Traffic Steering & Service Chaining
Optimize & Monetize with PEM

Bart Salaets
Solution Architect
 Agenda

• F5 Gi LAN Strategy
• Traffic Steering & Service Chaining
  • Recent Evolutions
  • Policy-Based “Per-Flow” and “Per-Transation” Steering
  • Static & Dynamic Service Chaining : Evolution to IETF model
• Policy Enforcement Manager
  • Traffic Classification
  • Policy Actions
• Evolution towards NFV
• Summary
F5 Gi LAN Strategy
F5 in the S/Gi network – A Consolidated Approach
Simplifying the delivery of network services

BEFORE F5

WITH F5
Traditional Steering to VAS & Optimization platforms
A router steers all port 80 traffic to VAS platforms

All port 80 traffic service chained through all VAS platforms
Challenges with the traditional approach

- All VAS platforms need to classify and process all port 80 traffic
  - Waste of resources for pass-through traffic
  - Duplication of resources
- Time-to-market challenge for new services
  - Network integration
  - PCC integration
- Video optimization and transparent caching requires a fresh look
  - Cost benefit or QoE mgmt tool
  - Rise of ABR video (HLS, MPEG-DASH)
  - Increase in SSL / SPDY
Challenges with the traditional approach

"Doing more of the same is economically no longer viable"
Solution: Intelligent traffic steering to VAS platforms
Offloading VAS services & Optimizing infrastructure utilization

INTELLIGENT STEERING

CONTEXT

SUBSCRIBER
DEVICE-TYPE
RAT-TYPE
CONTENT (VIDEO, URI, ...)
CONGESTION

Data Center

Video Optimization
Transparent Caching
Parental Controls
WAP Gateway

Context-aware & policy-driven steering & intelligent service chaining
Policy-Based “per-flow” Steering

• Use cases – Steering policy for each flow dependent on ...
  • Subscriber policy
  • RAT-Type (2G / 3G / LTE / Wifi)
  • Location (roaming)
  • Network congestion
  • Device-type (IMEI, HTTP User-Agent)
  • Content-Type (HTTP Content-Type, DPI signature)
    ... or any combination of the above

• Control Plane interactions
  • Diameter Gx (from PCRF)
  • Radius (from GGSN)
  • Custom API (eg for congestion based steering)
Policy-based Flow Steering in Action
Steering to 2 VAS services: Subscriber + RAT-type based

<table>
<thead>
<tr>
<th>User</th>
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Service Provider VAS
- Video Optimization
- Parental Control

Control Plane
- PCRF
- AAA

John
- Emma
- GGSN
- PGW
- Radius (RAT-type updates)

Paul
- Internet
Policy-based Flow Steering in Action

User John: http traffic in LTE

User | Service Policy
---|---
John | Video Optimization “LTE bypass”
    | Parental Control “No”
Paul | Video Optimization “Always”
    | Parental Control “Yes”
Policy-based Flow Steering in Action
User John: http traffic in 3G
Policy-based Flow Steering in Action
User Paul: http traffic in 3G or LTE

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Service Provider VAS
- Video Optimization
- Parental Control

Control Plane
- PCRF
- AAA

- GGSN
- PGW
- Subscriber
- Radius
- Diameter Gx
- Other API
- Internet

Policy-based Flow Steering in Action:
User Paul: http traffic in 3G or LTE
Policy-Based Flow Steering & Service Chaining

Summary

POLICY-BASED STEERING + LOAD BALANCING

CONTEXT

SUBSCRIBER POLICY DETERMINES STEERING TO PARENTAL CONTROL

RAT-TYPE DETERMINES STEERING TO VIDEO OPT.

POLICY-BASED STEERING + LOAD BALANCING

RADIUS
(RAT-TYPE updates for subscriber in interim accounting)

DIAMETER Gx
(subscriber policy indicates parental control)

PGW/GGSN

RADIUS

RTR

PCRF

RADIUS

PCRF

Intelligent Steering Platform

Steering leg controlled by Radius (RAT-Type)

Steering leg controlled by PCRF (subscriber policy)

Internet

Data Center

Video Optimization

Transparent Caching

Parental Control

WAP Gateway

Firewall CGNAT

DPI
Policy-based “per-transaaction” Steering

• Video Optimization – A changing use case
  • Increasing desire to offload any HTTP traffic that is not carrying video
  • Increasing desire to offload ABR video traffic
  • Possibly further refined with per-subscriber (for QoE differentiation) and RAT-type based (for LTE offload) steering policies

• The Technical Challenge
  • Accurate video detection requires checking both the HTTP request and the response headers
  • If the detection happens at the response level, how can we steer video to video optimizers ‘after-the-facts’ (connection to video server is already established) ?

