SIGMETRICS'16*, June 14–18, 2016, Antibes Juan-les-Pins, France.
- 2015 [Meddle: Enabling Transparency and Control for Mobile Internet Traffic.](#) Rao A, Kakhi A, Razaghpanah A, Li A, Choffnes D, Legout A, Mislove A, Gill P. Technology Science. 2015103003. October 30, 2015.
- 2014 [How to Network in Online Social Networks.](#) Giovanni Neglia, Xiuhui Ye, Maksym Gabielkov, and Arnaud Legout. *In Proc. of IEEE NetSciCom'14*, May 2, 2014, Toronto, Canada.
- [Studying Social Networks at Scale: Macroscopic Anatomy of the Twitter Social Graph.](#) Maksym Gabielkov, Ashwin Rao, and Arnaud Legout. *In Proc. of ACM SIGMETRICS'14*, June 16–20, 2014, Austin, Texas. USA.
- 2013 [Data Plane Throughput vs Control Plane Delay: Experimental Study of BitTorrent Performance.](#) Claudio Testa, Darrio Rossi, Ashwin Rao, and Arnaud Legout. *In Proc. of IEEE P2P'13* (short paper), Sep. 9–11, 2013, Trento, Italy
- 2012 [The Complete Picture of the Twitter Social Graph.](#) Maksym Gabielkov, Arnaud Legout. *In Proc. of ACM CoNEXT'12 Student Workshop*, Dec. 10, 2012, Nice, France
- [Meddle: Middleboxes for Increased Transparency and Control of Mobile Traffic.](#) Ashwin Rao, David Choffnes, Justine Sherry, Arnaud Legout, Arvind Krishnamurthy, Walid Dabbous. *In Proc. of ACM CoNEXT'12 Student Workshop*, Dec. 10, 2012, Nice, France.
- [Classification of Content and Users in BitTorrent by Semi-Supervised Learning Methods.](#) K. Avrachenkov, P. Gonçalves, A. Legout, M. Sokol. *In Proc. of IEEE IWCWC'2012, TRAC Workshop*, Aug. 27–31, 2012, Limassol, Cyprus. (Best paper award)
- [Experimental Assessment of BitTorrent Completion Time in Heterogeneous TCP/uTP swarms.](#) Claudio Testa, Dario Rossi, Ashwin Rao and Arnaud Legout. *In Proc. of Traffic Monitoring and Analysis (TMA) Workshop 2012*, 12 March 2012, Vienna, Austria.
- 2011 [Network Characteristics of Video Streaming Traffic.](#) Ashwin Rao, Yeon-sup Lim, Chadi Barakat, Arnaud Legout, Don Towsley, and Walid Dabbous. *In Proc. of ACM CoNEXT'11*, Dec. 6–9, 2011, Tokyo, Japan.
- [I Know Where You are and What You are Sharing: Exploiting P2P Communications to Invade Users' Privacy.](#) Stevens Le Blond, Chao Zhang, Arnaud Legout, Keith Ross, and Walid Dabbous. *In Proc. of ACM SIGCOMM/USENIX IMC'11*, Nov. 2–3, 2011, Berlin, Germany.
- [Network Non-Neutrality Debate: An Economic Analysis.](#) Eitan Altman, Arnaud Legout, Yuedong Xu. *In Proc. of IFIP Networking'11*, May 9–13, 2011, Valencia, Spain.
- [One Bad Apple Spoils the Bunch: Exploiting P2P Applications to Trace and Profile Tor Users.](#) Stevens Le Blond, Pere Manils, Abdelberi Chaabane, Mohamed Ali Kaafar, Claude Castelluccia, Arnaud Legout, Walid Dabbous. *In Proc. of LEET'11*, March 29, 2011, Boston, MA, USA.

