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TOMORROW starts here.

CISCO

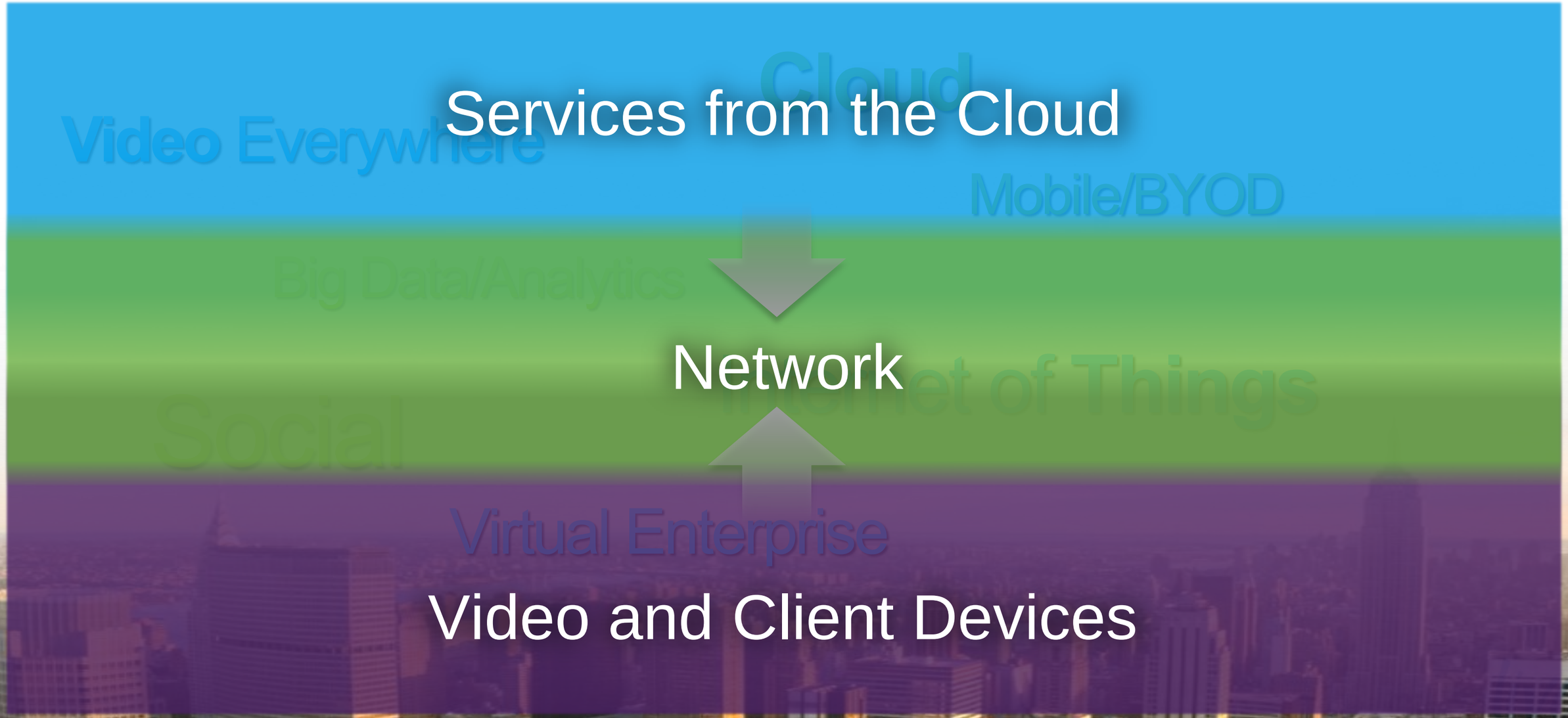
Building Next Generation Services Delivery Architecture

BRKSPG-2661

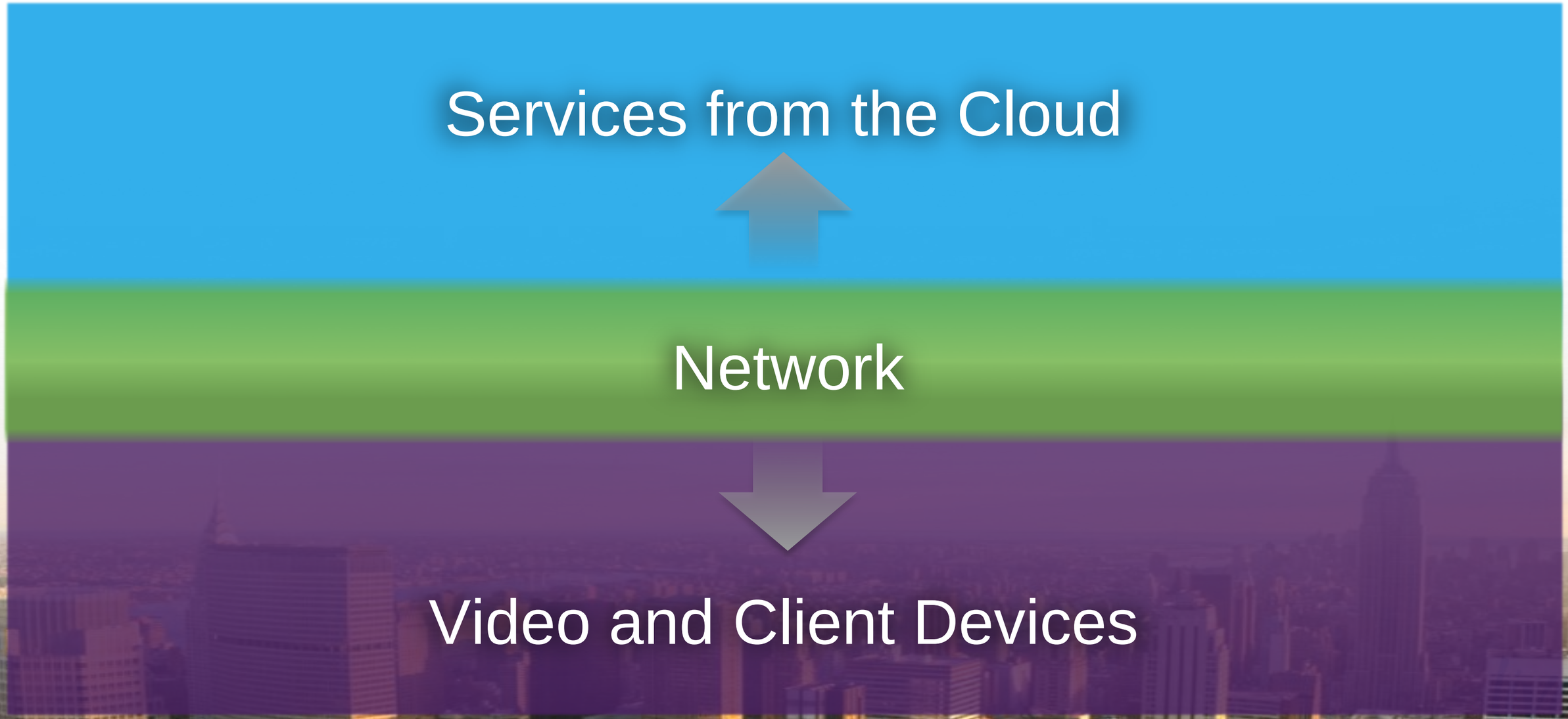
Agenda

1. Market Transitions and Challenges
2. Service Architecture Framework
   - Network
   - Policy
   - Analytics
3. Service Convergence
4. Summary

