Agenda

- Company Introduction

- NoviFlow Software Stack

- NoviSpeaker Advantages

- NoviSpeaker Architecture

- NoviFlow P4Runtime based SDN Application Products

NoviFlow

ABOUT NOVIFLOW

World's leading provider of SDN Network Operating Systems and solutions for programmable match-action data planes

★ *NoviWare™:* First commercial SDN NOS for Edgecore Tofino* products (2018)

FOUNDED
2012

Business Model
Software Licensing
Systems Sales

FOCUS
SDN
Cybersecurity
DCi

PRODUCTS
NOS
Whitebox switches
Controller Applications

ARCHITECTURES
NPU
Tofino

Production deployments worldwide
by global network operators,
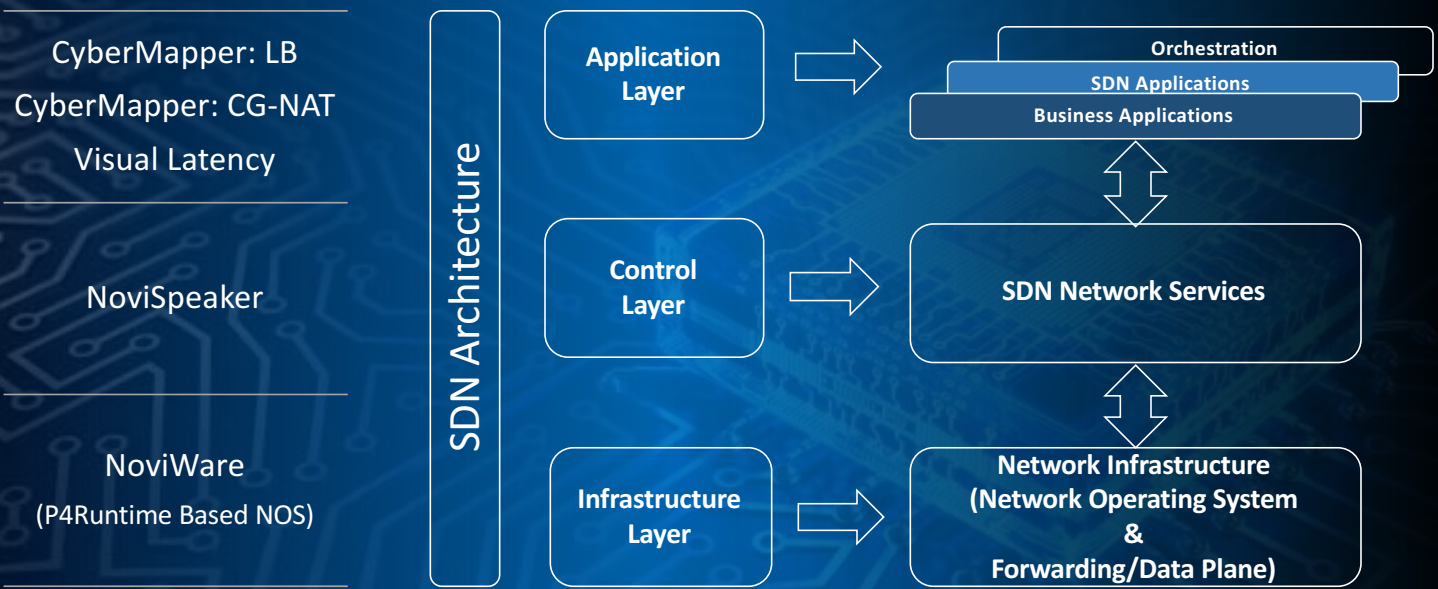hyperscalers, large enterprises and
government agencies

RED HERRING GLOBAL 100 WINNER
2017

RED HERRING GLOBAL WINNER 100
2018

INTEL NETWORK BUILDERS WINNERS' CIRCLE AWARDS
PARTNER

F⊕RTINET.
Fabric-Ready

NoviFlow

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SDN Architecture

CyberMapper: LB

CyberMapper: CG-NAT

Visual Latency

NoviSpeaker

NoviWare
(P4Runtime Based NOS)

