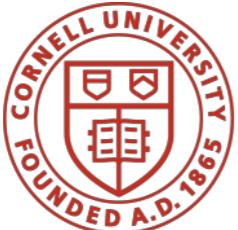


# 2019 P4 Workshop

Nate Foster  
Cornell



Nick McKeown  
Stanford

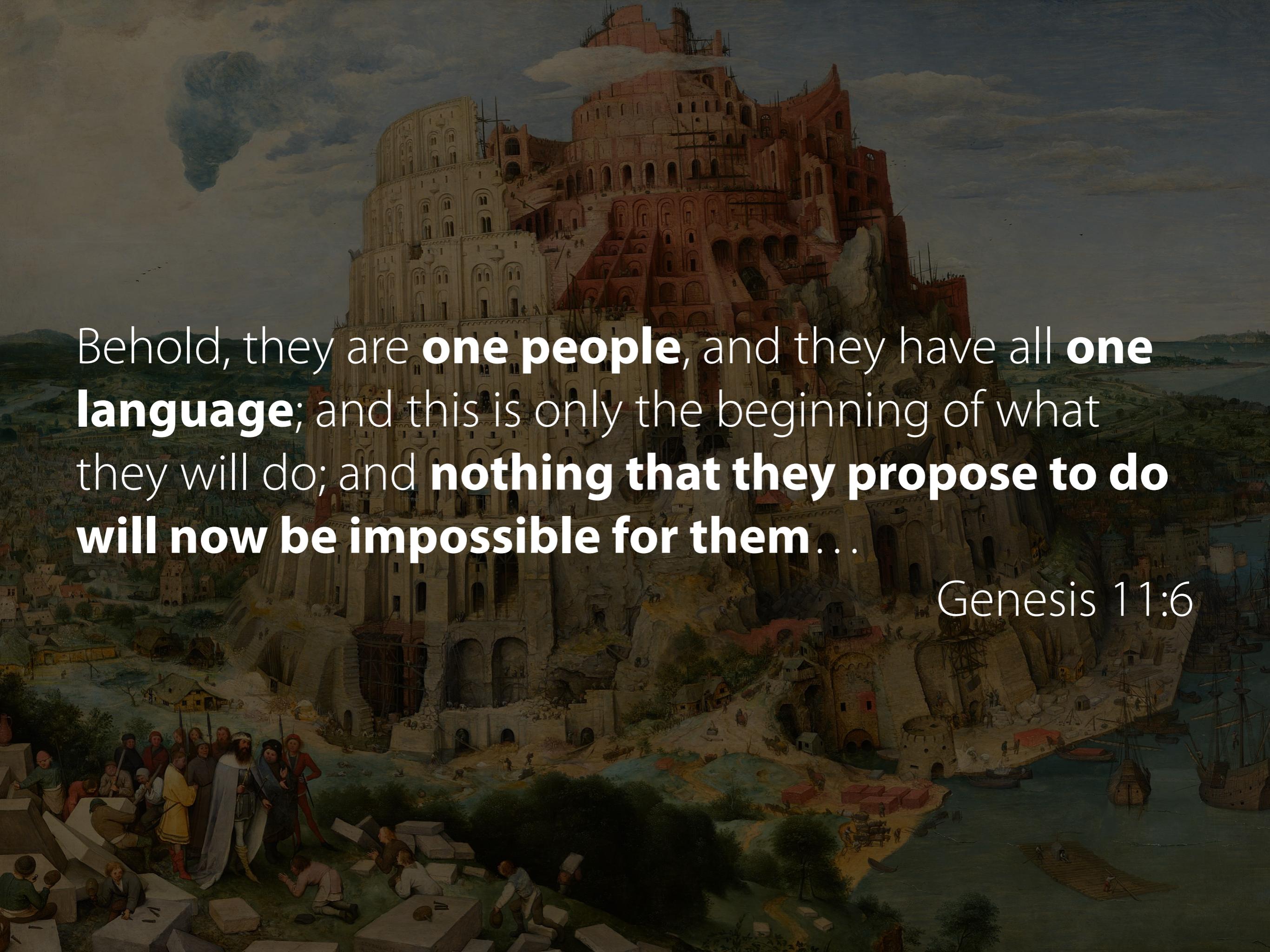


Guru Parulkar  
ONF









Behold, they are **one people**, and they have all **one language**; and this is only the beginning of what they will do; and **nothing that they propose to do will now be impossible for them...**