• The Technical Solution
  • Requires HTTP request-based & response-based (per-transaaction) steering
HTTP Messages Differ from IP Packets & TCP Flows

- HTTP message can span multiple packets
- Packets may have multiple HTTP messages
- Delimiting HTTP messages may require inspection of every byte
- Message steering in some cases may cause TCP stream to be split – may lead to chaos in client to end point communication
Steering on HTTP Request

• Establish TCP connection with client (full handshake)

• For each HTTP request message within that TCP connection from client
  • Parse the HTTP request headers
  • If steering policy is dependent on value(s) of one or more of the HTTP headers, then determine the nexthop (VAS endpoint) for this HTTP message according to this steering policy

• Establish new TCP connection with the VAS selected in the steering policy and forward the HTTP message between client and selected VAS

• In case of service chaining (multiple VAS endpoints) there will be several TCP connections being set up over which the HTTP message will be forwarded
Steering on HTTP Response

• Establish TCP connection with client (full handshake)
• Establish another TCP connection with the server (full handshake)
• Forward HTTP message from client to server over the full proxy
• For each HTTP response message within that TCP connection from server
  • Parse the HTTP response headers
  • If steering policy is dependent on value(s) of one or more of the HTTP headers, then determine the nexthop (VAS endpoint) for this HTTP message according to this steering policy
  • But how do we steer to the VAS? The connection with the server is already established ...
Steering on Response – Sequence of events

**HTTP Request**

1. **Mobile Client** sends a HTTP Request to **RAN**.
2. **RAN** forwards the request to **PGW/GGSN**.
3. **PGW/GGSN** forwards the request to **RTR**.
4. **RTR** forwards the request to **Intelligent Steering Platform**.
5. The Intelligent Steering Platform makes a decision based on the policy and forwards the request to **INTERNET**.
6. **INTERNET** processes the request and returns an **HTTP Response**.
7. The **HTTP Response** is forwarded to the **Intelligent Steering Platform**.
8. The **Intelligent Steering Platform** checks if the content is a video, if the content type starts with "VIDEO/" and the content length is greater than 1024KB, it redirects to **VIDEO OPTIMIZATION**.
9. The **Video Optimization** is then called by 123.com.

**Policy Execution**

IF 
CONTENT-TYPE STARTS WITH "VIDEO/" 
CONTENT-LENGTH > 1024KB
THEN 
REDIRECT TO VIDEO OPTIMIZATION

**Response to Client**

**HTTP Response** is responded to the client with a 302 redirect to the same URI extended with classification info.
Steering on Response – After the HTTP redirect

**Policy Execution**

**If**
- URI CONTAINS VIDEO CLASSIFICATION INFO

**Then**
- STEER TO VIDEO OPTIMIZATION & DELETE CLASSIFICATION INFO FROM URI

New HTTP request with classification info embedded in the URI

Steer HTTP Request to Video Optimizers

HTTP Response (optimized video)

HTTP Response (optimized video)

Steer HTTP Request to Video Optimizers

New HTTP connection (original video)
Steering on Response – ICAP variant with Skyfire

HTTP Request from client

Response to Client with 302 redirect to Skyfire Rocket optimizer (original URI embedded)

HTTP Response

ICAP Request (preview)

ICAP Response (302 redirect to Rocket Optimizer)

SKYFIRE PRE-FILTER LOGIC

IF
  CONTENT-TYPE STARTS WITH "VIDEO/"
  CONTENT-LENGTH > 1024KB
THEN
  ICAP REQUEST TO ROCKET CONTROLLER

Analyze ICAP preview
Do we optimize? Yes!
Steering on Response – After the HTTP redirect

```
SKYFIRE PRE-FILTER LOGIC
IF CONTENT-TYPE STARTS WITH “VIDEO/” AND CONTENT-LENGTH > 1024KB
THEN ICAP REQUEST TO ROCKET CONTROLLER
```

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**HTTP request**
- Original URL + cookie
- HTTP response (original video)
- HTTP response (optimized video)