SDN Architecture

Application Layer ⟹

Orchestration
SDN Applications
Business Applications

⇕

Control Layer ⟹ **SDN Network Services**

⇕

Infrastructure Layer ⟹ **Network Infrastructure (Network Operating System & Forwarding/Data Plane)**

NoviFlow

NoviSpeaker accelerates P4 Projects

Faster Development	Easier Deployment	Faster Time-to-market
• Will allow customers to have an advantage over competitors in writing P4 applications effectively • NoviSpeaker is highly robust proven carrier grade controller that is already deployed in Tier 1 carrier networks as part of CyberMapper deployment • Other available P4 controllers only provide support of limited connection management between P4 controller and switch	• Easy to deploy P4 applications • Help developers in writing P4 programs • Troubleshooting problems is easier & cheaper • Low Customer support	• Target independence: the underlying Tofino architecture is hidden from the programmer. Hence learning of many of the internals of Tofino architecture is not required. • Save time in maintaining and managing connection mechanism between application and switch hardware. • Port mappings and the mapping of various entities provides ease in debugging and writing management & control plane software.

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NoviSpeaker – Technical Advantages

More efficient use of Tofino switch silicon resources

- Support of BF_Runtime in NoviSpeaker
- Many of the Tofino configurations are taken care by the NoviSpeaker.
  - Reduced overhead compared to the traditional way doing P4 programing
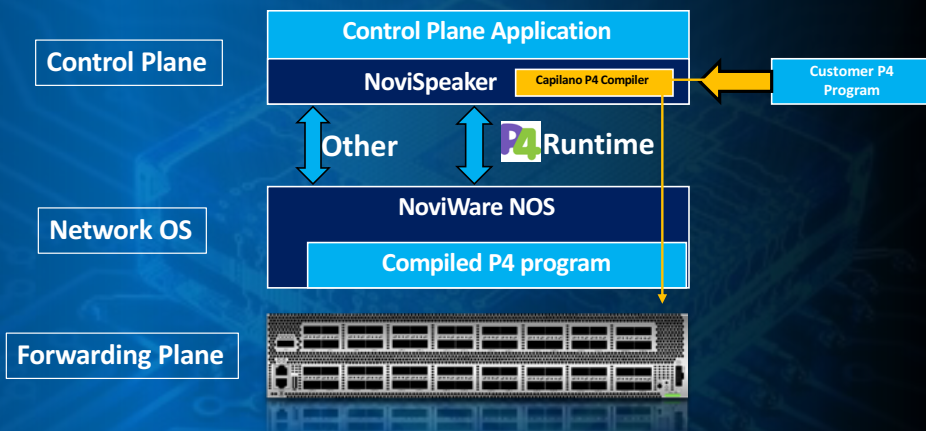
High visibility of the running pipeline

- NoviSpeaker provides high visibility of the pipeline running in the data plane

Support of standard & proprietary proto files together

- Support of proprietary proto file (novi.proto) along with P4/BF-Runtime proto file enables capability of providing many features like LAG in NoviSpeaker that are not part of the standard P4/BFRuntime specification.

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P4 From Concept to Deployment…