Genesis 11:6

# State of P4

*Behold! We are one community, and we now have all of the ingredients we need to design, build, and operate networks with P4.*

*Nothing that we propose to do will be impossible for us!*

# State of P4

*Behold! We are one community, and we now have all of the ingredients we need to design, build, and operate networks with P4. Nothing that we propose to do will be impossible for us!*



## Academic Interest

- Award-winning papers at top conferences
- New courses at leading universities

# State of P4

*Behold! We are one community, and we now have all of the ingredients we need to design, build, and operate networks with P4. Nothing that we propose to do will be impossible for us!*



## Academic Interest

- Award-winning papers at top conferences
- New courses at leading universities

## Industry Momentum

- Real-world deployments
- Diverse set of P4 targets
- Growing number of P4-based products

# State of P4

*Behold! We are one community, and we now have all of the ingredients we need to design, build, and operate networks with P4. Nothing that we propose to do will be impossible for us!*



## Academic Interest

- Award-winning papers at top conferences
- New courses at leading universities

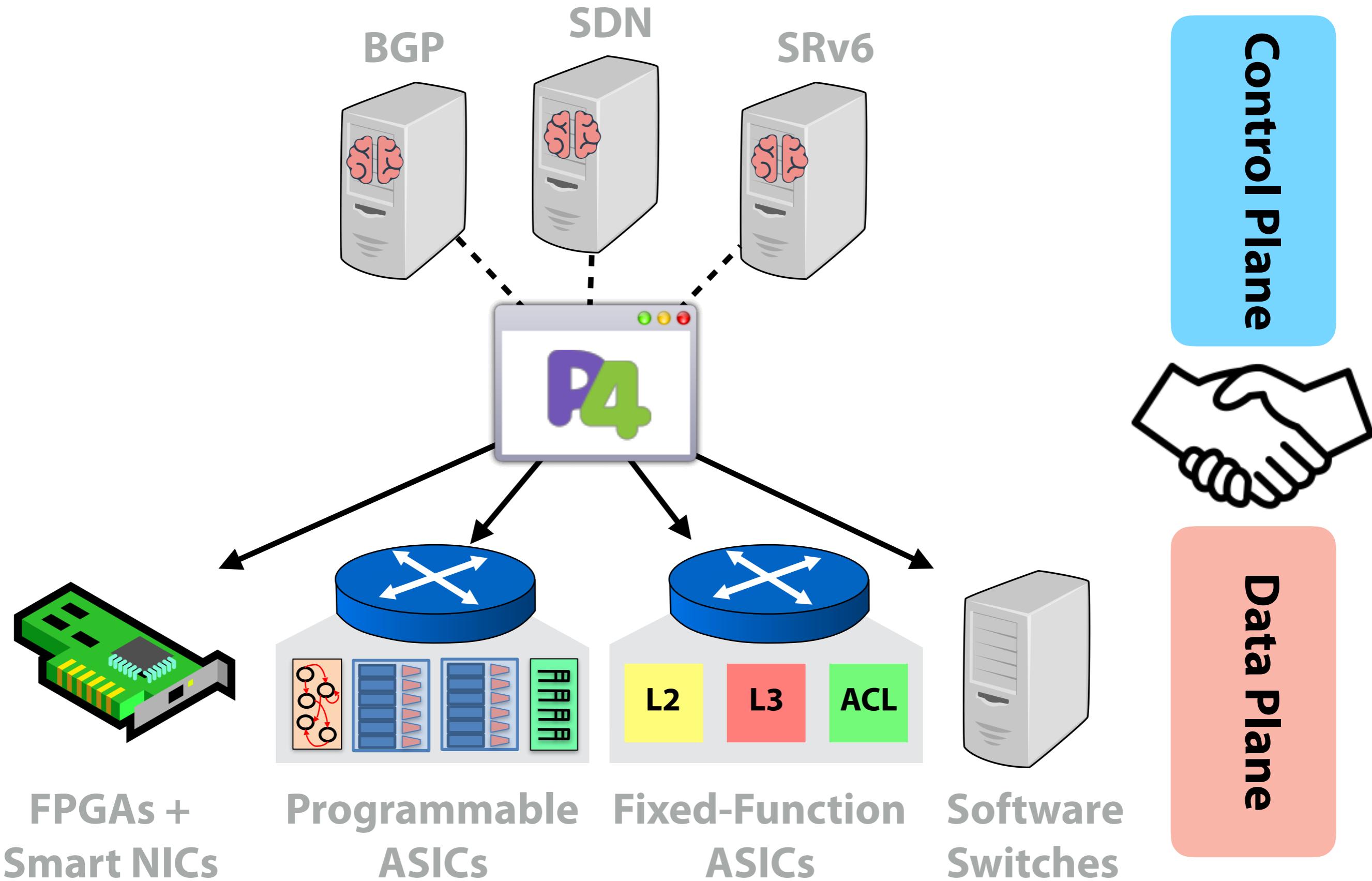
## Industry Momentum

- Real-world deployments
- Diverse set of P4 targets
- Growing number of P4-based products