- 2010 [Pushing BitTorrent Locality to the Limit](#). Stevens Le Blond, Arnaud Legout, Walid Dabbous. *Computer Networks*, doi:10.1016/j.comnet.2010.09.014, 2010.
- [Can Realistic BitTorrent Experiments Be Performed on Clusters?](#). Ashwin Rao, Arnaud Legout, Walid Dabbous. In *Proc. of P2P'10*, August 25–27, 2010, Delft, Netherlands.
- [Spying the World from your Laptop - Identifying and Profiling Content Providers and Big Downloaders in BitTorrent](#). Stevens Le Blond, Arnaud Legout, Fabrice Lefessant, Walid Dabbous, Mohamed Ali Kaafar. In *Proc. of LEET'10*, April 27, 2010, San Jose, CA, USA.
- 2009 [Swarming Overlay Construction Strategies](#). Anwar Al Hamra, Nikitas Liogkas, Arnaud Legout, Chadi Barakat. In *Proc. of ICCCN'2009*, August 2–6, 2009, San Francisco, CA, USA.
- 2008 [Small Is Not Always Beautiful](#). P. Marciniak, N. Liogkas, A. Legout, E. Kohler *IPTPS'2008*, Tampa Bay, FL, USA, February 2008.
- 2007 [Clustering and Sharing Incentives in BitTorrent Systems](#). A. Legout, N. Liogkas, E. Kohler, L. Zhang. In *proceedings of ACM SIGMETRICS'2007*, San Diego, CA, USA, June 2007.
- 2006 [Rarest First and Choke Algorithms Are Enough](#). A. Legout, G. Urvoy-Keller, and P. Michiardi. In *Proceedings of ACM SIGCOMM/USENIX IMC'2006*, Rio de Janeiro, Brazil, October 2006.
- 2005 [Understanding BitTorrent: An Experimental Perspective](#). A. Legout, G. Urvoy-Keller, and P. Michiardi. *Technical Report (inria-00000156, version 2 - 19 July 2005)*, INRIA, Sophia Antipolis, July 2005.
- 2002 [Revisiting the Fair Queuing Paradigm for End-to-End Congestion Control](#). A. Legout, and E. W. Biersack. *IEEE Network Magazine*, 16(5), September 2002.
- 2001 [Bandwidth Allocation Policies for Unicast and Multicast Flows](#). A. Legout, J. Nonnenmacher, and E. W. Biersack. *IEEE/ACM Transactions on Networking*, 9(4), August 2001.
- 2000 [Pathological Behaviors for RLM and RLC](#). A. Legout, and E. W. Biersack. In *Proceedings of NOSSDAV'2000*, Chapel Hill, North Carolina, USA, June 2000.
- [PLM: Fast Convergence for Cumulative Layered Multicast Transmission Schemes](#). A. Legout, and E. W. Biersack. In *Proceedings of ACM SIGMETRICS'2000*. Santa Clara, CA, USA, June 2000.
- 1999 [Bandwidth Allocation Policies for Unicast and Multicast Flows](#). A. Legout, J. Nonnenmacher, and E. W. Biersack. In *Proceedings of IEEE INFOCOM'99*. New York, NY, USA, March 1999.

PATENTS

- 2004 **Process for selecting a server in a content delivery network**. A. Legout, L. Anliker, J. Hummes. *EPI322094A1*, Granted September 2004. *WO03055178*, Published Application July 2003.
- 2003 **A process for providing access of a client to a content provider server under control of a resource locator server**. A. Legout, J. Hummes. *EP1278112B1*, Granted May 2003. *JP2003122724*, Published Application July 2003.

TEACHING

ACADEMIC COURSE

- Course Material **The Art and Science of Writing. How to write easy-to-read text?** Arnaud Legout. Slides *cel-00879035, version 2, - 22 January 2015*, INRIA, Sophia Antipolis, January 2015. License CC BY-NC-SA.
- How to Give a Good Talk?** Arnaud Legout. Slides (*cel-00529505, version 7, - 22 January 2015*, INRIA, Sophia Antipolis, January 2015. License CC BY-NC-SA.
- Peer-to-Peer Applications: From BitTorrent to Privacy.** Arnaud Legout. Slides (*cel-00544132, version 2, - 6 January 2012*), INRIA, Sophia Antipolis, Janvier 2012. License CC BY-NC-SA.
- 2018—now
- Taught the course *Blockchain and privacy* (graduate level, master Ubinet, UNSA).
- 2014—2018
- Taught the course *Peer-to-Peer Applications : From BitTorrent to Privacy* (graduate level, master Ubinet, UNSA).
- 2012—2018
- Taught the course *Scientific Communication* (master 1 International, UNSA, F).
- 2010—2013
- Taught the course *Peer-to-Peer Applications : From BitTorrent to Privacy* (graduate level, master Ubinet, UNSA).
 - Taught the course *Peer-to-Peer Applications : From BitTorrent to Privacy* (graduate level, master RTM, IUP GMI Avignon).
- 2009
- Taught a course on *peer-to-peer file replication* (graduate level, master Ubinet, UNSA).
 - Taught a course on *peer-to-peer file replication* (graduate level, master IFI, UNSA).
 - Taught a course on *peer-to-peer file replication* (graduate level, master RTM, IUP GMI Avignon).
 - Taught a course on *peer-to-peer file replication* (graduate level, master TSM, UNSA).
- 2008
- Taught a course (short version) on *peer-to-peer file replication* (graduate level, ETH Zurich, Switzerland).
 - Taught a course on *peer-to-peer file replication* (graduate level, master RTM, IUP GMI Avignon).
 - Taught a course on *peer-to-peer file replication* (graduate level, master RSD, UNSA).
 - Taught a course on *peer-to-peer file replication* (graduate level, master TIM, UNSA).
 - Taught a course on *computer networks* (undergraduate level, IUT GTR).
- 2007
- Taught a course on *peer-to-peer file replication* (graduate level, master RSD, UNSA).
 - Taught a course on *peer-to-peer file replication* (graduate level, master TIM, UNSA).
 - Taught and supervised laboratory sessions on *C system programming on Unix* (undergraduate level, IUT GTR).
- 2006
- Taught a course on *peer-to-peer file replication* (graduate level, master RSD, UNSA).
 - Taught a course on *computer networks* (undergraduate level, IUT GTR).
 - Taught and supervised laboratory sessions on *C system programming on Unix* (undergraduate level, IUT GTR).
- 2005
- Taught and supervised laboratory sessions on *C system programming on Unix* (undergraduate level, IUT GTR).