- Write the P4 Pipeline program

- Compile the P4 Program and push it in the Tofino based white-box switch

- Write the control plane application

- Register the application with NoviSpeaker

- NoviSpeaker is used with Tofino based switches as well as BF simulator

Control Plane

Network OS

Forwarding Plane

Control Plane Application

NoviSpeaker | Capilano P4 Compiler ← Customer P4 Program

Other | **P4** Runtime

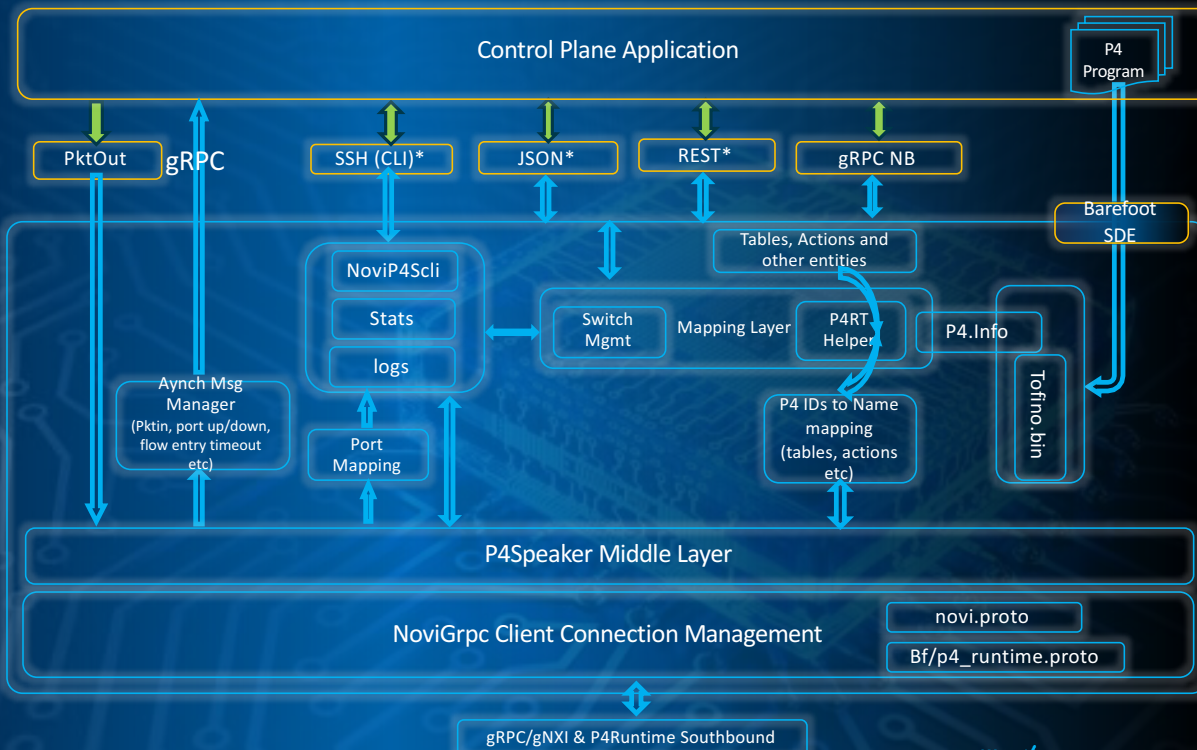NoviWare NOS

Compiled P4 program

NoviFlow

NoviSpeaker Architecture

Highly efficient & robust channel between the P4 applications & the switch

Multiple connection support) gRPC, gNOI, gNMI, JSON*, REST* etc (*Roadmap items)

Support of different features through Extern & bf/p4runtime protobuf and proprietary protobuf

N O V I S P E A K E R

Control Plane Application

P4 Program

PktOut   gRPC

SSH (CLI)*

JSON*

REST*

gRPC NB

Barefoot SDE

NoviP4Scli

Stats

logs

Tables, Actions and other entities

Switch Mgmt

Mapping Layer

P4RT Helper

P4.Info

Aynch Msg Manager (Pktin, port up/down, flow entry timeout etc)

Port Mapping

P4 IDs to Name mapping (tables, actions etc)

Tofino.bin

P4Speaker Middle Layer

NoviGrpc Client Connection Management

novi.proto

Bf/p4_runtime.proto

gRPC/gNXI & P4Runtime Southbound

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NoviSpeaker Features   Cntd...