## Open Source Community

- > 125 members + 5 working groups
- Open governance model
- Community events
- ONF alignment to nurture further growth

# P4: *Lingua Franca* of Networking



# API Working Group

## This year:

- Released v1.0.0 of the P4Runtime Specification in January!
- P4Runtime is being used in Stratum NOS and the ONOS Controller



Antonin Bas  
Barefoot



Waqar Mohsin  
Google

## Looking ahead:

- Improving controller arbitration process
- Exploring the notion of “controller role” to enable partitioning switch between multiple controllers
- Developing an interactive shell in Python for interacting with P4Runtime-controlled switches



A screenshot of the P4Runtime Specification document cover. The title "P4Runtime Specification" and "version 1.0.0" are at the top. Below that is the subtitle "The P4.org API Working Group" and the date "2019-01-29". A large red starburst graphic with the word "NEW" in white is overlaid on the right side. The document includes sections for "Abstract", "Contents", and a detailed table of contents.

**P4Runtime Specification**  
version 1.0.0

The P4.org API Working Group  
2019-01-29

**Abstract**

P4 is a language for programming the data plane of network devices. The P4Runtime API is a control plane specification for controlling the data plane elements of a device defined or described by a P4 program. This document provides a precise definition of the P4Runtime API. The target audience for this document includes developers who want to write controller applications for P4 devices or switches.

**Contents**

1. Introduction and Scope	4
1.1. P4 Language Version Applicability	4
1.2. In Scope	5
1.3. Not In Scope	5
2. Terms and Definitions	5
3. Reference Architecture	7
3.1. Idealized Workflow	8
3.2. P4 as a Behavioral Description Language	8
3.3. Alternative Workflows	9
3.3.1. P4 Source Available, Compiled into P4Info but not Compiled into P4 Device Config	9
3.3.2. No P4 Source Available, P4Info Available	9
3.3.3. Partial P4Info and P4 Source are Available	9
3.3.4. P4Info Role-Based Subsets	10
4. Controller Use-cases	10
4.1. Single Embedded Controller	10
4.2. Single Remote Controller	10
4.3. Embedded + Single Remote Controller	11
4.4. Embedded + Two Remote Controllers	11
4.5. Embedded Controller + Two High-Availability Remote Controllers	11
5. Master-Slave Arbitration and Controller Replication	13
5.1. Default Role	15
5.2. Role Config	15
5.3. Rules for Handling MasterArbitrationUpdate Messages Received from Controllers	16
5.4. Mastership Change	17
6. The P4Info Message	17

# Architecture Working Group

## This year:

- Released v1.1 of the PSA Specification
- Initial PSA implementation (see demo!)

## Looking ahead:

- Design of Portable NIC Architecture
- Exploring features to support programmable scheduling and active queue management
- Improving documentation of current architecture specifications (PSA, v1model)



Calin Cascaval  
Barefoot



Andy Fingerhut  
Cisco

# Language Design Working Group

## This year:

- Fixed many inconsistencies and bugs
- Ergonomic improvements to type system
- Design of modular programming features

## Looking ahead:

- Finalize P4 module system
- Develop constructs to support specifying behavior of P4 architectures
- Enrich notion of events (e.g., packets, timers, etc.)
- Formalize language semantics



Mihai Budiu  
VMware



Nate Foster  
Cornell

# Applications Working Group

## This year:

- Much progress toward inband-network telemetry (INT) specification v2.0.0
- YANG model for INT metadata
- Extensions to support different transports, and export of telemetry data at each hop



Mukesh Hira  
VMware



JK Lee  
Barefoot

## Looking ahead:

- Release v2.0.0!
- Possibly exploring applications other than telemetry

# Education Working Group

## This year:

- Created repository for teaching materials
- Presented tutorials
  - Cambridge, UK (IEEE ICNP)
  - Budapest, Hungary (ACM SIGCOMM)
  - San Francisco, CA (NANOG)
  - Tokyo, Japan
  - Milan, Italy
- Organized hackathons
  - Boston, MA (USENIX NSDI)
  - Frankfurt, Germany