1998—2000

- Assisted in teaching a course on *High-Speed Networking and Internet Protocols* (graduate level, Institut Eurecom).
- Taught and supervised laboratory sessions on *ATM, error and flow control mechanisms, advanced TCP, advanced scheduling and buffer* (graduate level, Institut Eurecom) .

MOOC

I created with Thierry Parmentelat a MOOC on Python in French. This MOOC is used in several universities such as UPMC (L3 mathematics), CentraleSupélec (first year students), central paris (master SIO), Esisar du groupe Institut Polytechnique de Grenoble (first year students).

2019-now

The MOOC on Python 3 is now permanently opened. We have 49 369 registrations.

2018

Second iteration of the MOOC on Python 3. We got 12 748 registrations.

2017

New version of the MOOC on Python 3. We got 13 191 registrations.

2016

Third iteration of the MOOC on Python. We got 12 954 registrations, and 1 603 received the final completion certificate.

2015

Second iteration of the MOOC on Python. We got 9 845 registrations.

2014

First iteration of the MOOC on Python. We got 9 200 registrations.

PROFESSIONAL TRAINING

2011—2020

Professional training *Introduction to the Python Programming Language*.

References: Orange, Cisco, Observatoire de Nice, EPCOS SAS, Transvalor, Ecole des marins pompiers de marseille, Inria, CNEDI-CERTIAM, Gemalto SA, Supersonic Imagine, CNRS, Intel mobile communication, INRAE.

PROFESSIONAL ACTIVITIES

- **Editorial Board**
 - Proceedings on Privacy Enhancing Technologies (PoPETs) (2021—2023)
 - Elsevier Computer Networks (2012—2016)
- **TPC Chair**
 - ICCCN'2009 P2P track (co-chair with Yi Cui)
- **Technical Program Committee**
 - PETS 2023, PETS 2022, PETS 2021, ACM IMC 2016, ACM CoNEXT 2015, ACM IMC 2014, IEEE TMA 2013, IEEE P2P 2012, IEEE HotPOST 2012, Algotel 2012, Usenix IPTPS 2009, ACM CoNEXT 2008, P2P-TV Workshop 2007, ACM Sigcomm 2007 PC heavy, ACM Sigcomm 2006 PC light, ACM Sigcomm 2005 shadow PC.
- **Reviewer**
 - *Journals*: IEEE/ACM Transactions on Networking, IEEE/ACM Transactions on Computers, IEEE Transactions on Parallel and Distributed Systems, IEEE Network, Computer Communications, ACM SIGCOMM CCR, Computer Networks.
 - *Conferences*: IEEE Infocom, ACM Sigmetrics.
 - *Workshops*: HPSR'07.
- **Other Activities**
 - Reviewer of STREP projects for the European Commission (2009, 2010).
 - Member of the scientific committee for the summer school RESCOM'2008.
 - External expert for Eurecom students master thesis defense (2004 - 2009).
 - Expert Conseil Régional d'Aquitaine (2006).
 - ACM Member (2010-present).
 - IEEE Member (1997-present).

MENTORING AND SUPERVISING STUDENTS

Post-doc

- Dongliang Guan (Apr. 2005 – Oct. 2005, University of Shanghai JiaoTong, China).