**ICAP Request**
- ICAP Request (preview)

**ICAP Response**
- ICAP Response (204: No content)

**Rocket Controller**
- Analyze ICAP preview
  This is optimized flow

**Intelligent Steering Platform**
- Forward HTTP request
- Forward HTTP response (optimized video)

**Mobile Client**
- http://cloud.skyfire.com/[URL]?[cookie]

**Network Components**
- RAN
- PGW/GGSN
- RTR
- 123.com

**Optimization Flow**
- Forward HTTP response (optimized video)
- ICAP Request (preview)
- ICAP Response (204: No content)
- Analyze ICAP preview
  This is optimized flow

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F5 Agility 2014
IETF – Service Chaining Working Group

- IP networks rely more and more on the combination of advanced functions
  - Besides basic routing and forwarding functions (optimization, proxy, DPI, FW)
- The goal is to enforce service-inferred forwarding for traffic traversing a given domain
  - Differentiated by the set of Service Functions to be invoked
  - Service-inferred forwarding is policy-based. Policies may be:
    - Subscriber-aware
    - Based on flow characteristics
    - TE-oriented (e.g., optimize network resource usage)
    - Combination thereof
- Several Service Function Chaining (SFC) IETF drafts available
IETF – Service Function Chaining

- SFC ingress: Policy classification will determine service chain SFC-ID – pointing to a sequence of service functions (SFs)
  - All Service Functions may be policy controlled via a control plane
  - Meta-data can be added to the packets (to convey the SFC-ID to the SFs)
- Packet forwarding between SFs can be plain IP, SDN, overlay networks, ...

SFC-ID=1

- LOAD BALancer (SF1)
- WEB PROXY (SF2)
- FIREWALL (SF3)
- NAT44 (SF4)

SFC-ID=2

- DPI (SF5)
- HEADER ENRICHM. (SF6)
- FIREWALL (SF3)
Static & Dynamic Service Chaining – Today with F5

INTELLIGENT SERVICE CHAINING

INTelliGent SteerinG PolICY DeFINes a FiXed Service Function Chain (E.G. VAS1-vas4)

STATIC SERVICE CHAINING

INTELLIGENT STEERING POLICY DEFINES A FIXED SERVICE FUNCTION CHAIN (E.G. VAS1-VAS4)

DYNAMIC SERVICE CHAINING

INTELLIGENT STEERING POLICY HAS BUILT-IN CONDITIONAL CHECKS PER VAS LEG TO DETERMINE NEXT-HOP IN THE SERVICE CHAIN
**Intelligent Service Chaining – Today and Future**

- Available today – F5 TCP & HTTP proxy
- Flexible use of "steering headers" towards VAS platforms (HTTP headers, DSCP, ...) 
- Forwarding based on “connection entries”
- VAS health check built in (load balancing)
- Control plane steering possible (eg ICAP)

- IETF drafts
- Requires all vendors to agree on same standard (packet header for metadata)
- How to leverage SDN for forwarding?
- How to do VAS health-checks?
- How to do control plane steering?
Policy Enforcement Manager (PEM)
### Policy Enforcement Manager – Policy Definition

#### Policy Name: Bronze
- **Rule 1:**
  - **Classifier Rule:** RULE_10
  - **Policy Action:** RULE_10
- **Rule 2:**
  - **Classifier Rule:** RULE_10
  - **Policy Action:** RULE_10
- **Rule 3:**
  - **Classifier Rule:** RULE_10
  - **Policy Action:** RULE_10

#### Policy Name: Silver
- **Rule 1:**
  - **Classifier Rule:** RULE_20
  - **Policy Action:** RULE_20
- **Rule 2:**
  - **Classifier Rule:** RULE_20
  - **Policy Action:** RULE_20
- **Rule 3:**
  - **Classifier Rule:** RULE_20
  - **Policy Action:** RULE_20

#### Policy Name: Gold
- **Rule 1:**
  - **Classifier Rule:** RULE_30
  - **Policy Action:** RULE_30
- **Rule 2:**
  - **Classifier Rule:** RULE_30
  - **Policy Action:** RULE_30
- **Rule 3:**
  - **Classifier Rule:** RULE_30
  - **Policy Action:** RULE_30

