# 15-745: Project Proposal

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## 1 Project Title

**P4CKET: Efficient Online Profiling for P4 Programs**

## 2 Project Web Page

Project Link

## 3 Project Description

P2GO (P4 Profile-Guided Optimizations) is a system designed to enhance the efficiency of P4 programs through dynamic profiling of network trace files. By analyzing these traces, P2GO identifies frequently executed paths and optimizes them, aiming to improve network performance while reducing hardware resource consumption. The system employs a four-phase approach: profiling, removing dependencies, optimizing table accesses, and code generation. P2GO focuses on experimenting with static optimizations, adjusting recompilation frequency, and addressing variable traffic patterns in online profiling. The project's main challenge is to strike a balance between the overhead of profiling and the performance benefits gained. By tailoring optimizations to observed traffic patterns without relying on hardware-specific data structures for profiling, P2GO offers a practical solution for improving P4 program efficiency while preserving the original program's semantics for given traces.

### 3.1 Project Goals

1. 75% Goal : Optimize the recompilation and deployment frequency of P4 Programs using offline profiling and time intervals
2. 100% Goal : Implement online profiling while maintaining optimal balance between associated overheads and the performance benefits.
3. 125% Goal : Develop and integrate additional static optimization techniques to further enhance P4 program efficiency.

# 4 Logistics

## 4.1 Plan of Attack and schedule

1. Week 1 : Research and Setup
   (a) Both team members will conduct research on existing P4 optimization techniques and profile-guided optimization approaches
   (b) Setup the development environment and P4 Compiler
2. Week 2 : Research profiling mechanisms and P4 programs
   (a) Member 1 : Research about basic profiling mechanisms and implement profiling network traces
   (b) Member 2 : Gather sample P4 programs and network trace files for testing and also partake in researching about profiling mechanisms.
3. Week 3 : Static optimization techniques
   (a) Member 1 : Research about basic static optimization techniques and implement them
   (b) Member 2 : Create a framework for modifying P4 programs based on profiling data
4. Week 4 - 5 : Adaptive Instrumentation
   (a) Member 1 and Member 2 : Implement hot path identification techniques and use it to adapt the instrumentation in the code.
   (b) Member 1 and Member 2 : Finding a sweet spot in terms of the frequency of recompilation and deployment to the switch
5. Week 6 : Evaluation
   (a) Member 1 and Member 2 : Integrate all the components and evaluate the performance of the implementation using benchmarking applications.
   (b) Member 1 and Member 2 : Prepare the documentation and work on the final report

## 4.2 Milestone

We aim to accomplish several key objectives for the P2GO system. We will complete our research on P4 optimization techniques and profile-guided approaches. Additionally, we will set up the development environment and P4 compiler to ensure we have the necessary tools in place. A significant milestone will be the implementation of basic profiling mechanisms to analyze network traces, which will support our adaptive instrumentation efforts. We also hope to accomplish hot path identification. Building on this, we plan to begin implementing

adaptive instrumentation, allowing us to dynamically adjust the level of instrumentation based on identified hot paths and program behavior. This progress gives us enough headroom to proceed with more advanced optimizations and evaluations in the later stages of the project.

### 4.3 Literature Search

We have done an extensive literature review to inform our project on profile-guided optimizations for P4 programs. Key papers we have studied include:

1. Morpheus: A Run Time Compiler and Optimizer for Software Data Planes
2. P2GO: P4 Profile-Guided Optimizations
3. P4: programming protocol-independent packet processors
4. Open-Tofino

### 4.4 Resources Needed

To conduct our study, implement and evaluate profile guided optimizations, we believe we require the following resources :

1. P4 development tools and compiler (SDE 8.2 or later)
2. Barefoot Tofino simulator or a Tofino switch

### 4.5 Getting Started

As of now, we have completed the initial research phase, reviewed the existing literature on P4 program optimizations and profile-guided optimization techniques. Our primary focus until now has been on understanding the structure of P4 programs, identifying potential areas of optimization and how to use dynamic profiling to optimize the program.