Mega Market Transitions…New Challenges for Service Providers

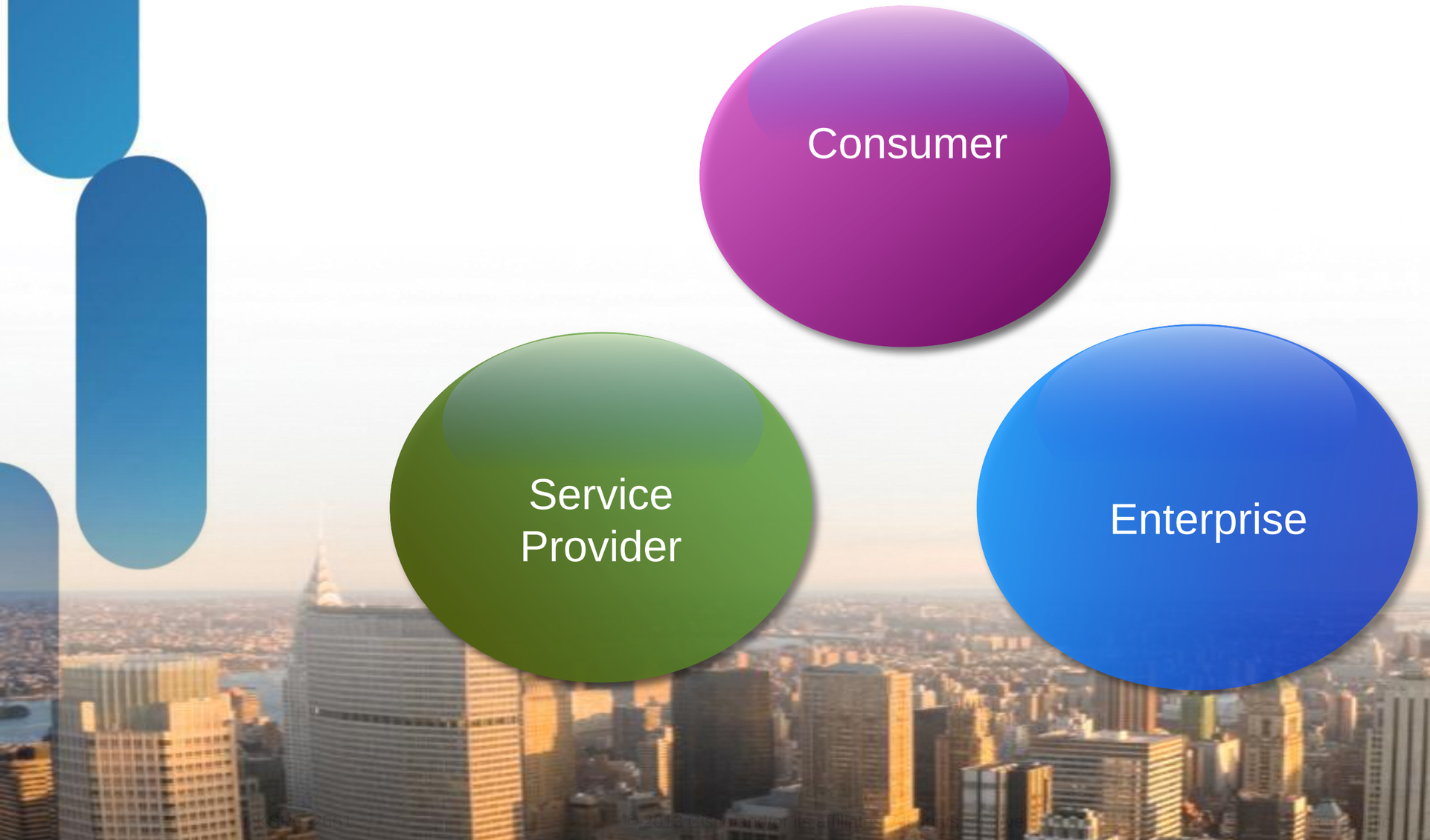


Mega Market Transitions



Mega Market Transitions

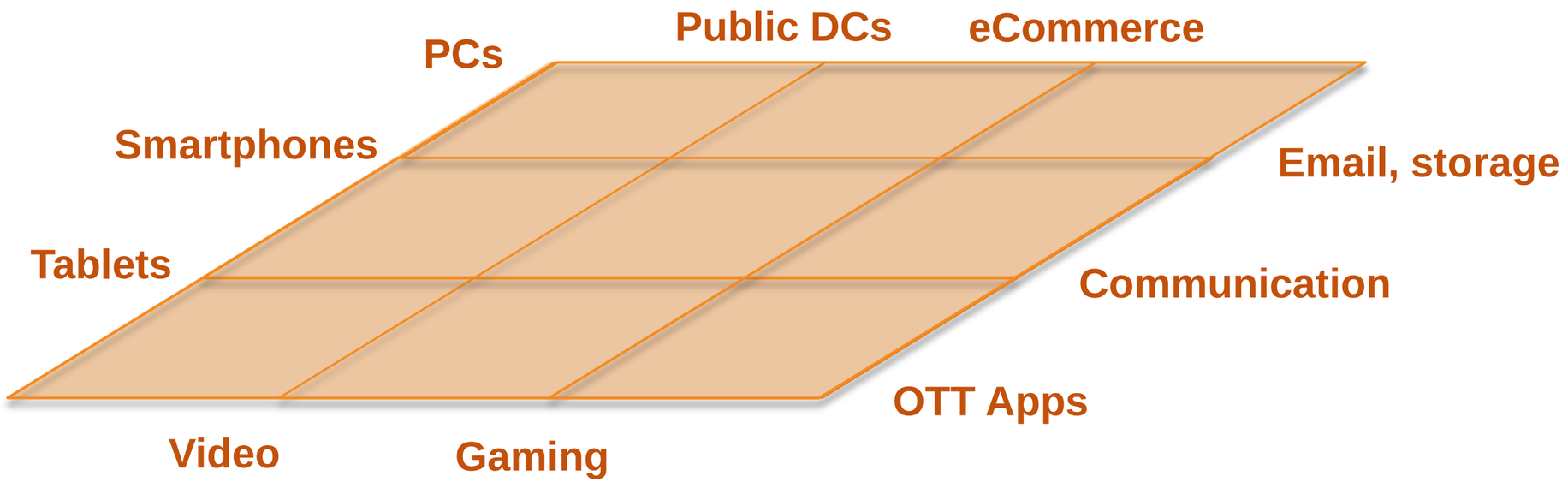
Mega Market Transitions



Mega Market Transitions

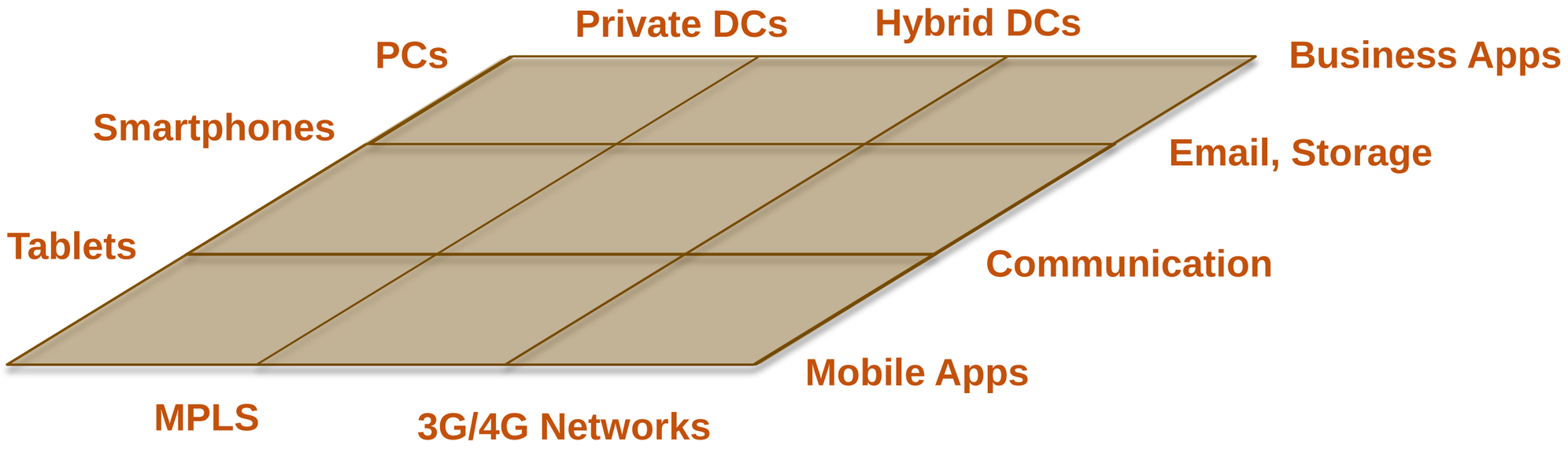
Today, Networks Stand Apart

Public Internet and Applications



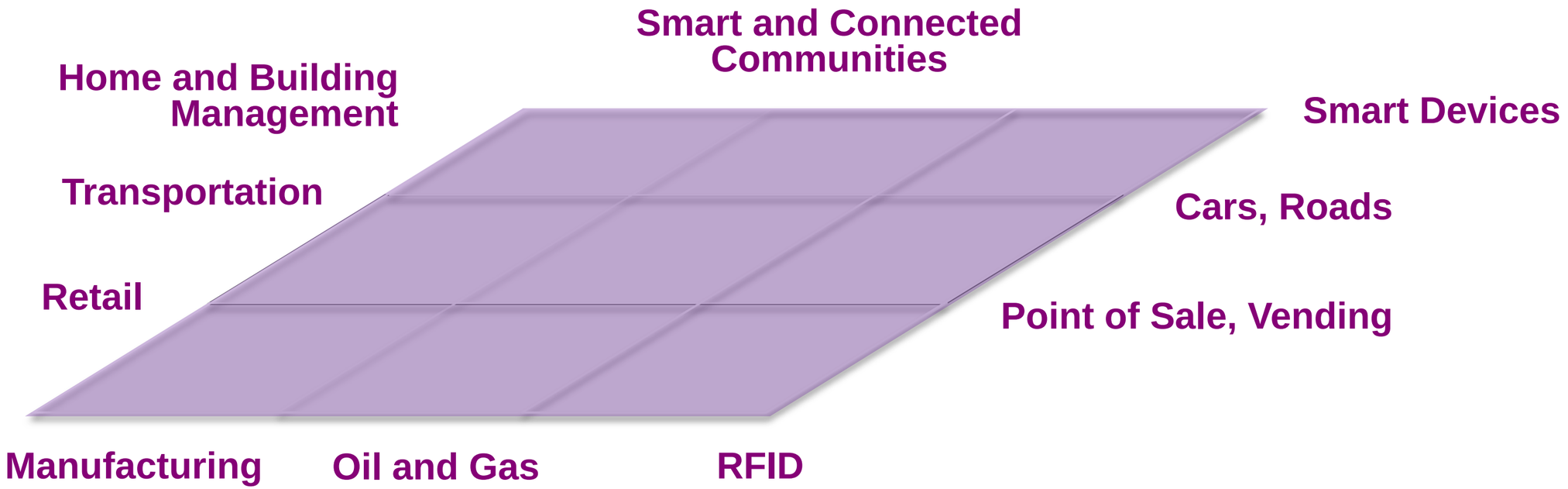
Today, Networks Stand Apart

Business Networks and Business Applications



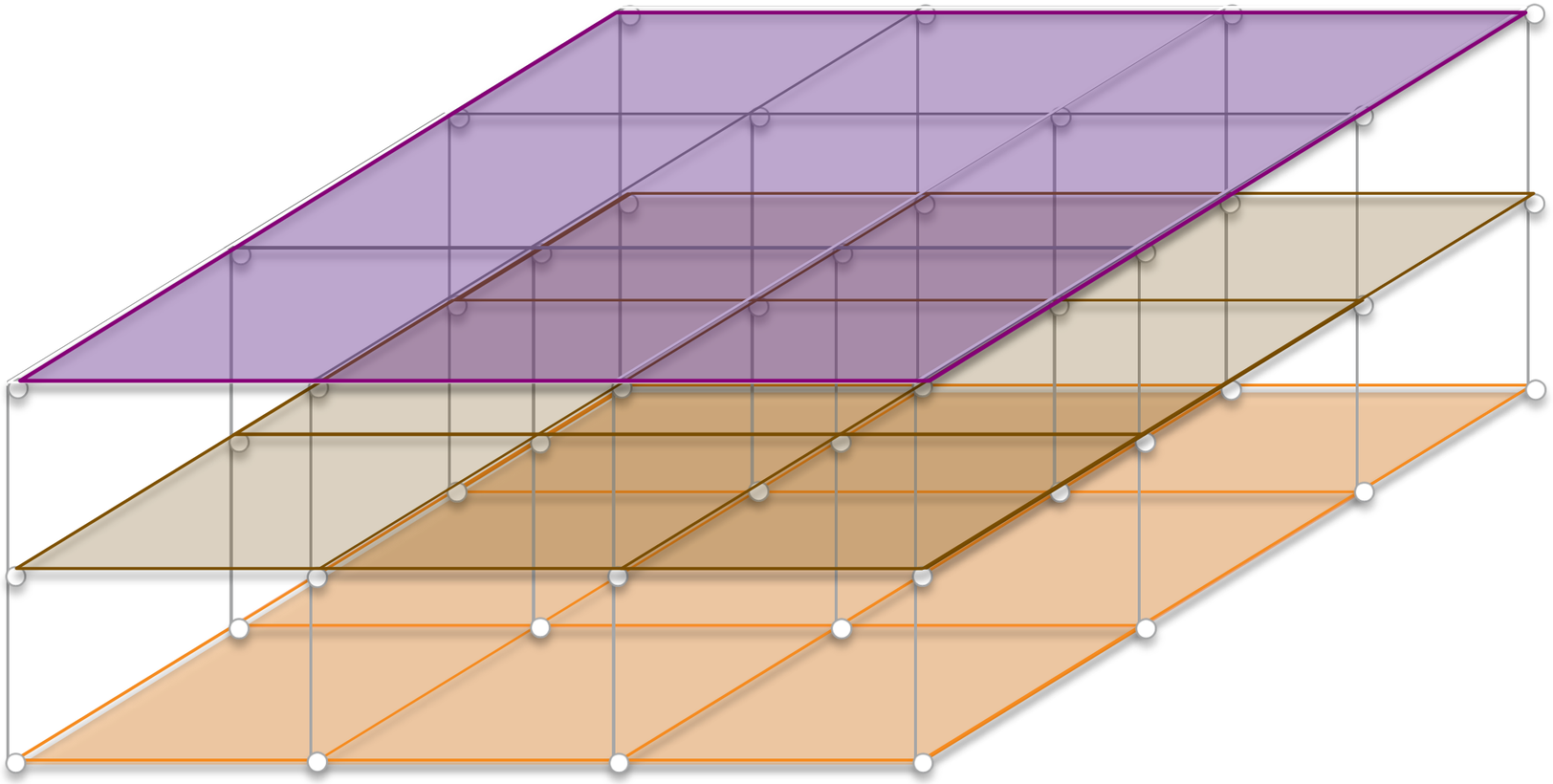
Today, Networks Stand Apart

Industrial Internet (Sensors and M2M)

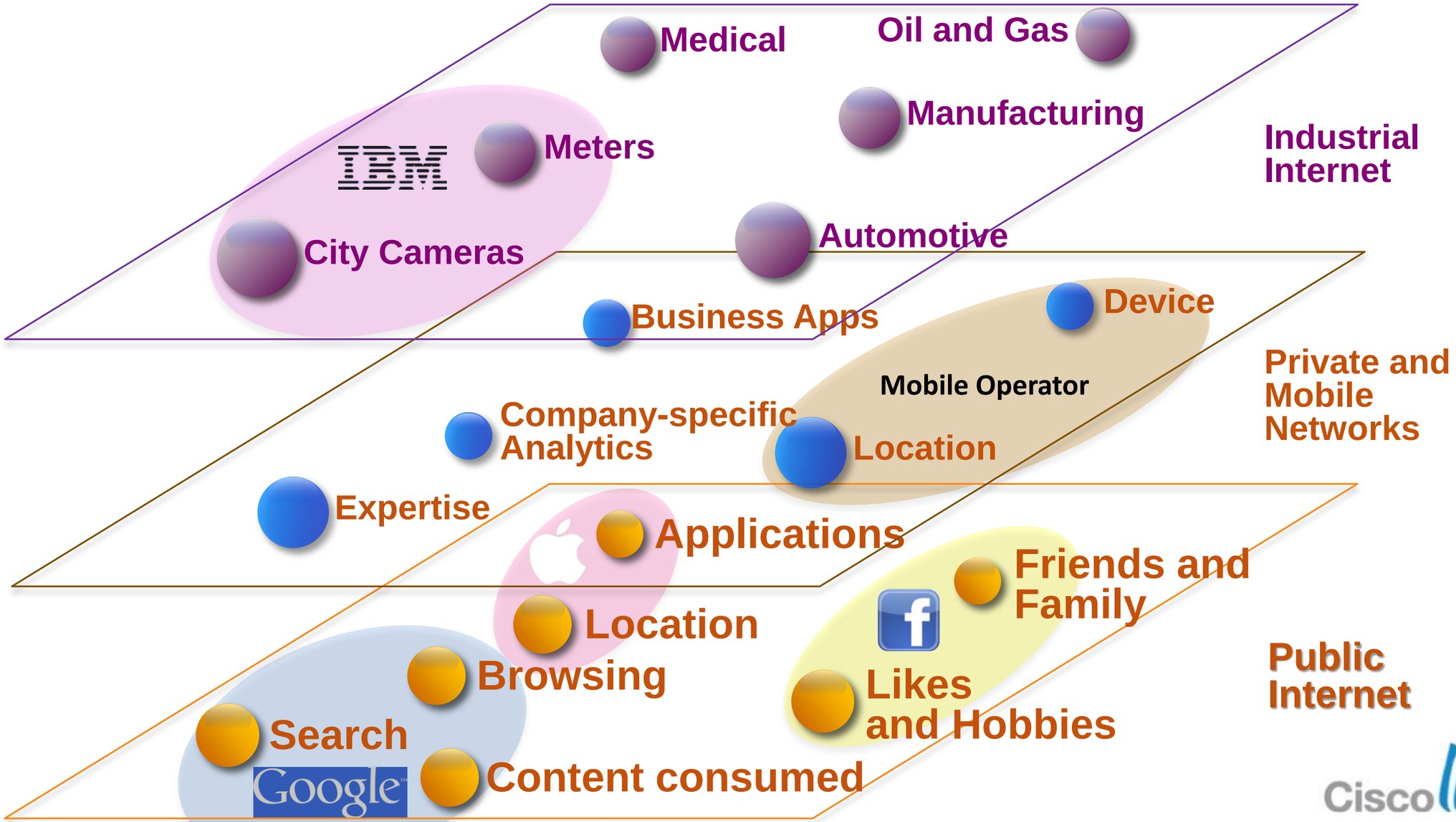


Today, Networks Stand Apart

Federating All Networks, Data Centres, and Applications Is Critical Step to Enabling Customised User Experiences