Ph.D. students

- Yanis Boussad (Oct. 2017 – Sept. 2021, co-supervised with Leonardo Lizzi), [manuscript](#)
- Imane Fouad (Oct. 2017 – Jun. 2021, co-supervised with Nataliia Bielova), [manuscript](#)
- Mathieu Thiery (Apr. 2017 – Dec. 2020, co-supervised with Vincent Roca), [manuscript](#)
- Maksym Gabielkov (Oct. 2012 – Jun. 2016), [manuscript](#)
- Ashwin Rao (Sep. 2009 – Dec. 2013, co-supervised with Walid Dabbous), [manuscript](#)
- Stevens Le Blond (Sep. 2007 – Apr. 2011, co-supervised with Walid Dabbous)

Engineer

- David Migliacci (Jan 2018 – May 2019)
- Abdelhakim Akodadi (May 2017 – Apr. 2019)
- Mondri Ravi (March 2016 – May 2019)
- Inderjeet Singh (Dec. 2013 – Dec. 2015)

Master students

- Angelo Rodio (Mar. 2020 – Aug. 2020, Master Ubinet, Sophia Antipolis France)
- Rachid Youssef (Mar. 2019 – Aug. 2019, Master Ubinet, Sophia Antipolis France)
- Tareq Si Salem (Mar. 2019 – Aug. 2019, Master Ubinet, Sophia Antipolis France)
- Mohamed Janati Idrissi (Mar. 2018 – Aug. 2018, Master Ubinet, Sophia Antipolis France)
- Neha Agarwal (Apr. 2017 – Sep. 2017, Master Ubinet, Sophia Antipolis France)
- Yanis Boussad (Mar. 2017 – Aug. 2017, Master Ubinet, Sophia Antipolis France)
- Anastasia Kuznetsova (Jan. 2016 – May 2016, Master 1 international, Sophia Antipolis France, Jul. 2016 – Aug. 2016, summer intern, Mar. 2016 – Aug. 2016, Master Ubinet, Sophia Antipolis France)
- Hackob Melconian (Mar. 2016 – Aug. 2016, Master Ubinet, Sophia Antipolis France)
- Mourjo Sen (Mar. 2015 – Aug. 2015, Master Ubinet, Sophia Antipolis, France).
- Nicoleta Oita (Mar. 2013 – Aug. 2013, Master Ubinet, Sophia Antipolis, France).
- Maksym Gabielkov (Apr. 2012 – Aug. 2012).
- Ludovic Fardel (Feb. 2009 – Aug. 2009, EPFL, Lauzanne, Switzerland).
- Guy Hugot-Derville (Apr. 2008 – Jul. 2008, École Polytechnique, Palaiseau, France).
- Pawel Marciniak (Mar. 2007 – Jul. 2007, M.Sc., Poznan University of Technology, Poland).
- Mounir Chahid (Apr. 2007 – Jul. 2007, M1 MPRI, École Polytechnique, Palaiseau, France).
- Edmond Abboud (Jan. 2006 – Jun. 2006, Master RSD, Sophia Antipolis, France).
- Youssef Zaki (Mar. 2006 – Sep 2006, Master RSD, Sophia Antipolis, France).
- Clement Perrin (Apr. 2006 – Jun. 2006, École Polytechnique, Palaiseau, France).
- Vincent Charpin (Apr. 2005 – Jun. 2005, École Polytechnique, Palaiseau, France).

EDUCATION

- 2019 **Digital Startup, Executive Training**
EM Lyon
- Jan 2012 **Habilitation à diriger des recherches**
Université de Nice-Sophia Antipolis.
Title: "[Efficacité et vie privée : de BitTorrent à Skype](#)".
- Nov 1997-Oct 2000 **Ph.D. in Communication Systems**
Université de Nice-Sophia Antipolis.
Title: "[Contrôle de congestion multipoint pour les réseaux best effort](#)".
Advisor: Prof. Ernst W. Biersack. Institut Eurecom.
- 1996-1997 **Military service**
- 1995-1996 **Postgraduate School qualification in Networking and Distributed Systems**
Université de Nice-Sophia Antipolis.
- 1994-1995 **Master degree in mathematics**
Université de Nice-Sophia Antipolis.

LANGUAGES

- **French:** Native language.
- **English:** Working language.

COMPUTER SKILLS

- **Languages:** Python, Android, Java, C, JavaScript, XML, XSL, Tcl, OTcl, Shell programming, HTML, awk.
- **Systems:** Linux, Windows.
- **Softwares:** Matlab, Network Simulator (ns), Scarab (issue/bug tracking tool), LaTeX, Emacs.
- **Networking:** TCP/IP, IP-Multicast, IP lookup, scheduling and buffer management mechanisms, multicast and unicast: routing protocols, congestion control protocols, reliable protocols; cryptography, quantum networks, peer-to-peer protocols, DHT, privacy.