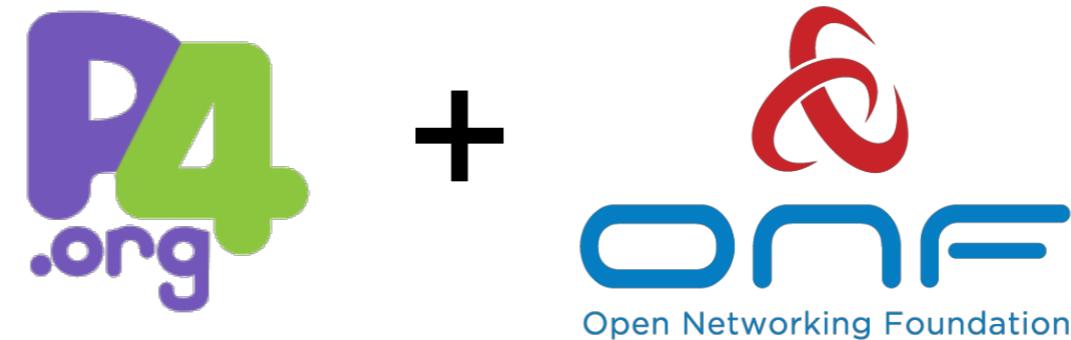
Robert Soulé  
Lugano



Noa Zilberman  
Cambridge

## Looking ahead:

- Curate academic courses
- Develop a programmer's guide



## Business as usual

- All P4 properties are still active (web, GitHub, mailing lists, etc.)
- All P4 working groups remain active under the same leadership
- Anyone can continue to contribute to P4-related activities
- As before, no fees required to participate

## Governance

- P4 will be managed by the P4 Technical Steering Team (TST)
- Initial TST: current P4 Board and ONF Executive Director
- Starting in 2020: TST elected by active contributors to P4
- <https://github.com/p4lang/governance>

## Future Synergies

- ONF software platforms (ONOS, Stratum)
- Seek alignment with Linux Foundation

# Get Involved

## Become a member of the community!

- No fee to join
- Code and data licensed under Apache2

## Participate in working groups

- Activities are open to everyone
- Anyone with a good idea can help shape the future of P4

## Contribute to open-source software

- Compiler (p4c)
- Software switch (bmv2)
- Control-plane APIs (P4Runtime)
- Tutorials
- Documentation
- Applications

# **P4 Distinguished Service Award**

# P4 Distinguished Service Award

**Citation:** *For dedicated service as co-chair of a working group, contributor to software project, and mentor to new members of the community.*

*Over the past few years, he has been one of the most active members of the P4 community. He regularly participates in multiple working groups and has made essential contributions to the P4 Language, P4Runtime, and PSA specifications. He has written numerous lines of open-source code, including hundreds of test cases for p4c and bmv2 that exercise tricky corner cases and inform design discussions. And he has been a dedicated mentor to new users, answering questions on our mailing lists and Slack channel, and curating a wonderful set of example programs that are a popular introduction to P4.*

# P4 Distinguished Service Award



**Andy Fingerhut**

Cisco

**Citation:** *For dedicated service as co-chair of a working group, contributor to software project, and mentor to new members of the community.*

*Over the past few years, he has been one of the most active members of the P4 community. He regularly participates in multiple working groups and has made essential contributions to the P4 Language, P4Runtime, and PSA specifications. He has written numerous lines of open-source code, including hundreds of test cases for p4c and bmv2 that exercise tricky corner cases and inform design discussions. And he has been a dedicated mentor to new users, answering questions on our mailing lists and Slack channel, and curating a wonderful set of example programs that are a popular introduction to P4.*

