Leveraging In-Network Application Awareness

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NAI’21
Application

Proc1
Proc2

L[1-...]

Network

Switch

L1

Needs

Resources
Application

L[1-…]

Prog1
Prog2

Network

Switch

In-Network Program

Needs

Resources

Need+Resource Planning

Need+Resource Interaction

Needs

Resources
Flightplanner: Features vs Costs

Needs

In-Network Program

Application

Network

Need+Resource Interaction

Resources

L[1-…]

Prog1

Prog2

A

B

C

D

E

Switch
Flightplan: Dataplane Disaggregation and Placement for P4 programs

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https://flightplan.cis.upenn.edu/
Flightplan’s original scope

Disaggregation & Placement

Dataplane program

Server

Switch

FPGA

L1

L2

L3

L4
Dataplane program

1. Segment
2. Abstract Program
3. Abstract Resource Semantics
4. Network Description
5. Planning Objectives
6. Plan
7. Split
8. Segment mapping

Flightplan's original scope
Disaggregation & Placement

Flightplan’s original scope
Flightplan’s original scope
Disaggregation & Placement

Flightplan’s original scope
Disaggregation & Placement

Flightplan’s original scope
1. Application-needs Model

2. Disaggregation & Placement

Flightplan's original scope
1. Application-needs Model

2. Disaggregation & Placement

3. Changed needs or demand

Flightplan's original scope
1. Application-needs Model

2. Disaggregation & Placement

3. Changed needs or demand

4. Reconfiguration

Dataplane program

Flightplan’s original scope
Xeon2450-1:

\( \pi_{\text{Requires}} = \{ \text{Rate} \leq 10^{10} \} \), \quad \pi_{\text{Provides}} = \{ \text{CPU} \},

\text{Ports} = \{ 1 \mapsto \{ \pi_{\text{Requires}} = \{ \text{Rate} \leq 10^{10} \}, \pi_{\text{Provides}} = \{ \} \} \} \)
\textbf{Prog1 mode:} \textbf{M1}: \\
\(\pi_{\text{Requires}} = \{\text{Rate } \leq 1^{10}\}\), \(\pi_{\text{Provides}} = \{\text{Traffic}\}\), \\
\text{Ports} = \{(\text{Xeon2450-1}, 1)\}, \text{Peers} = \{\text{Prog2}\}, \\
\text{OnPath} = \{\text{InNetProg1}\}\)
Prog1 \text{ mode:} \text{M1}: \\
\pi_{\text{Requires}} = \{ \text{Rate } \leq 1^{10} \}, \quad \pi_{\text{Provides}} = \{ \text{Traffic} \}, \\
\text{Ports} = \{(\text{Xeon2450-1, 1})\}, \quad \text{Peers} = \{ \text{Prog2} \}, \\
\text{OnPath} = \{ \text{InNetProg1} \}

\begin{align*}
\text{Prog1} &= \text{mcdClient} \\
\text{Prog2} &= \text{mcdServer} \\
\text{Traffic} &= \text{UDP(200)} \\
\text{M1} &= \text{LowActivity} \quad (\text{lower } \pi_{\text{Requires}})
\end{align*}
Prog1 mode: M1:

\[ \pi_{\text{Requires}} = \{ \text{Rate} \leq 1^{10} \}, \quad \pi_{\text{Provides}} = \{ \text{Trafﬁc} \}, \]
\[ \text{Ports} = \{ (\text{Xeon2450-1, 1}) \}, \quad \text{Peers} = \{ \text{Prog2} \}, \]
\[ \text{OnPath} = \{ \text{InNetProg1} \} \]

Prog1 = mcdClient
Prog2 = mcdServer
Traffic = UDP(200)
M1 = LowActivity (lower \( \pi_{\text{Requires}} \))
InNetProg1 = (None)
**Prog1** mode: **M1**: 

\[ \pi_{\text{Requires}} = \{ \text{Rate} \leq 1^{10} \}, \quad \pi_{\text{Provides}} = \{ \text{Traffic} \}, \]

Ports = \{(Xeon2450-1, 1)\}, Peers = \{\text{Prog2}\},

OnPath = \{\text{InNetProg1}\}

**Prog1 = mcdClient**

**Prog2 = mcdServer**

**Traffic = UDP(200)**

**M1 = LowActivity**

**InNetProg1 = (None)**

**Prog1 = mcdClient**

**Prog2 = mcdServer**

**Traffic = UDP(200)**

**M1 = HighActivity** (higher \( \pi_{\text{Requires}} \))

**InNetProg1 = MCD\_Cache**
Prog1:\text{mode:} \mathbf{M1}: 
\pi_{\text{Requires}} = \{ \text{Rate} \leq 1^{10} \}, \quad \pi_{\text{Provides}} = \{ \text{Traffic} \},
\text{Ports} = \{(\text{Xeon2450-1}, 1)\}, \quad \text{Peers} = \{ \text{Prog2} \},
\text{OnPath} = \{ \text{InNetProg1} \}

Prog1 = \text{mcdClient}
Prog2 = \text{mcdServer}
Traffic = \text{UDP}(200)
M1 = \text{HighActivity, NightTime}
InNetProg1 = \text{MCD\_Cache}
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