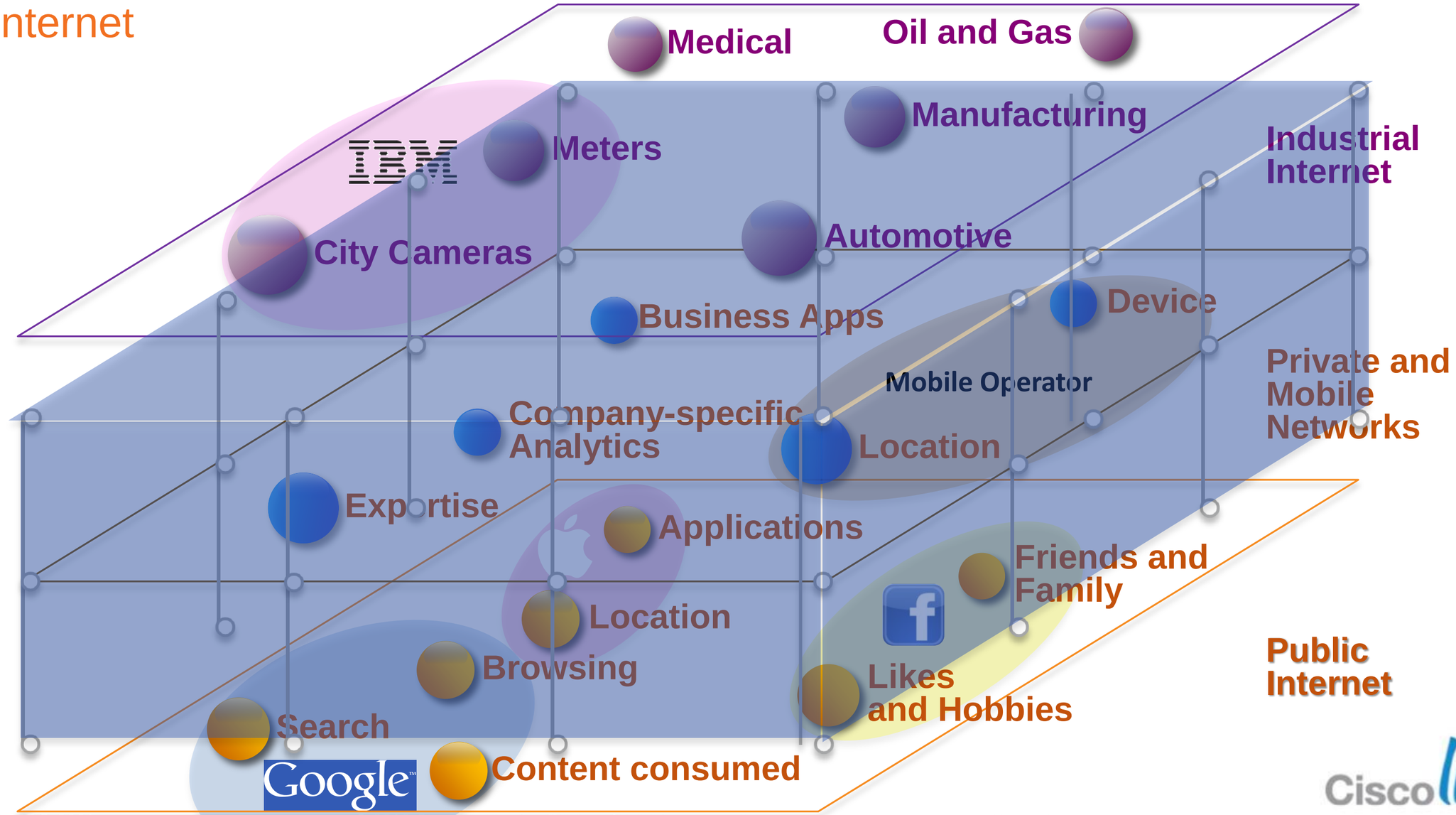


Scattered Analytics Getting Collected



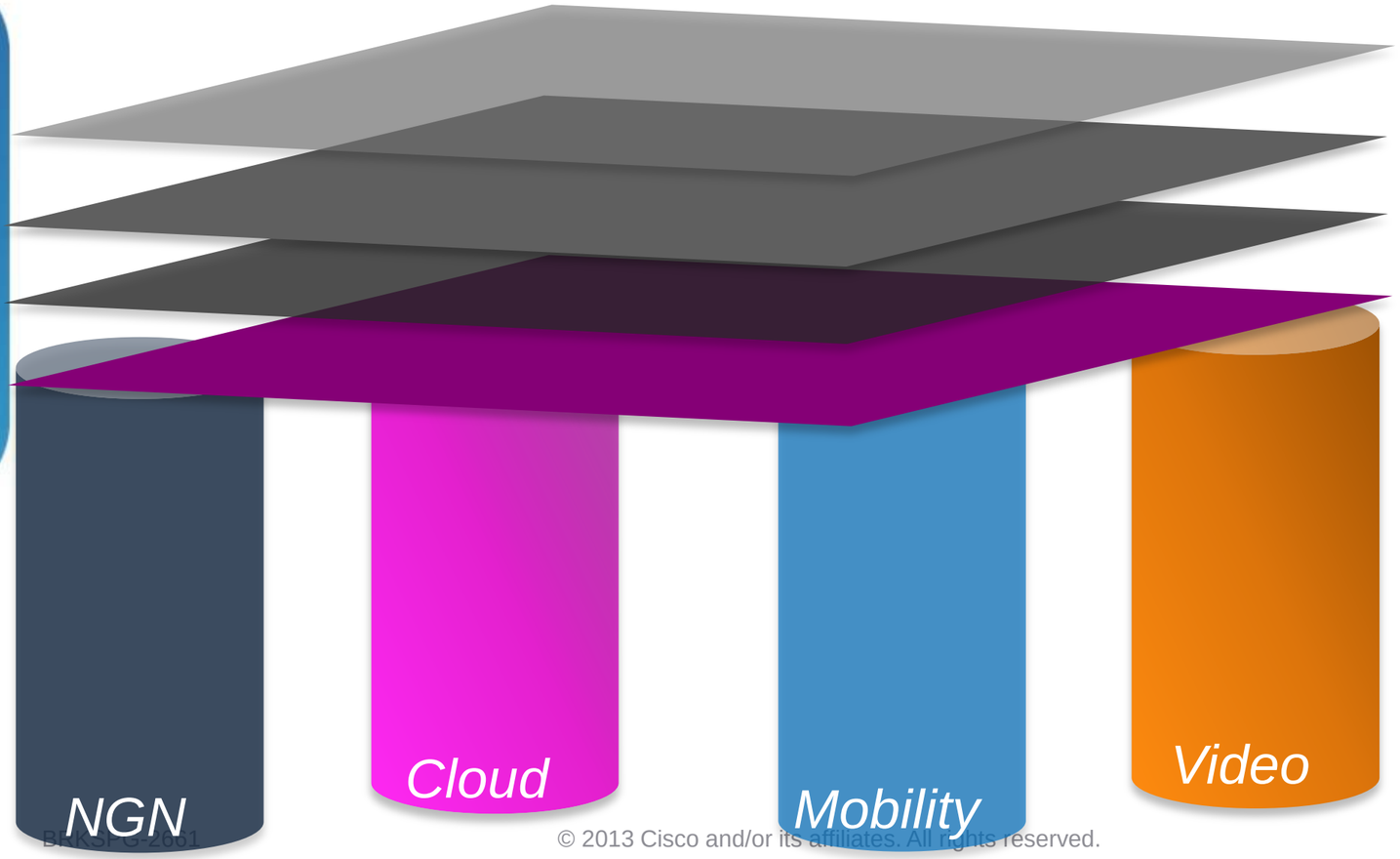
Network Is the Common Denominator

Analytics will become the currency of the next generation Internet…the Intelligent Internet



The Intelligent Network Delivering the Platform

Common platform for new services and network optimisation



Applications and Services APIs

Analytics and Policy

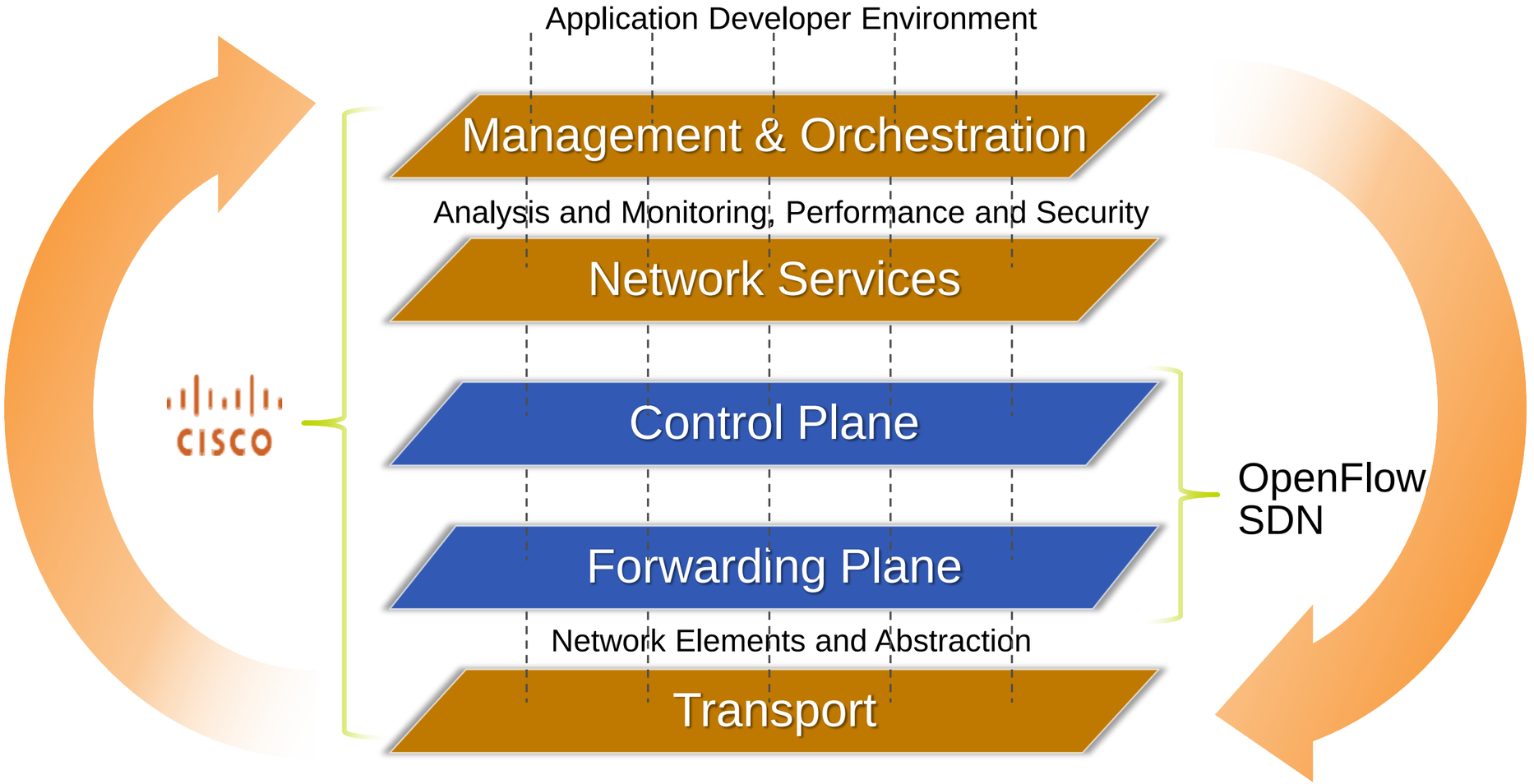
Common Network Abstraction

Network Virtualisation

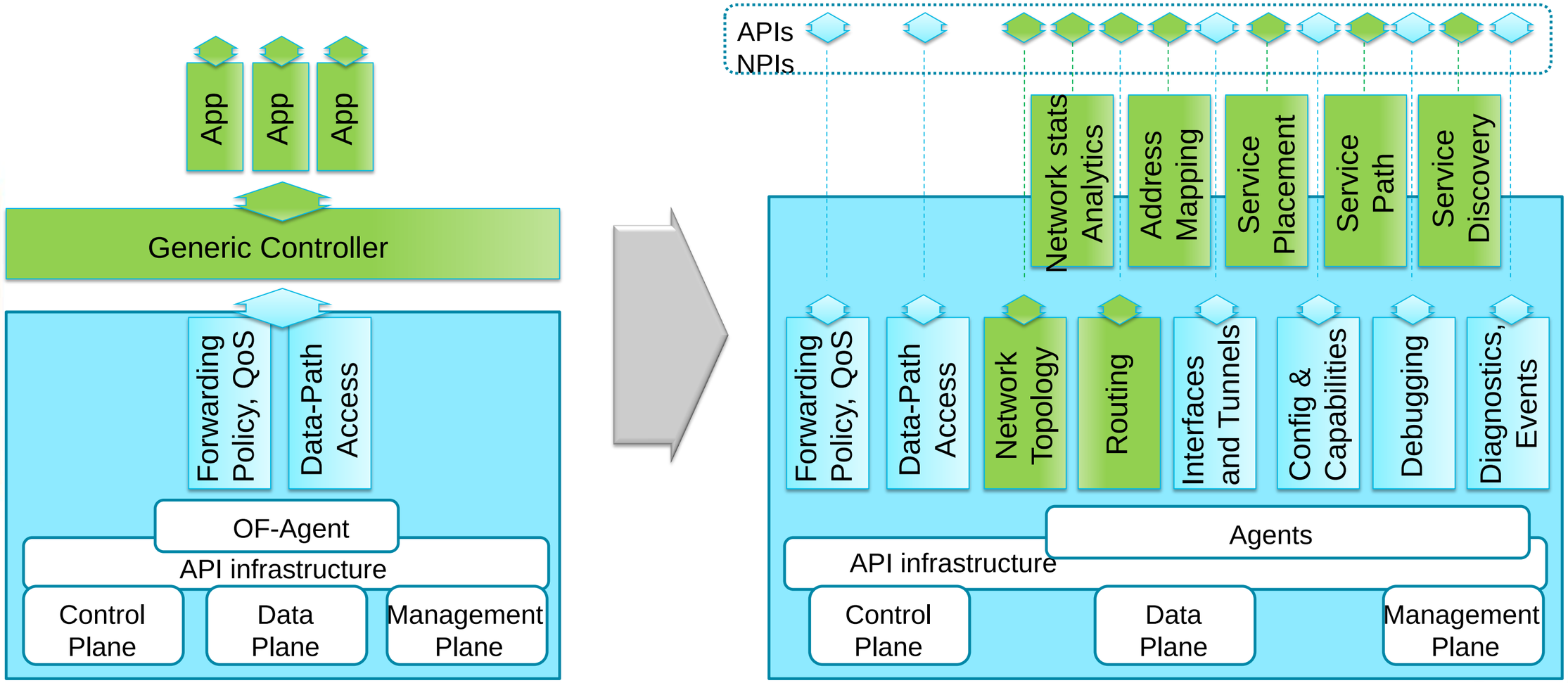
Services Architecture Framework

Programmability at Multiple Layers of the Network

Flexibility in Deriving Abstractions

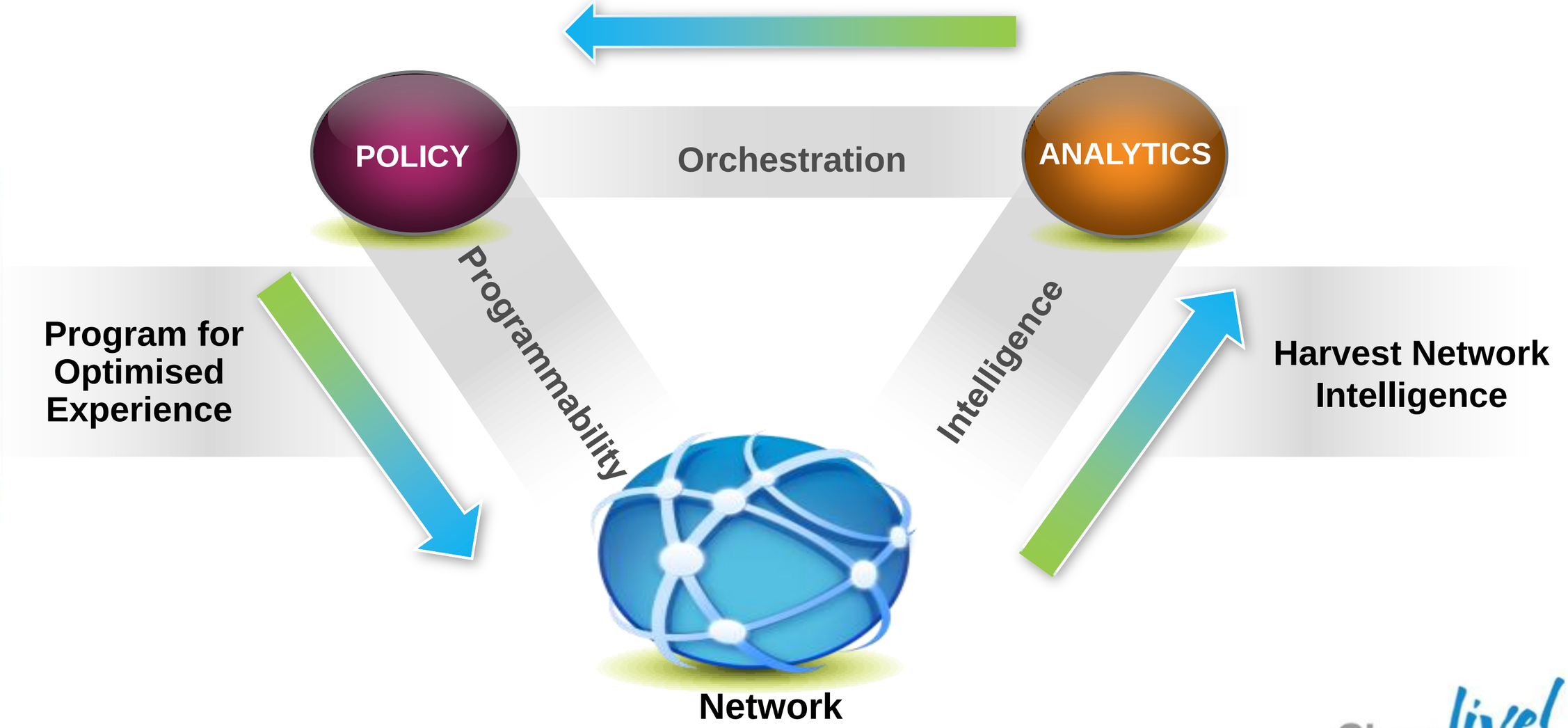


Evolve the Service Delivery Model
… towards diverse information and interfaces

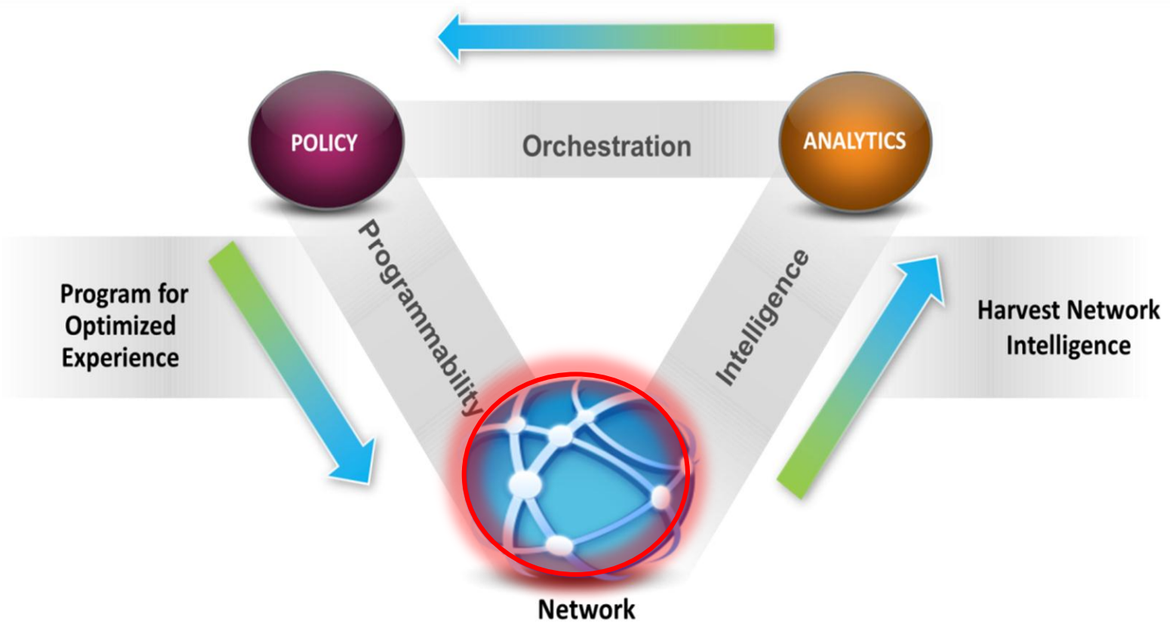


Services Architecture Framework

Leverage Network Value



Network & Control



The Network Control Architecture

Evolving Design Constraints on the Control Plane

- Classic generic networks
  - Operate without communication guarantees

    A distributed system with arbitrary failures, nearly unbounded latency, and highly variable resources on each node in the system
  - Compute the configuration/forwarding-state of each physical device and keep the information up to date as conditions change