- **Management of the connections :**
  - NoviSpeaker simplifies the management of the connections with switches running P4Runtime based NoviWare.
  - NoviSpeaker exposes a northbound gRPC interface for management and runtime control.

- **Protobufs :**
  - Support for both NoviFlow protobuf (novi.proto) as well as BareFoot/P4 protobuf (bf/p4_runtime.proto).

- **Extern :**
  - Support for features not part of standard P4Runtime specifications (eg Extern).
  - Multicast groups, LAGs, mirror sessions etc are supported that are not part of the P4Runtime.

- **ASYNCH messages :**
  - Port up/down

- **SDN Interfaces:**
  - The same gRPC stub can be used for gNMI, gNOI, gRPC and P4Runtime interface using both NoviFlow protobuf and BareFoot/P4 protobuf files simultaneously.

- **P4Runtime Translation Layer :**
  - Mapping of IDs from P4.info to naming convention (tables, actions etc) to facilitate applications and it's users.
  - Port Mapping to expose front panel port numbers to the applications.

- **Switch Mode :**
  - Automatically put the NoviWare switch in P4 runtime mode if switch is running NoviWare in OpenFlow mode.

- **ROLLBACK_ON_ERROR :**
  - Implementing ROLLBACK_ON_ERROR feature which is not available in Tofino by itself.

- **Port stats and configs :**
  - Get port stats* and Set port configuration that are not part of P4Runtime.

- **Debugging :**
  - Run the switch in debug mode (for SM5000) and expose virtual ports via grpc stream. (for internal use only for now)
  - Provide logs, error reporting and debugging information to help debug applications, NoviSpeaker and NoviP4Runtime based NoviWare. These are provided through the Docker.

- **Swapping of P4 program :**
  - Support for live swapping of P4 programs.
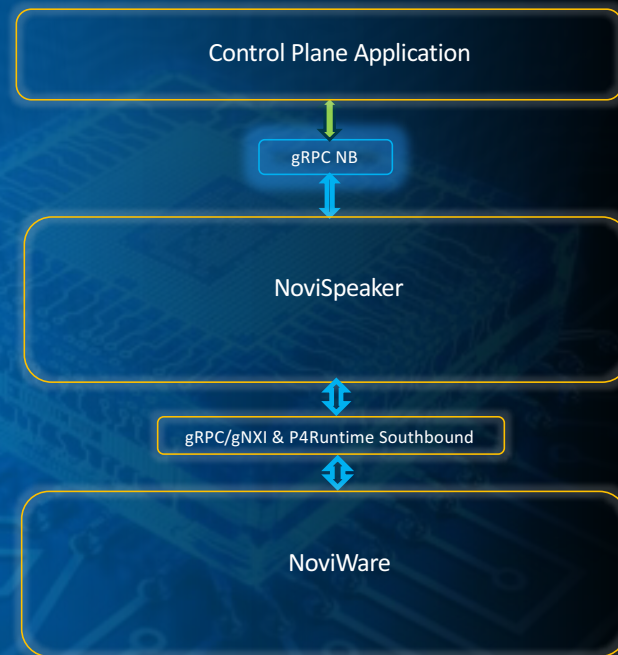
NoviFlow

NoviSpeaker Protobuf

```
// Register an application with the NoviSpeaker
rpc RegisterApplication(RegisterApplicationRequest)
   returns(RegisterApplicationResponse) {};


 // Receive switch info, such as serial number etc.
rpc ReceiveSwitchInfo(ReceiveSwitchInfoRequest)
     returns(ReceiveSwitchInfoResponse) {};


 // Modify the runtime state of the P4 program by inserting,
// modifying or deleting entities.
rpc WriteP4Entities(WriteP4EntitiesRequest)
   returns(WriteP4EntitiesResponse) {};
rpc ReadP4Entities(ReadP4EntitiesRequest)
   returns(stream ReadP4EntitiesResponse) {};
. . . . . .
Etc.
```