# Agenda

## Overview

- Status
- Roadmap

## Presentation Track

- 9 talks
- ~20 minutes each

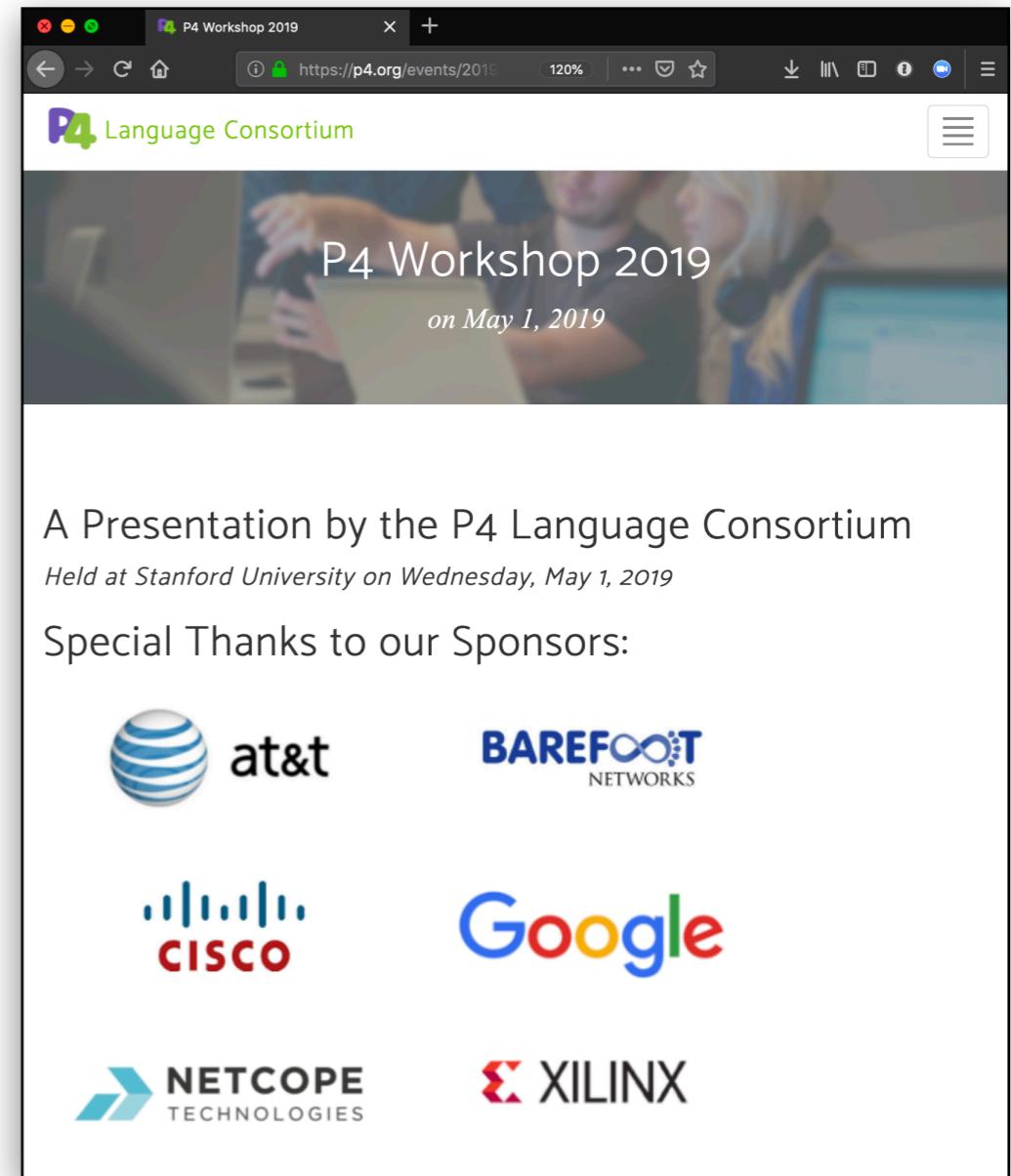
## Keynote

- John Hennessy, Stanford

*The End of Moore's Law and Faster  
General Purpose Processors, and a  
New Road Forward*

## Demo Track

- 13 accepted demos + 2 posters
- 1 minute lightning talks + live demos  
(at other end of building)



# Thank You

## Program Committee

- Nate Foster, Cornell (co-chair)
- Nick McKeown, Stanford (co-chair)
- Anirudh Sivaraman, NYU
- Gordon Brebner, Xilinx
- Hongqiang Liu, Alibaba
- Mina Tahmasbi Arashloo, Princeton
- Sandesh Kumar Sodhi, Juniper

## Conference Organization

- Sedef Ozcana, ONF
- Rachel Everman, Barefoot

## P4 Technical Steering Team

- Nate Foster, Cornell
- Nick McKeown, Stanford
- Guru Parulkar, ONF
- Jennifer Rexford, Princeton
- Amin Vadhat, Google

## Industrial Sponsors