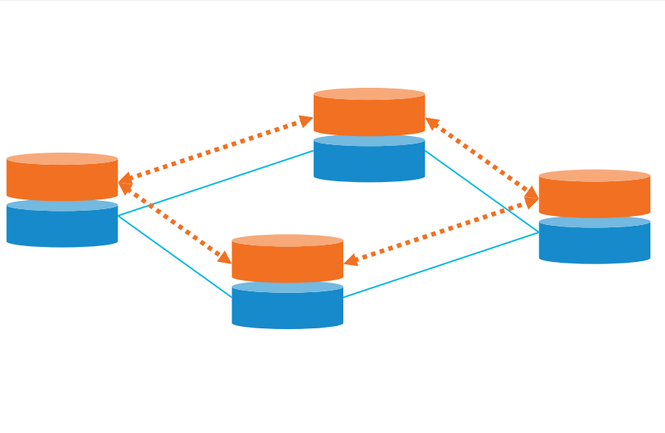
    Change of conditions typically detected by the network elements themselves
  - Operate within given network-level protocol (IP, Ethernet, …)
- Domain specific networks (e.g. Data-Centre, SP-Access/Agg,..)
  - Specific qualities of these networks relax or evolve network design constraints:

    Examples: Well defined topologies; little variety in network device-types; no arbitrary changes in connected end-hosts (change always an outcome of provisioning action),…
  - Independence of network-level protocol (combined L2, L3 service delivery,…)

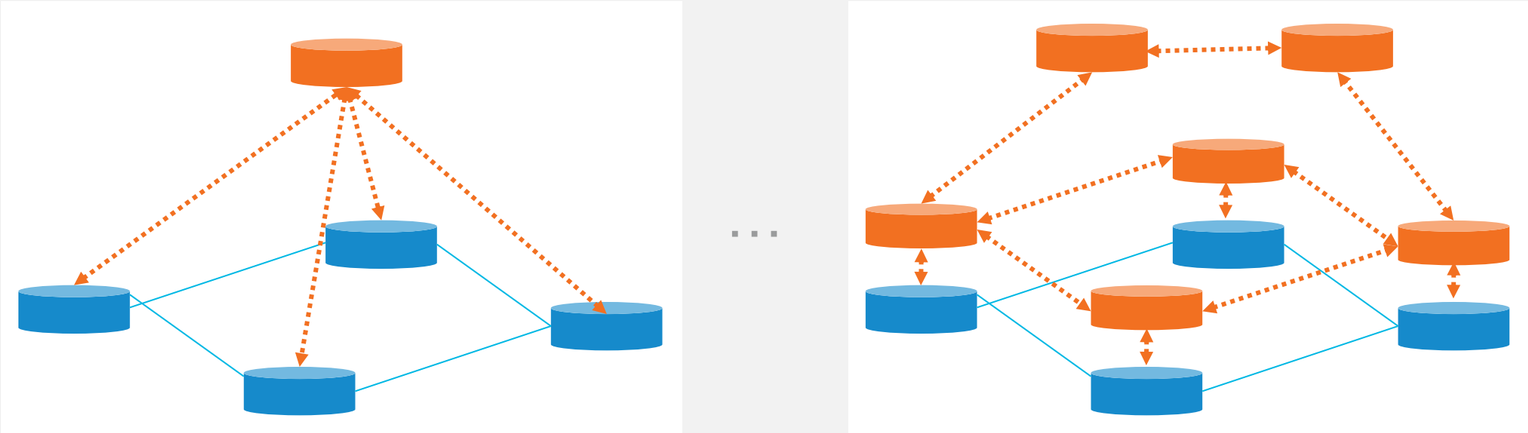
Towards the Open Network Environment

Implementation Perspective: Evolve the Control-Plane Architecture

Traditional Control Plane Architecture



Control Plane Architecture with SDN (Examples)



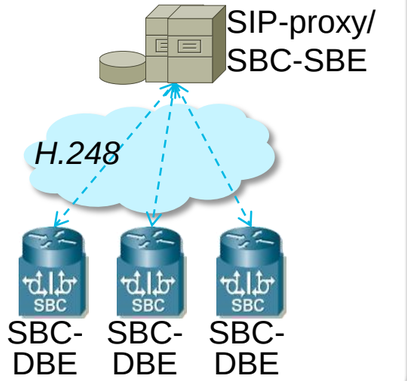
- Enable modularisation and componentisation of network control- and data-plane functions, with associated open interfaces. This allows for optimised placement of these components (network devices, dedicated servers, application servers) and close interlock between applications and network functions.
- Anticipated benefits include: Closely align the control plane with the needs of applications, enable componentisation with associated APIs, improve performance and robustness, enhance manageability, operations and consistency

Control-plane component(s) Data-plane component(s)

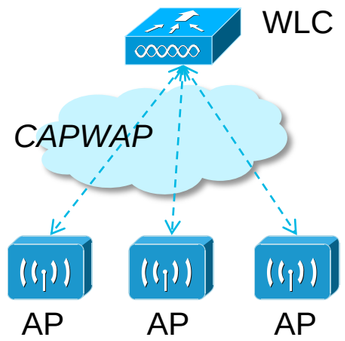
Network Agents and Controllers

Agent-Controller pairs examples

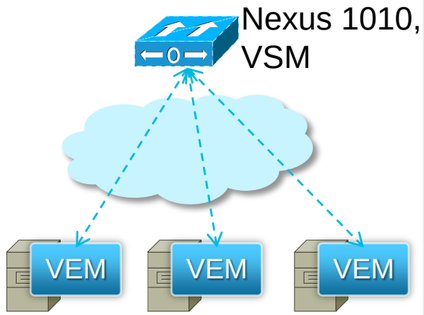
Session Border Control



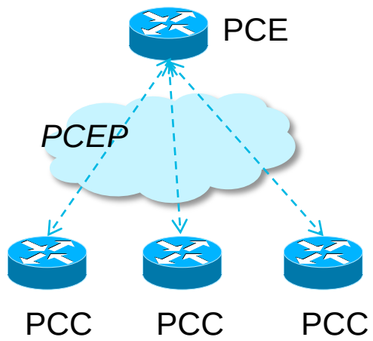
Wireless LAN Control



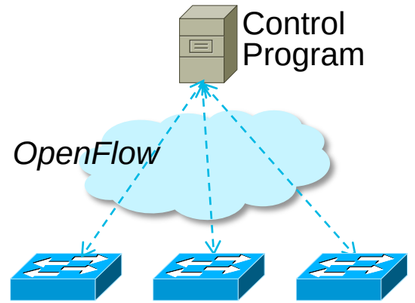
Virtual Switch Control



Path Computation



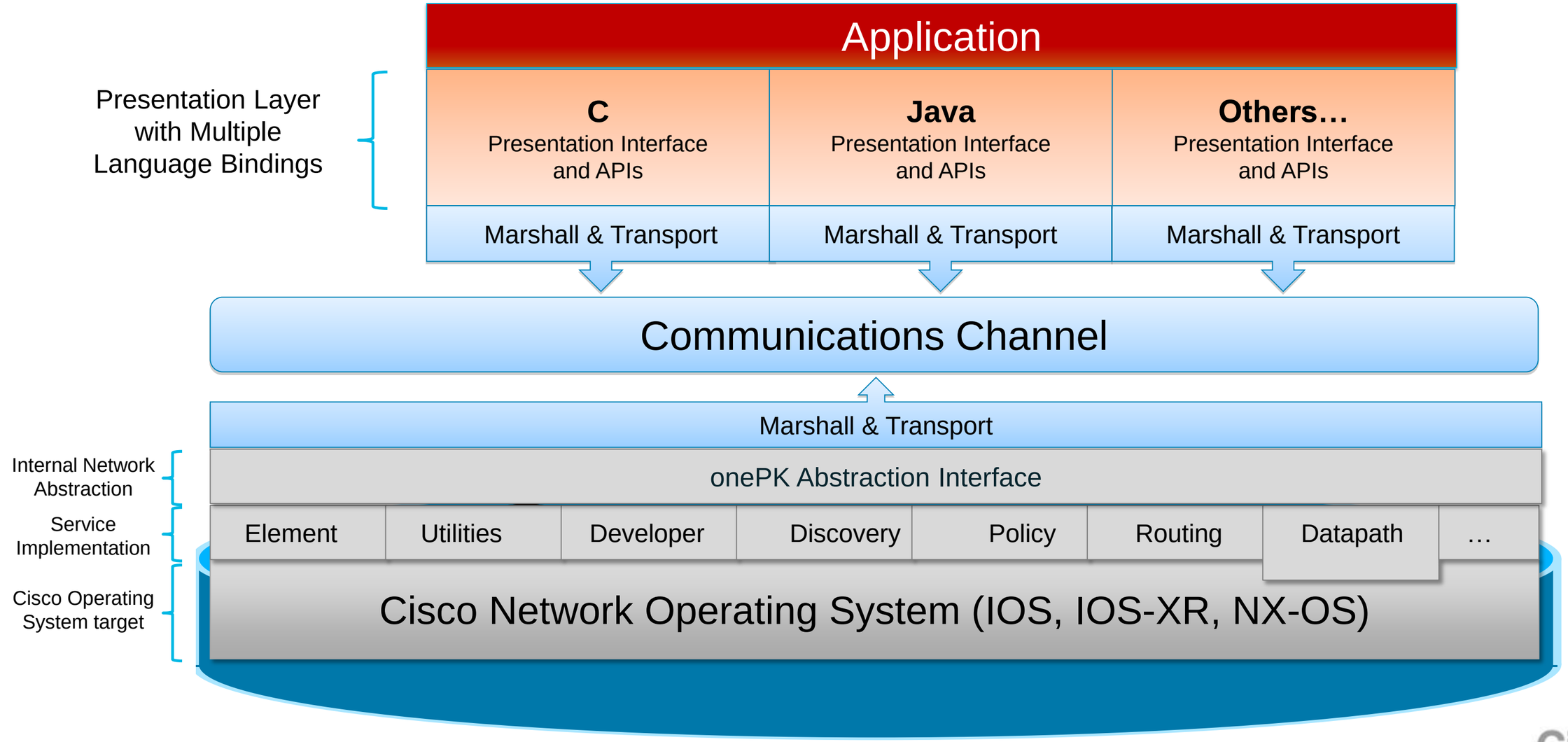
Flow Control with SDN



- Agents and Controllers are a component of Open Network Environments and a key component of the evolving “Software Defined Network” concept
- The Concept of Agents and Controllers exists in the Industry for quite some time
- Observation: Current Agent-Controller pairs always serve a specific task (or set of tasks) in a specific domain

APIs make Abstractions available to Programmers

Example: Cisco's onePK (one Programming Kit)



Example Network Abstractions

API “Service Sets” delivered through Cisco’s onePK (one Platform Kit)

Base Service Sets

Element

- Element Capabilities
- Configuration Management
- Interface/Ports Events
- Location Information

Utilities

- Syslog Events and Queries
- AAA Interface
- Path Trace

Discovery

- Network Element Discovery
- Service Discovery
- Topology Discovery

Developer

- Debug Capabilities
- Tracing Interfaces
- Management Extensions

Data Path

- Packet/Flow Classifiers
- Copy/Punt/Inject
- Statistics

Policy

- Interface Policy
- Interface Feature Policy
- Forwarding Policy
- Flow Action Policy

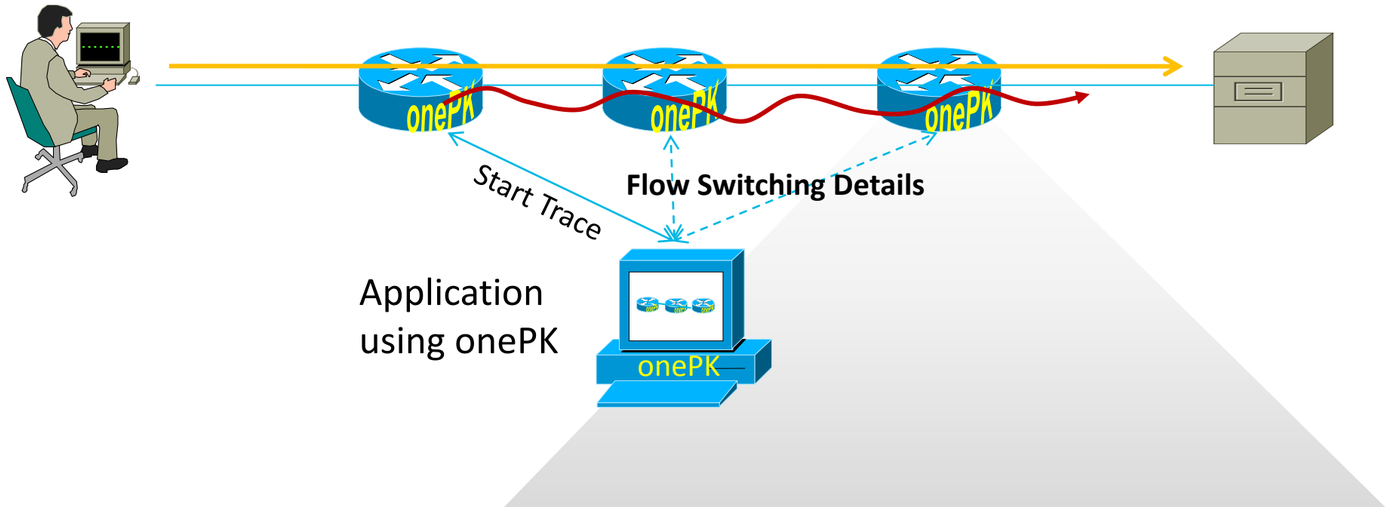
Routing

- Read RIB Routes
- Add/Delete Application Routes
- RIB Events (Route up/down)

Example: Element APIs

Statistics, Diagnostics & Troubleshooting

- Objective:
  - Provide operators/ administrators/ support engineers with details about how packets flow through the network.
  - Reveal network issues
- Approach
  - NMS application leverages onePK APIs to show path of flow, timestamp, ingress/egress interfaces, interface packet counts




```
Ingress time: May 15, 2011 00:46:55.145
Ingress intf: Gi0/1
Ingress pkts: 30
Egress time: Jun 6, 2011 00:46:55.251
Egress intf: Gi0/0
Egress pkts: 5
```