Control Plane Application

gRPC NB

NoviSpeaker

gRPC/gNXI & P4Runtime Southbound
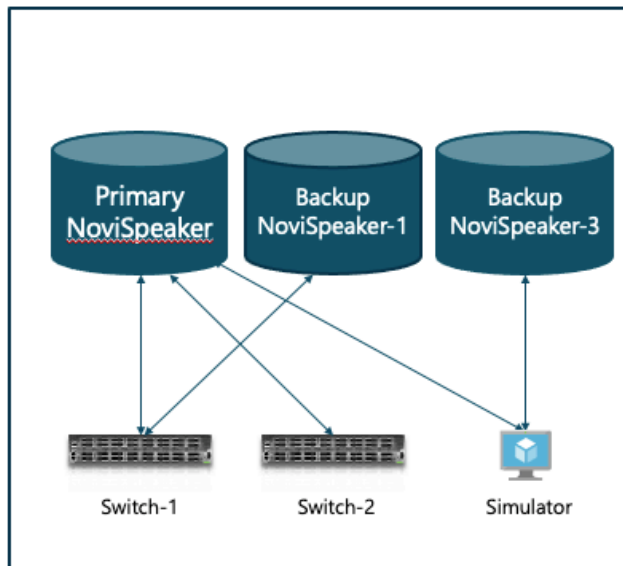
NoviWare

NoviFlow

NoviSpeaker Solution Setup

Containerized distribution (Ubuntu/*RedHat)

Works with Tofino-based switches running NoviWare or simulator (SM-5000) with NoviWare

NoviSpeaker supports *redundancy (Primary-Backup) and *multiple switch support

*Roadmap items

Primary NoviSpeaker

Backup NoviSpeaker-1

Backup NoviSpeaker-3

Switch-1

Switch-2

Simulator

NoviFlow

NoviSpeaker License & Setup Cntd...

NoviSpeaker annual software subscription enables customers to do lab trial on Tofino-based white-box switches running NoviWare

NoviSpeaker simplifies the management of the connections with switch/simulator running P4Runtime based NoviWare.

NoviSpeaker exposes a northbound gRPC interface for management and runtime control from application.

Provides tailored interfaces towards the applications (northbound) and the switch (southbound)

NoviFlow
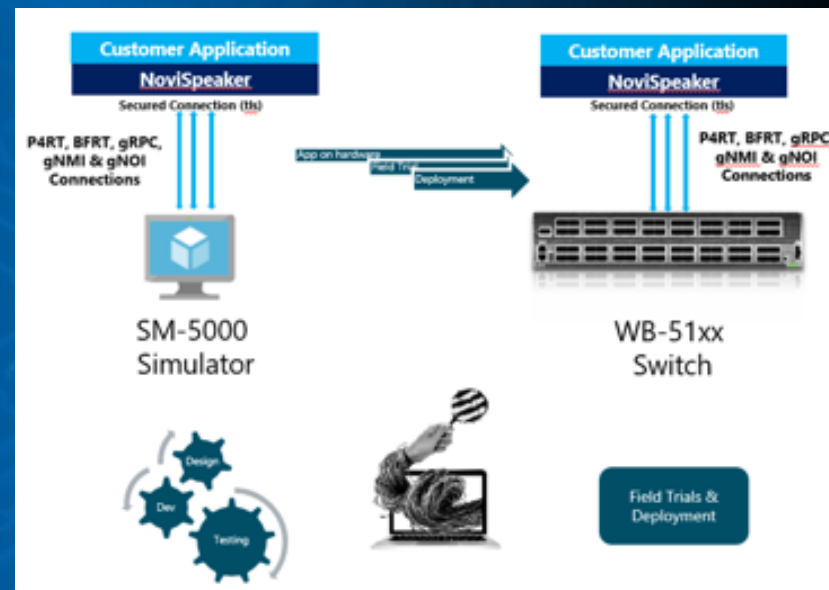
Migration to NoviSpeaker (For Existing P4 Applications)