### POLICY TYPE
- Global Policy
- Unknown Subscriber Policy
- Subscriber Policy

### SUBSCRIBER TYPE
- Static subscriber
- Dynamic subscriber
  - Radius
  - DHCP
  - Unknown IP SA

### POLICY ASSIGNMENT
- Diameter Gx
  - Predefined
  - Dynamic (gate, QoS)
- Radius
  - Custom

### ANALYTICS & CHARGING
- Syslog
- IPFIX
- Radius
- Gy
- Gx Usage Monitoring
Classification & Policy Actions

<table>
<thead>
<tr>
<th>APPLICATION CLASSIF.</th>
<th>URL CLASSIF.</th>
<th>FLOW CLASSIF.</th>
<th>CUSTOM CLASSIF.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Application Category (eg. P2P)</td>
<td>• URL Category (eg. Gambling)</td>
<td>• DSCP</td>
<td>• irule / TCL script</td>
</tr>
<tr>
<td>• Application (eg. bittorrent)</td>
<td>• URL database from third party</td>
<td>• Protocol (TCP/UDP)</td>
<td>• Examples</td>
</tr>
<tr>
<td>• Some applications are using F5 signatures, other applications rely on third party DPI signature engine</td>
<td>• Ability to create custom DB</td>
<td>• IP source address range &amp; port</td>
<td>• Other fields in the traffic flow (ip header, http header, ...)</td>
</tr>
<tr>
<td></td>
<td>• Used for HTTP and HTTPS (SNI check)</td>
<td>• IP destination address range &amp; port</td>
<td>• Other fields stored in the PEM sessionDB for that subscriber (RAT-type, roaming, tower-id)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Incoming VLAN</td>
<td></td>
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**Policy Actions**

- REPORTING
- QUOTA MGMT
- HTTP REDIRECT
- HTTP HDR ENR.
- STEERING (NH)
- STEERING (ICAP)
- SERVICE CHAIN
- GATE (FWD)
- QOS MARKING
- BW CONTROL
- CUSTOM / TCL
PEM – Wide range of use cases

**Per-subscriber Application & URL Bandwidth Control & Filtering**
- TCP-friendly rate limiter
- Separate up/down rates
- Highly scalable solution
- TCP Optimization as a bonus

**Subscriber Application Analytics**
- Subscriber ID / Rate Plan
- Charging rules
- Application Usage Reporting

**Intelligent Traffic Steering & Service Chaining to VAS**
- Steer traffic based on subscriber profile to Value Added Services & Optimization Services
- Intelligent Service Chaining

**Online Charging (Gy)**
- Flexible rating group definitions based on applications and/or URI
- Redirect or block upon quota expiration

**URL Filtering & Parental Control**
- Government lists
- Per-subscriber parental control opt-in/opt-out service
- For HTTP & HTTPS

**OTT Identification & Monetization**
- Per-subscriber OTT application detection
- Per-OTT bandwidth, marking and charging rules

**Header Enrichment & WAP offload**
- HTTP HE for content-based charging
- WAP GW bypass/offload and replacement

**Content Injection / Toolbars**
- Java-script based content injection
- Targeted advertisements

**Lightweight BRAS/BNG**
- DHCP-based BNG model for wifi and wireline deployments
- Radius AAA client
Evolution towards NFV
Step 1: Consolidate SGi Functions & Virtualize VAS Layer

- Virtualize the VAS layer
- Integrate both physical VIPRION and VNFs running VAS/optimization services into Orchestration tool
- Allow for dynamic VAS bursting
Step 2: Virtualize SGi + VAS layer (NFV)

- Virtualize the Gi & VAS layer
- Both Gi inline functions and VAS/optimization functions are fully virtualized (deployed as VNF)
- Several deployment models
Virtualizing SGi functions – VNF mapping alternatives

- Maintain the L4-L7 consolidation model as deployed in the physical world in the NFV world
- So you run PEM, CGN and AFM on the same VE (or on separate VEs but all inline in the data path)

- Only maintain PEM inline in the data path for intelligent traffic steering
- Treat functions such as CGNAT and security/firewall functions as VAS services (which are only used for selected flows)
Summary
Summary – Traffic Steering & Service Chaining

• Market is demanding advanced steering capabilities for VAS offload
  • F5 PEM platform supports context-aware intelligent steering and service chaining

• Market is demanding an evolution path towards IETF-based service chaining
  • F5 PEM platform provides a stepwise approach

• Market is demanding a solution that supports a wide variety of use cases
  • F5 PEM platform supports a wide range of classification criteria coupled with strong policy action mechanisms

• Market is demanding a solution that can migrate from physical to virtual
  • F5 PEM platform provides such a migration path, offering multiple alternative deployment options for NFV
Solutions for an application world.