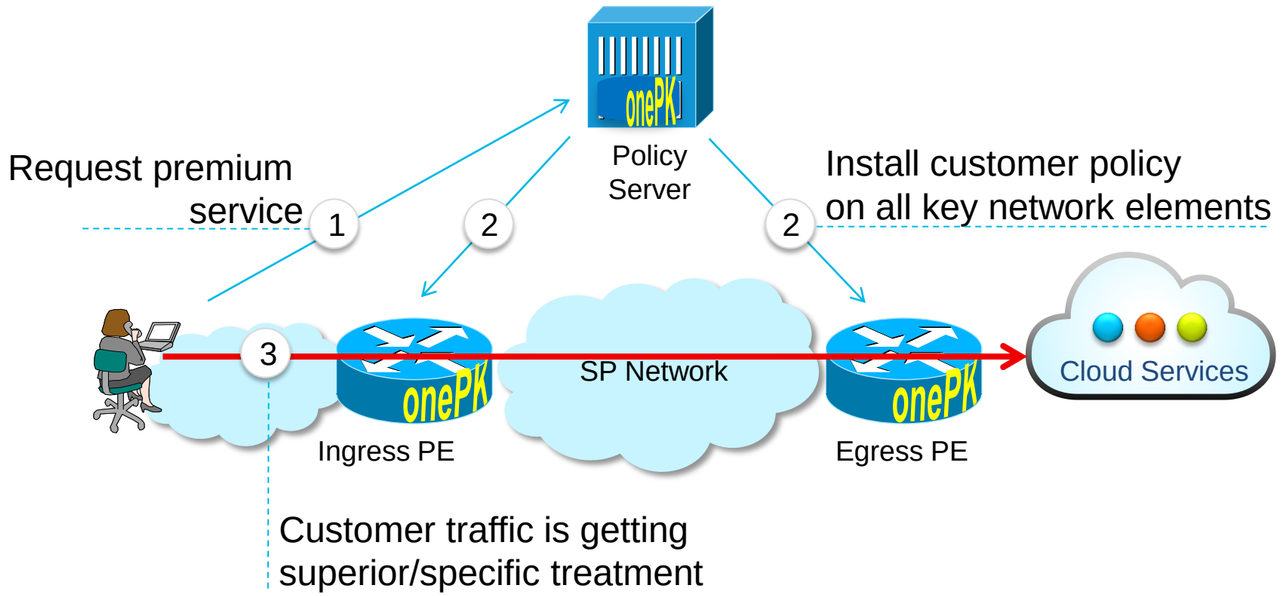
Example: Place in the Network APIs

Dynamic QoS Allocation

- Business Problem
  - Enable superior experience for subscribers which access a particular cloud service
- Solution
  - Install customer policy (QoS, access control,..) using **onePK** on key networking elements, e.g. Provider Edge (PE) routers
  - Similarities to broadband “Bandwidth on Demand” use cases

    Broadband: Policy controlled on Subscriber-Gateway (BRAS/BNG, GGSN/PGW, ..) only

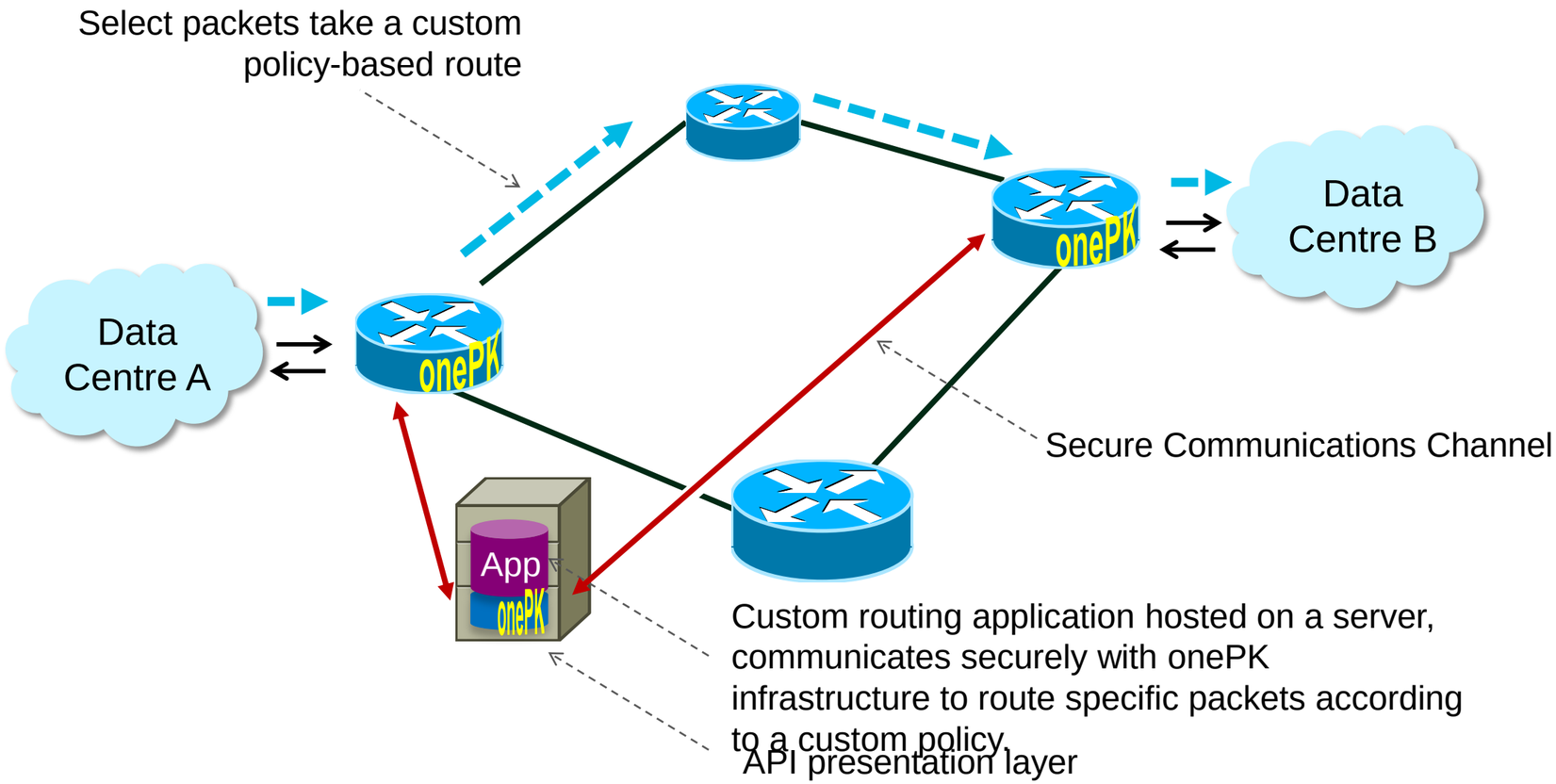
    Common API like onePK enables control points on all key networking devices



Example: Area APIs

Custom Routing

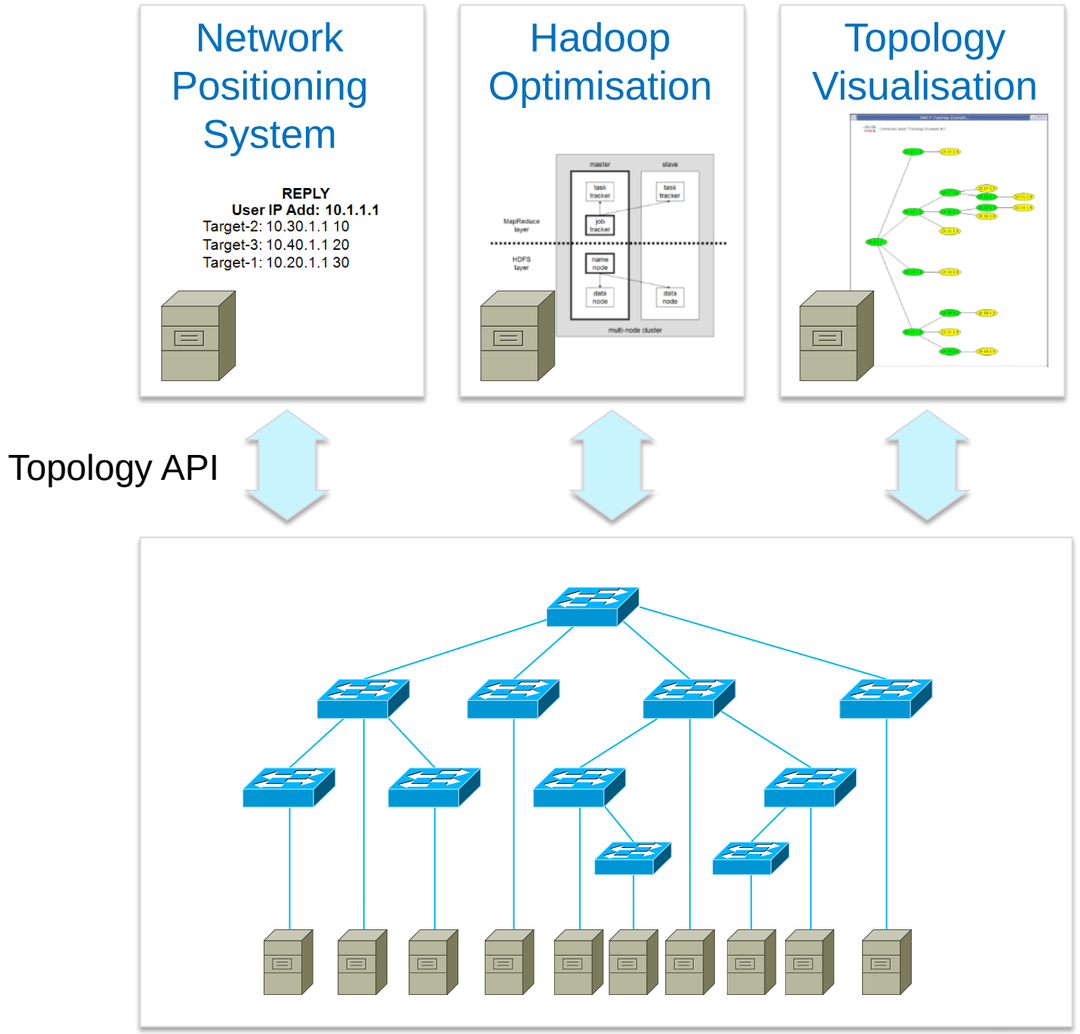
- Business Problem
  - Network operator needs to direct traffic using unique or external decision criteria; e.g route long lived elephant flows, like backup traffic differently
- Solution
  - Custom route application built and deployed using **onePK**, communicating directly with the forwarding plane.
  - Unique data forwarding algorithm highly optimised for the network operator's application.



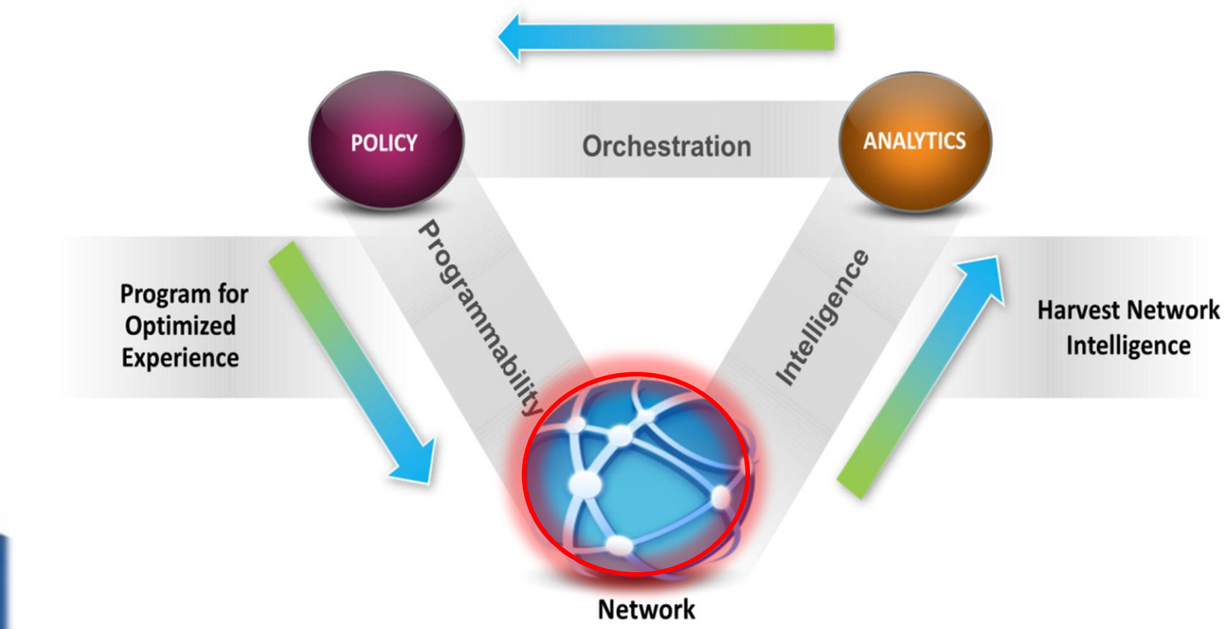
Example: Area APIs

Topology graph

- Business Problem
  - Several problems require a view of the network topology (area, domain, or whole network)
  - Examples:
    - Locate optimal service out of a given list
    - Optimise Load Placement
    - Visualise the active Network Topology
- Solution
  - Topology API to expose network topology to applications, such as
    - NPS (for service selection)
    - Hadoop (for optimal job placement)
    - NMS (for topology visualisation)



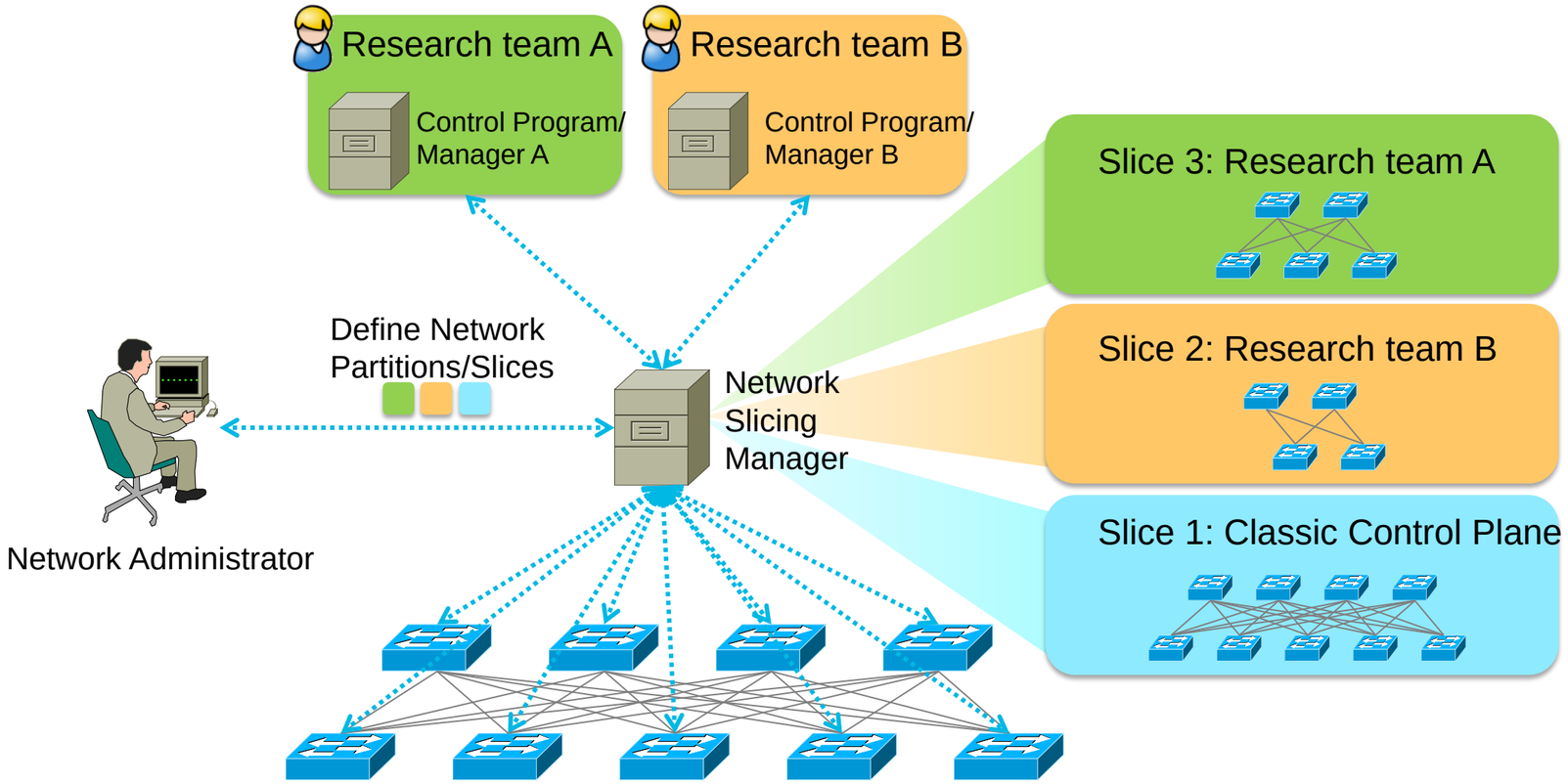
Virtualisation of Infrastructure and Services



Virtualisation: Network Partitioning

Example: Network Slicing Environments

- Business Problem
  - Administrator desires to “slice” the network into multiple partitions:
    - Production network – classic control plane
    - Several research networks – experimentation with new control algorithms, programs etc.
- Solution
  - Network Slicing Manager partitions the network based on e.g. ports or VLANs
    - Provides northbound interfaces, incl. OpenFlow (Flowvisor-like)
    - Effects of a particular control function of a partition/slice limited to that partition/slice



Complementing classic VPN technologies

Network Partitioning

- VPN (L3VPN, L2VPN) technologies combine
  - Network Partitioning/Segmentation
  - Packet Forwarding Control (Control plane)
- "Slicing" refers to Network Partitioning *only*, i.e. no assumptions on the control plane made
  - Slices fully isolated (one slice not effecting resources and operation of other slices)
  - Several existing technologies incorporate "slicing concepts", e.g.