Advantage of NoviSpeaker functionalities can easily be leveraged for existing P4 applications

No need to recompile the P4 application

No need to even reboot the Tofino switch if customer is already running NoviWare as a NOS in Tofino based whitebox switches.
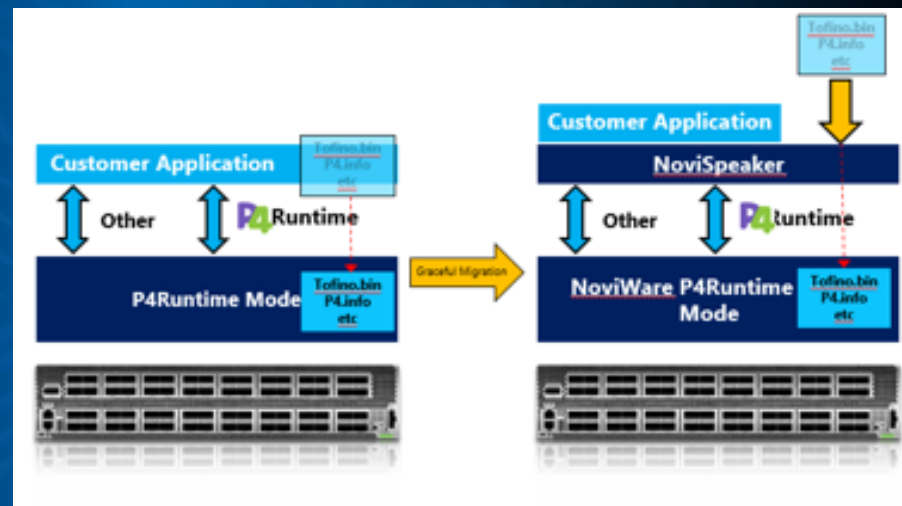
NoviFlow

# Testimonial to the Awesome Power of Tofino*/P4 SDN Applications Crafted with NoviWare & NoviSpeaker

- Four applications developed by NoviFlow and one "Sneak Peek" Announcement
- Silicon based Algorithms crafted by the Developer
- Development time-to-market an order of magnitude faster
- Terabit throughput for Load Balancing, Cyber Mitigation, Traffic Steering, etc.

NoviFlow

CyberMapper: Terabit Load Balancing and Security Mitigation

- Create Firewall Farms that scale to multi-Terabit solutions
  - Dynamic Scaling of Firewalls when new security tools are added to the cluster
  - Scales across Appliances, VMs and Containers
- Non-Destructive Failover, only affects the flows on a failed Firewall
  - Can failback all flows when failed device comes back online
- Increase Efficiency
  - Pre-Filter traffic using third-party IP reputation lists
  - Mitigation events and ACLs (blacklist) can be pushed into hardware

Algorithm / Pipeline:
- Symmetric, Affinity, Terabit Load Balancing
- Terabit Mitigation (Blacklist)
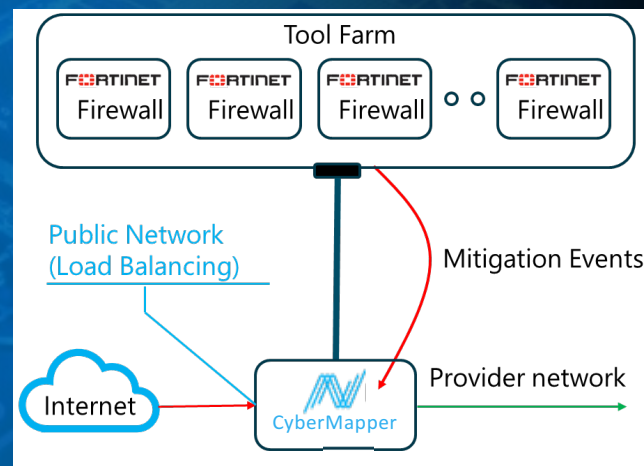
CyberMapper: Dynamic Packet Broker Services

- Includes all CyberMapper functionality
- Multi-Terabit Packet Broker for mixed passive/active tool farms
- Dynamic Tapping of flows
- Dynamic Packet Steering to Active in-line tools
- Dynamic whitelist to bypass tool farm
- Deep inspection inside of encapsulated packets
- Inspect IP headers inside multiple label encapsulation
- MPLS, GTP, etc.
- Filter protocol control packets from being sent to tool farms
- **Benefit**
  - Higher throughput and lower cost than competing solutions

Algorithm / Pipeline:
- Add Tap, Steering, and Whitelist
- Terabit Throughput

NoviFlow
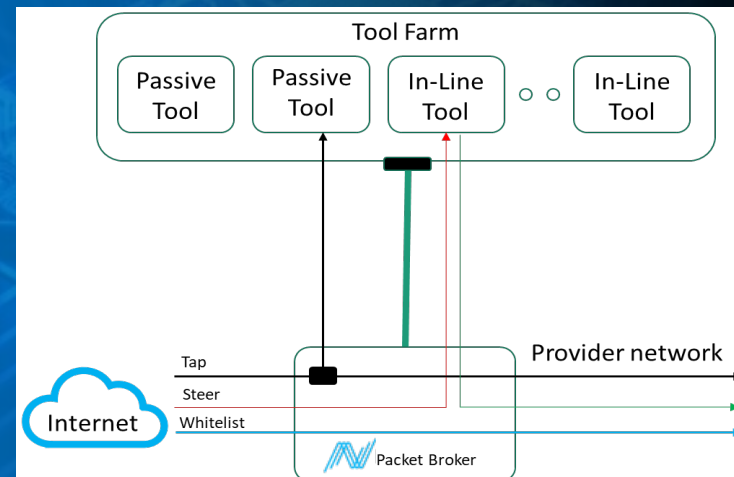
CGNmapper: Carrier Grade NAT Services

- Multiple Terabit scaling of CGNAT traffic
  - Designed from the ground up to scale CG NAT farms

- Load Balancing Algorithm pins a session to a specific Fortinet device

- Multiple CPE sessions can be distributed across the tool farm

- The return packets of the Public IP addressed assigned by Fortinet device is steered back to the same device

Benefit

- Scalable - Highest throughput CGNAT solution in the industry
- Most cost-effective scaling solution
- Allows incremental upgrades to Tool Farm

Algorithm / Pipeline:
- Load Balancing on Private side
- Traffic Steering on Internet side
- Symmetric – both sides of Flow always processed by same Tool


NoviFlow
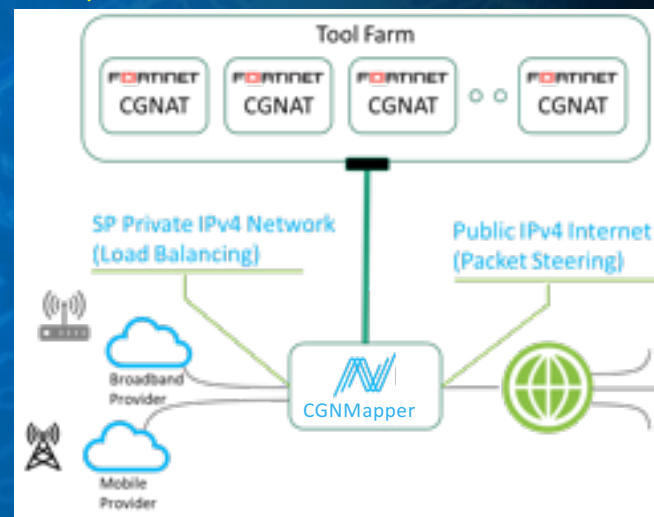
VisualLatency: INT Header to Capture Tool Latency