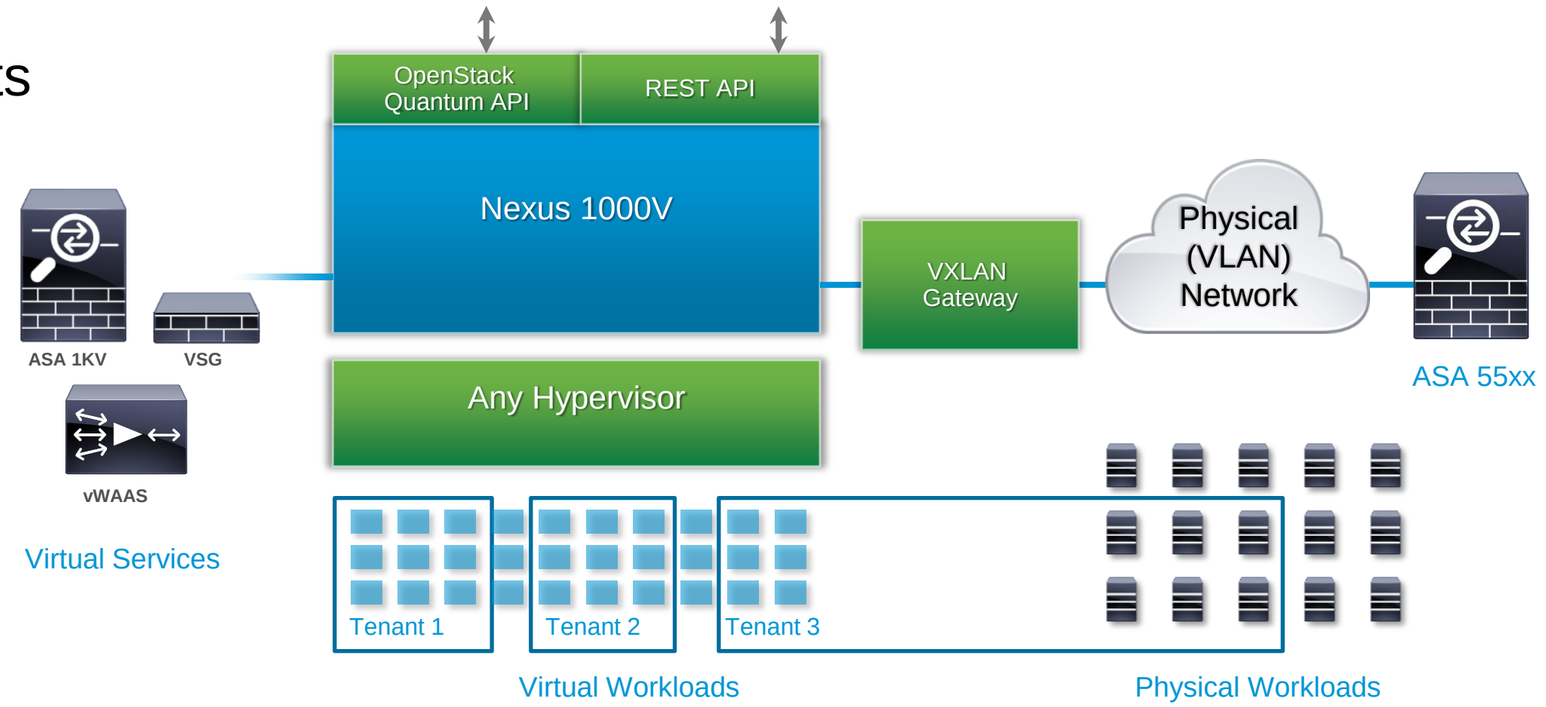
    PBB-TE – network partitioned based on I-SID/VLANs (one partition controlled by STP, another one through a NMS)

    MPLS-TP
- "Network slicing manager"
  - Slicing manager defines/administers slices and maintains view of all slices in the network
  - Users only see their "slice" – can be used e.g. as sandbox network for a given Dept/Developer

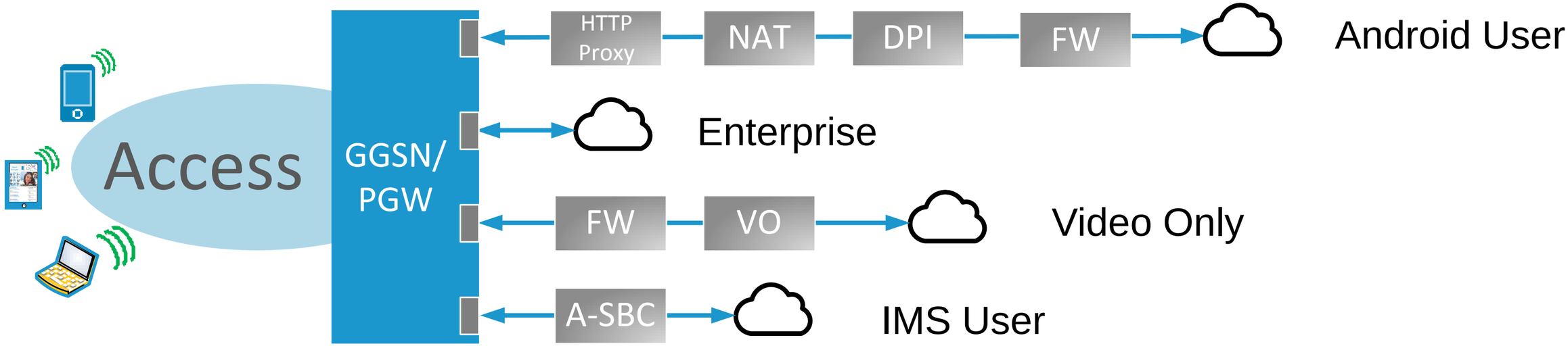
Virtual Overlay Networks

Example: Virtual Overlay Networks and Services

- Large scale L2 domains:
  Tens of thousands of virtual ports
- Common APIs
  - Incl. OpenStack Quantum API's for orchestration
- Scalable DC segmentation and addressing
  - VXLAN
- Virtual service appliances and service chaining/traffic steering
  - VSG (cloud-ready security), vWAAS (application acceleration), vPATH
- Multi-hypervisor platform support: ESX, Hyper-V, OpenSource Hypervisors
- Physical and Virtual: VXLAN to VLAN Gateway



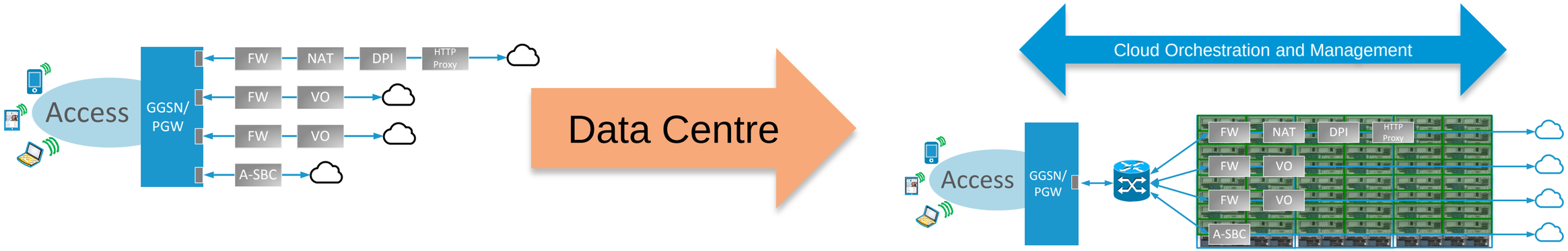
Mobile Gi-LAN Current Approach & Challenges



- Multiple NEs, each with own HW/SW, to manage and support (per service)
- Networking challenges: Multiple elements to hardwire to GGSN/PPGW
- Scaling (growth/de-growth) and capacity planning is difficult
- Diverse HA strategies to manage and support
- Lack of agility: there is no possibility to do a custom chain for a device

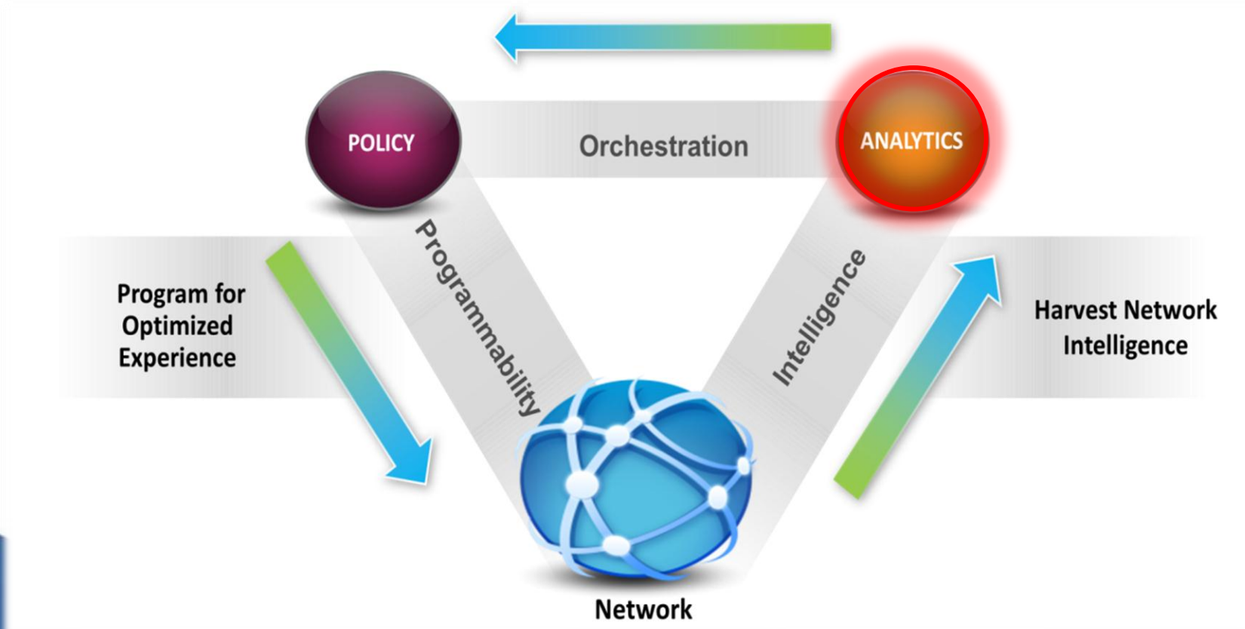
- While individual services might offer a programmatic interface, the Gi system itself doesn't
- Lack of subscriber awareness, no RAN awareness, no policy awareness. Partitioning of subscribers requires SIM device management and different, per-device class APNs
- No application awareness as there is no linkage to DPI
- Lack of subscriber/applications awareness hinders ability to monetise on subscriber knowledge

Addressing the Challenges:
The Gi-LAN Virtual Services Implementation

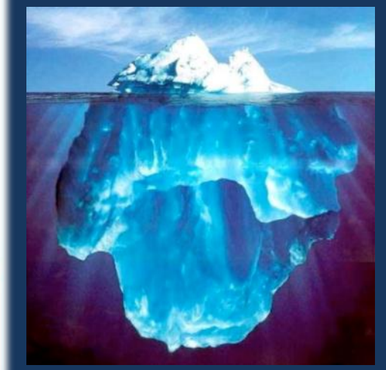


	Traditional Practice	Cloud Practice
Grow Capacity	Craft to add a service specific blade to chassis that has finite number of slots	Launch a VM and install the service on it – no manual operations
Reconfigure	Send craft to re-configure cabling	Use data centre management and SDN to reconfigure
New Applications (MVNO, M2M, …)	Complex partitioning (MOCN, BSS, GWs, …)	Partition using virtualisation and SDN
Capacity	Limited by slots in NE chassis	Unlimited
Fault Recovery	HA architectures with high resiliency built-in	VMs can be used for quick recovery
Operations Systems	FCAPS model	Cloud Platform (NM, Orchestration,..)
Distribution of Functions	Complex: results in high operational expense	Simple via distributed computers & cloud operations

Analytics and Data Management



New Sources of Data are Exploding



Every:

- Click
- Ad impression
- Billing event
- Fast Forward, pause,…
- Server request
- Transaction
- Network message
- Fault
- …




….

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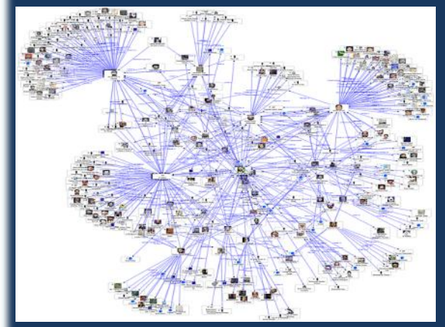
Internet of Things / M2M

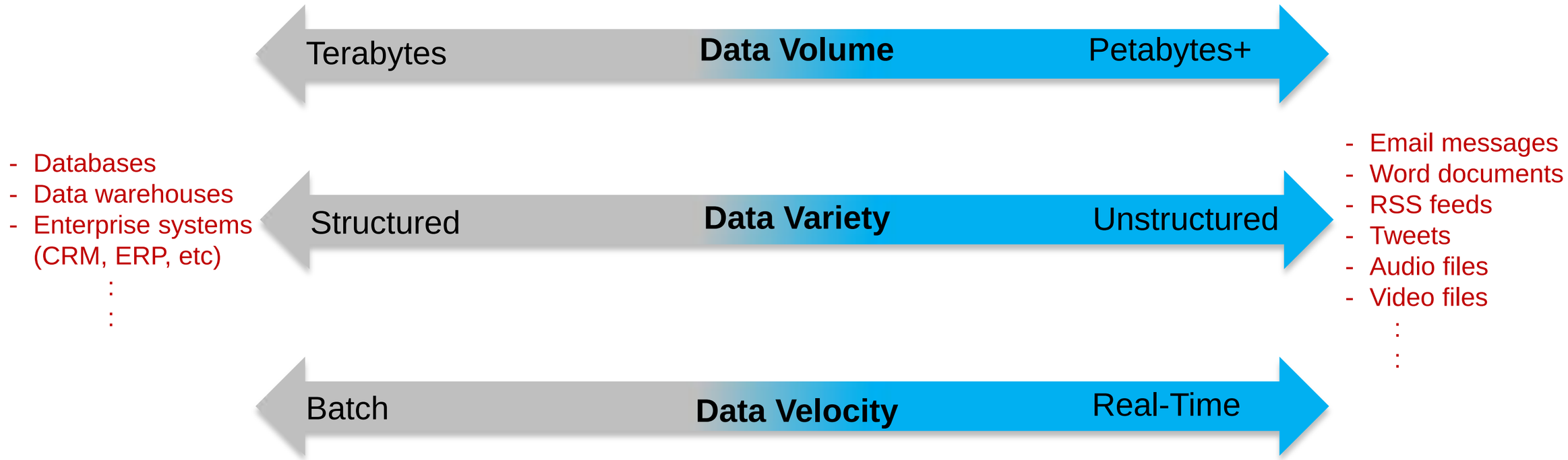
Graphical Analytics



- Social networks
- Communication Networks
- Collaboration/Relationship

Big Data Market Definition – Three Vs of Big Data

Big data - Techniques and technologies that make handling data at extreme scale (volume, variety & velocity) economical



Source: IDC

Big Data Transition

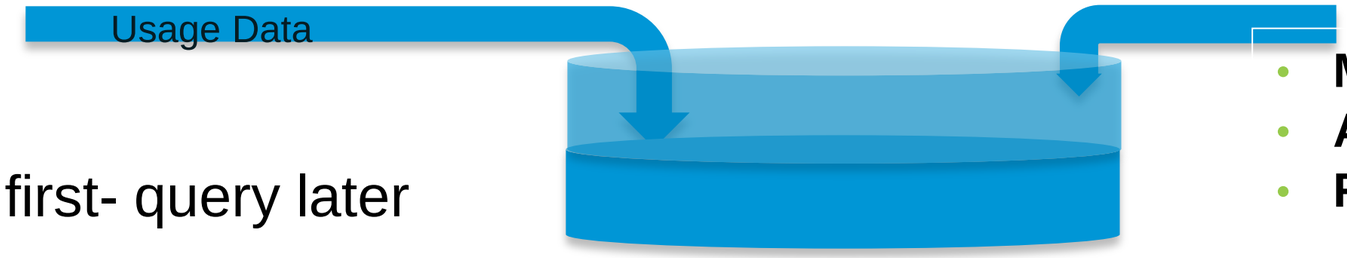
	From		To
External Probes	External Probes	→	Data from Network
Volume	Big warehouse and slow analysis	→	Timely and Actionable
Velocity	Store and Query	→	Streaming Analytics
Variety	Silo Applications and data stores	→	Collect once and Multiple apps

Mobile Analytics

Real Time Streaming Analytics

- Make your Data work for you:
  - Make it real-time actionable
  - Make it scale without sacrificing latency
  - Make it self-refining for late-arriving data
  - Seamlessly combine live AND historic data

Traditional analytics model (Store First, Query Later)



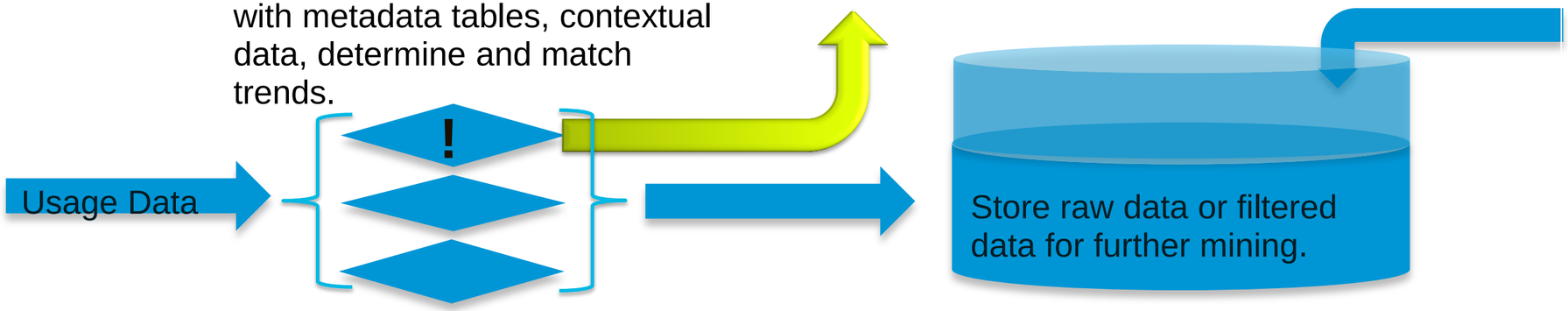
Store first- query later

- **Mine (fetch),**
- **Analyse,**
- **Report**

Next Gen Analytics

Generate an Actionable Event to Policy System, Management System, etc to allow for immediate control.

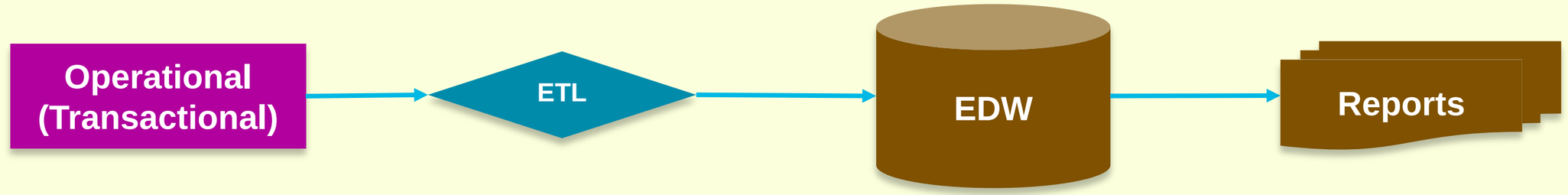
Apply predicates, aggregations, joins with metadata tables, contextual data, determine and match trends.



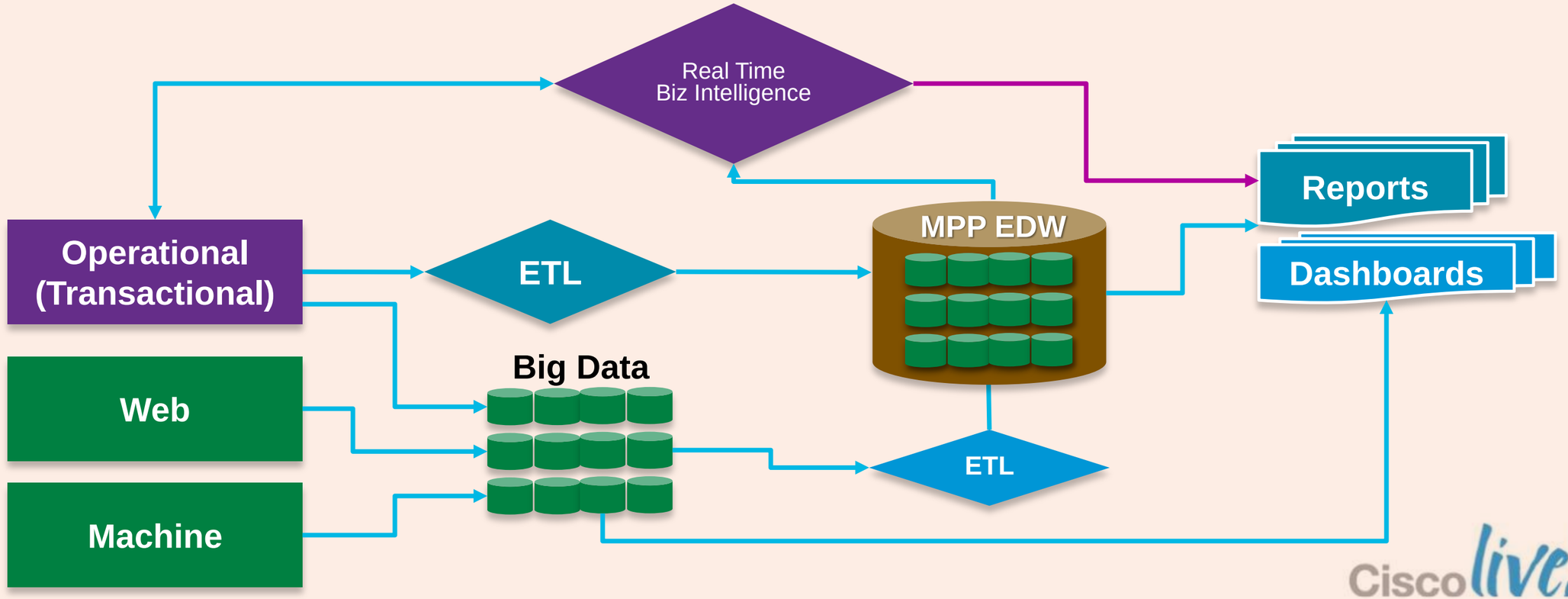
- **Mine (fetch),**
- **Analyse,**
- **Report**