- Packet Broker Enhancements
  - INT Header insert
  - Timestamp on every hop
  - Pop header, send to analytics
- NoviLake Analytics
  - Process INT packets
  - Ingest metadata
  - Visualization of analytics reports
- **Benefits:**
  - Complete visualization of the tool farms latency
  - Integrates multiple disaggregate systems into simple architecture
  - Removes complexity and cost
    - Removes intermediate switches
    - Removes optical taps
    - Less costly by integrating with Packet Broker

Algorithm / Pipeline:
- Insert INT Header at start of Security Chain
- Timestamp at each step
- Pop INT Header before Egress
- Send INT data to Analytics

NoviFlow
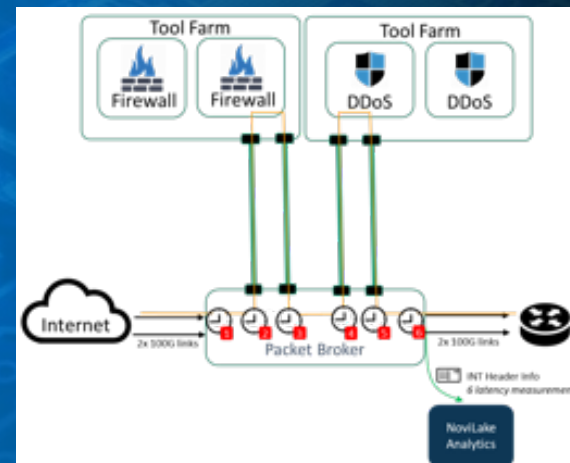
CM Aggregator: with "Agent Pipeline" Technology

- Consolidate similar tap and span feeds into Ingress Groups
- Craft powerful filtering Agents
- Filter on inner packet on encapsulated packet
- Handle ERSPAN packet from remote spans
- Multicast selected flows to multiple Tool groups.
- Load Balance to Multicast to multiple Tool clusters

Algorithm / Pipeline:
- Feed-to-Tool Pipeline that User Craft
- Four Stage process with configurable Agents
- Define the processing pipeline by connection Agents
- Concept to months and product in less than 6 month

Sneak Preview
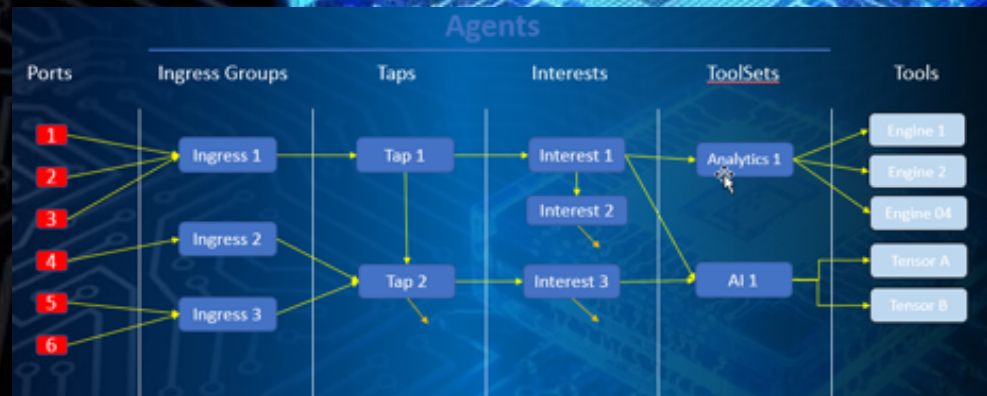
Summary

- SDN is a dynamic and powerful Network concept

- Tofino/P4 delivers the Match-Action pipeline technology required for true SDN

- NoviFlow's NOS and NoviSpeaker provide a development and deploy environment that harnesses the flexibility and productivity of the Tofino/P4 platform

- NoviFlow Applications are a proof point of this SDN technology leverage

NoviFlow