Application & Data Intelligence

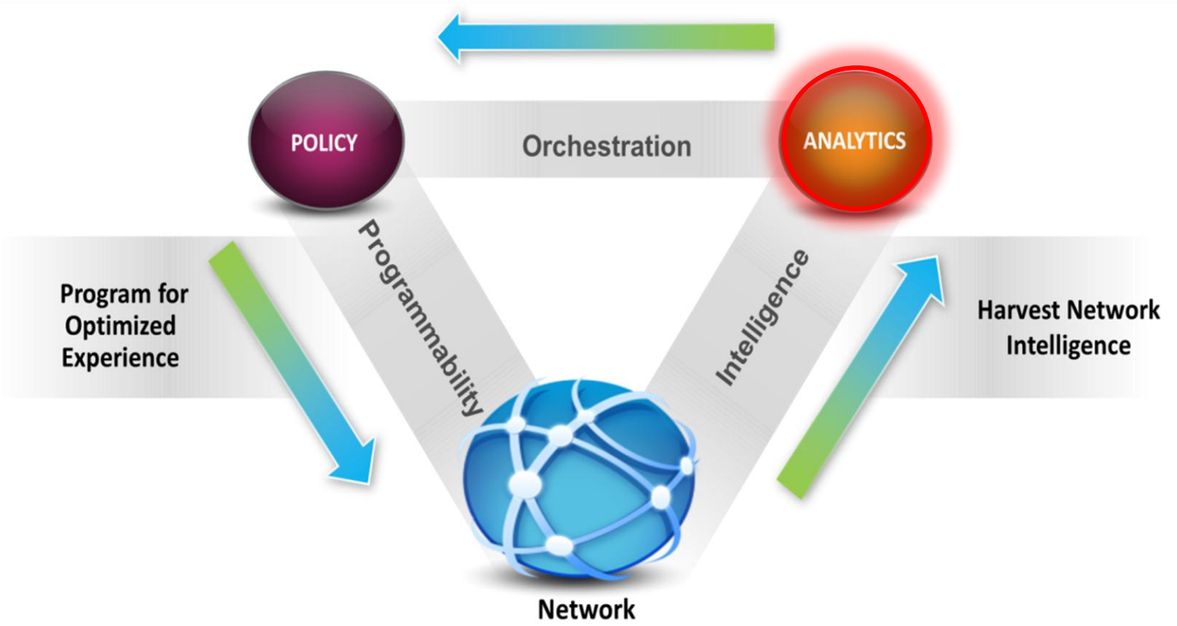
Traditional



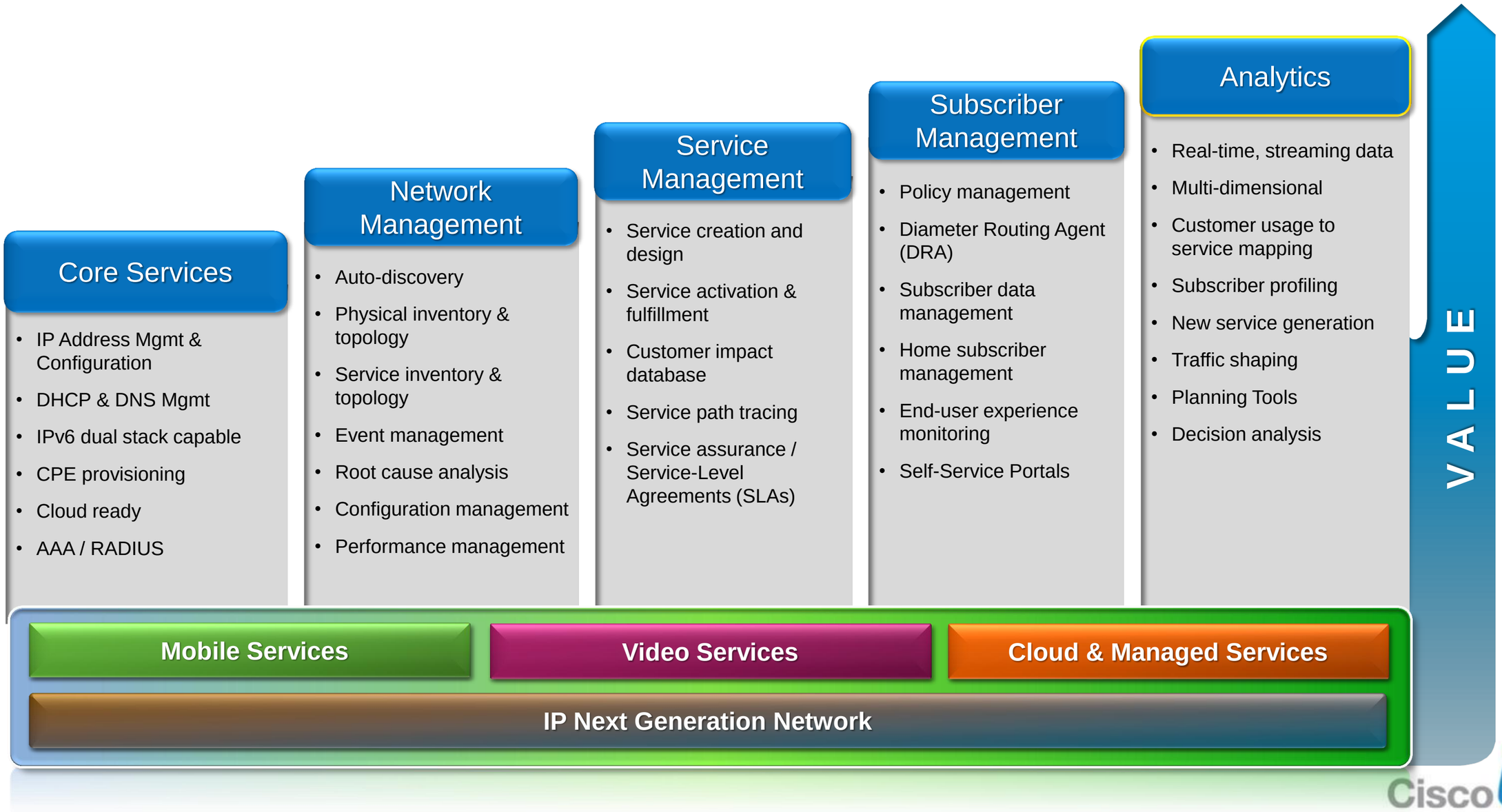
New



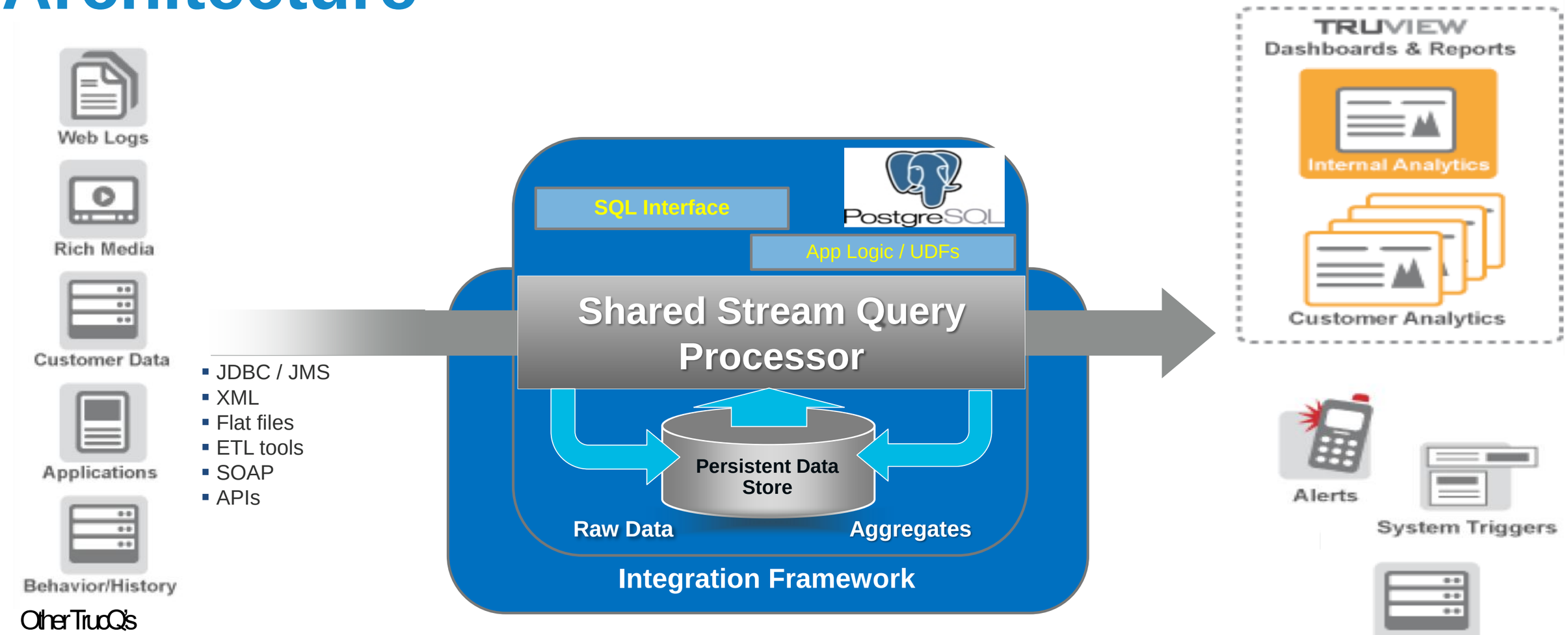
Cisco Data Analytics Solution



Cisco Prime Value Evolution

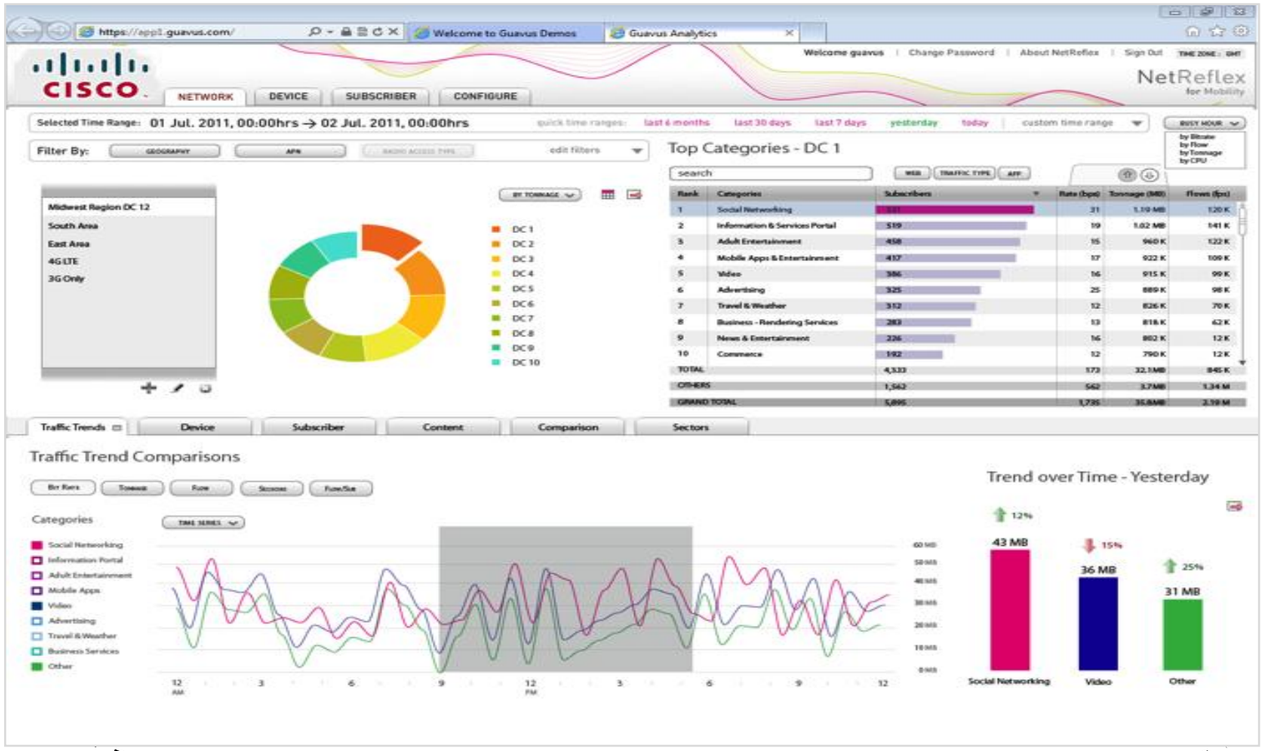


Cisco Prime Analytics Architecture



Mobility Unified Reporting and AnaLytics

Network, Devices, Subscribers, Contents and KPIs



Optimise Network Performance

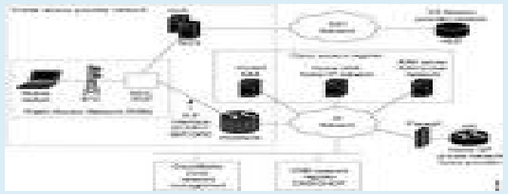
Target New Services

Plan Infrastructure Investments

Intelligent Network

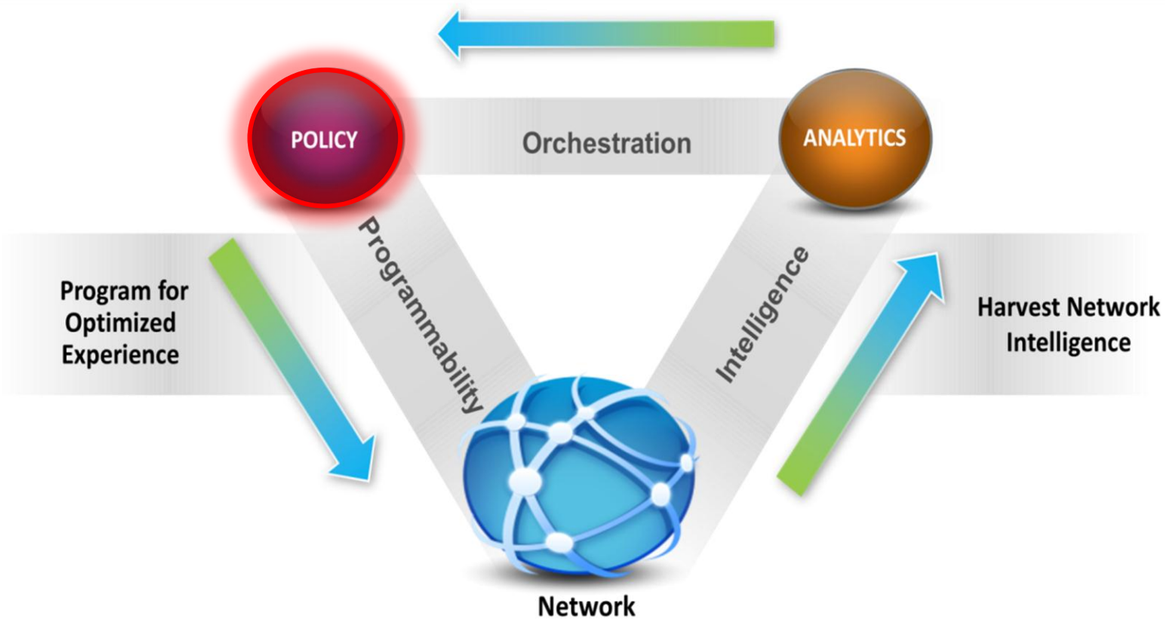
…Extract, Consolidate, Correlate, Customise and Monetise…

Mobile Analytics Insight and Execution

Device	Network	User	Content
Mobile Device Information	**Network Information**	**User Information**	**Application Information**
			
• Device Class Summary • Device Summary • Service Characteristics • Traffic Trends • Application usage • Regional Trends	• Bit rate Summary • Subscriber Base – Subscriber Summary • Subscriber Base – Device Summary • Traffic Trends • Top Applications	• Segmentation • Top Devices • Service Characteristics • Traffic Trends • Application usage • Top Users	• Application Summary • Top Service Providers • URL Classification • Search information • Regional Usage

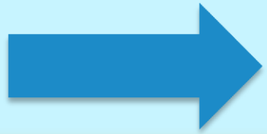
Support Monetisation, Optimise Cost and Customer Care

Policy Control



Requirements for Policy

Effective Use of Policy Management Helps Enable Better:

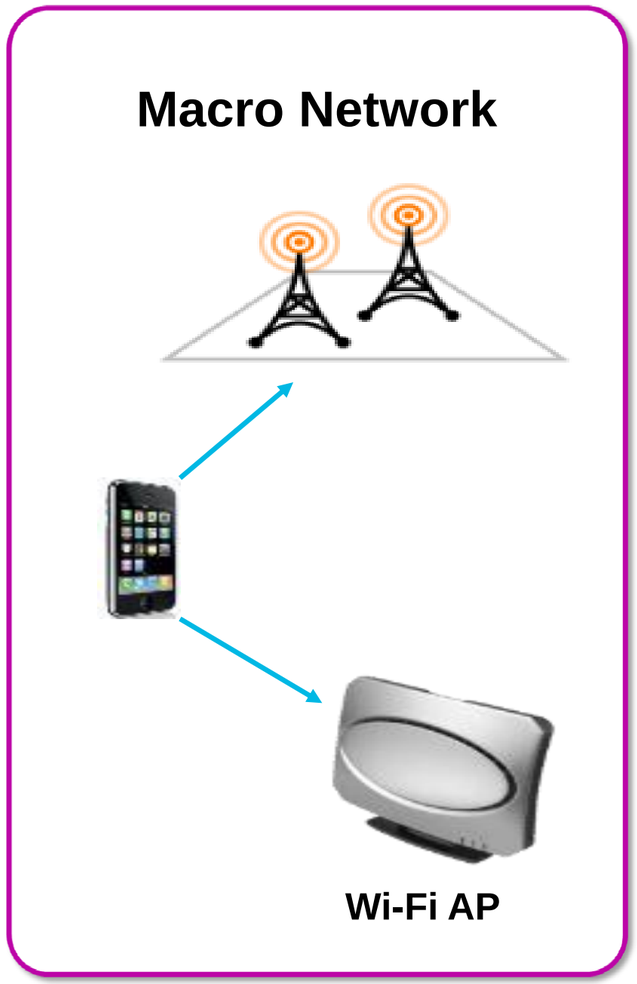
Service Provider Visibility: How are the limited network resources being used?		**Better operational efficiency**
Subscriber Visibility: How much of my allowance has been used?		**Improved customer experience**
Control network resources in real time across competing applications and subscribers		**Reduced capital expenses (capex)**
Monetisation, through flexible, innovative billing models, market segmentation, embrace over-the-top (OTT) services		**Improved average revenue per unit (ARPU)**
Personalisation, through self-service selection, subscriber-determined policies, high degree of personalisation		**Reduced churn**

Example Policy Requirements in Wireless

3G DEPLOYMENTS	4G DEPLOYMENTS
10,000 TPS in average network	100,000+ TPS in average network
100 policy controlled apps	1,000+ policy controlled apps, services
Policy applied to 10% of subs	Policy applied to 100% of subs
One or two policy triggers	10 to 100 policy triggers
Develop new policy services in months	Configure new policy-driven services in weeks
Interface to a single network or IT element	Interface to 10+ network or IT elements
One policy condition per service	Multiple policy conditions per service

From BroadHop-Heavy Reading Whitepaper, "The New Policy Paradigm: Apps, Not Pipes"

Example: Intelligent Mobile Offload



- Mobile Broadband traffic exploding
- Many operators with both fixed and mobile assets
- WLAN AP are widely available in Residential and Public places
- WLAN = cost efficient, easy operation and scalable access

Benefits

- Competitive differentiation with packages
- Improve user loyalty and reduce churn
- Ability to take and monetise competing service provider data traffic

Example: Shared Quotas – Devices, Users

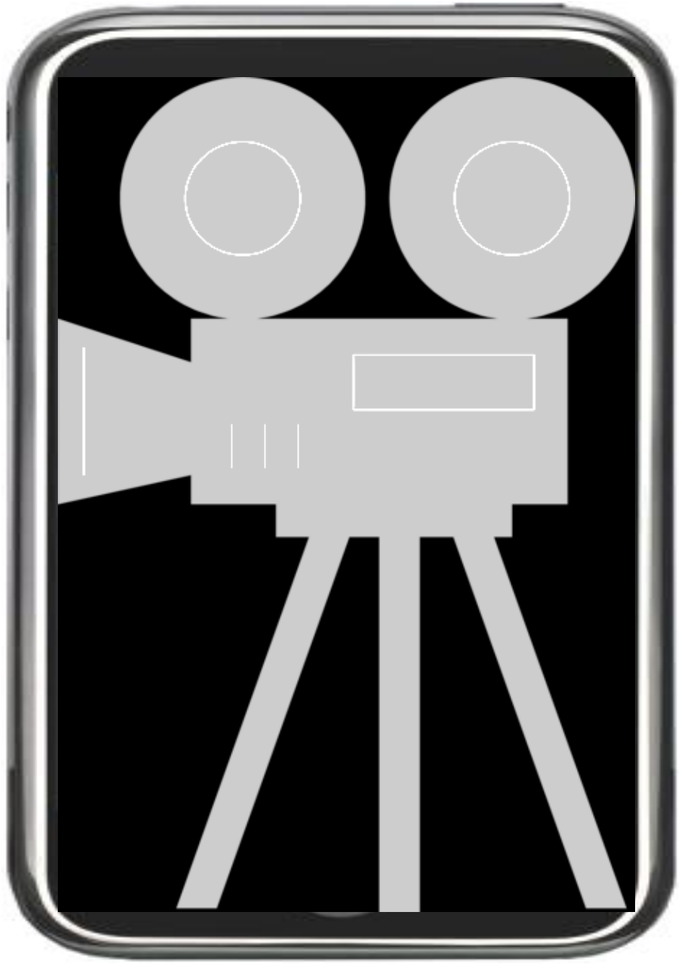
Multi-Device, Multi-Access Quota Sharing

- Single Quota Bucket
- Per-Device Usage and Thresholds
- Portal-based Top-Up
- FMC Shared Quota (Mobile, Fixed, WiFi)
- Example Packages
  - Power Users
  - Family Bundle
  - SME Bundle

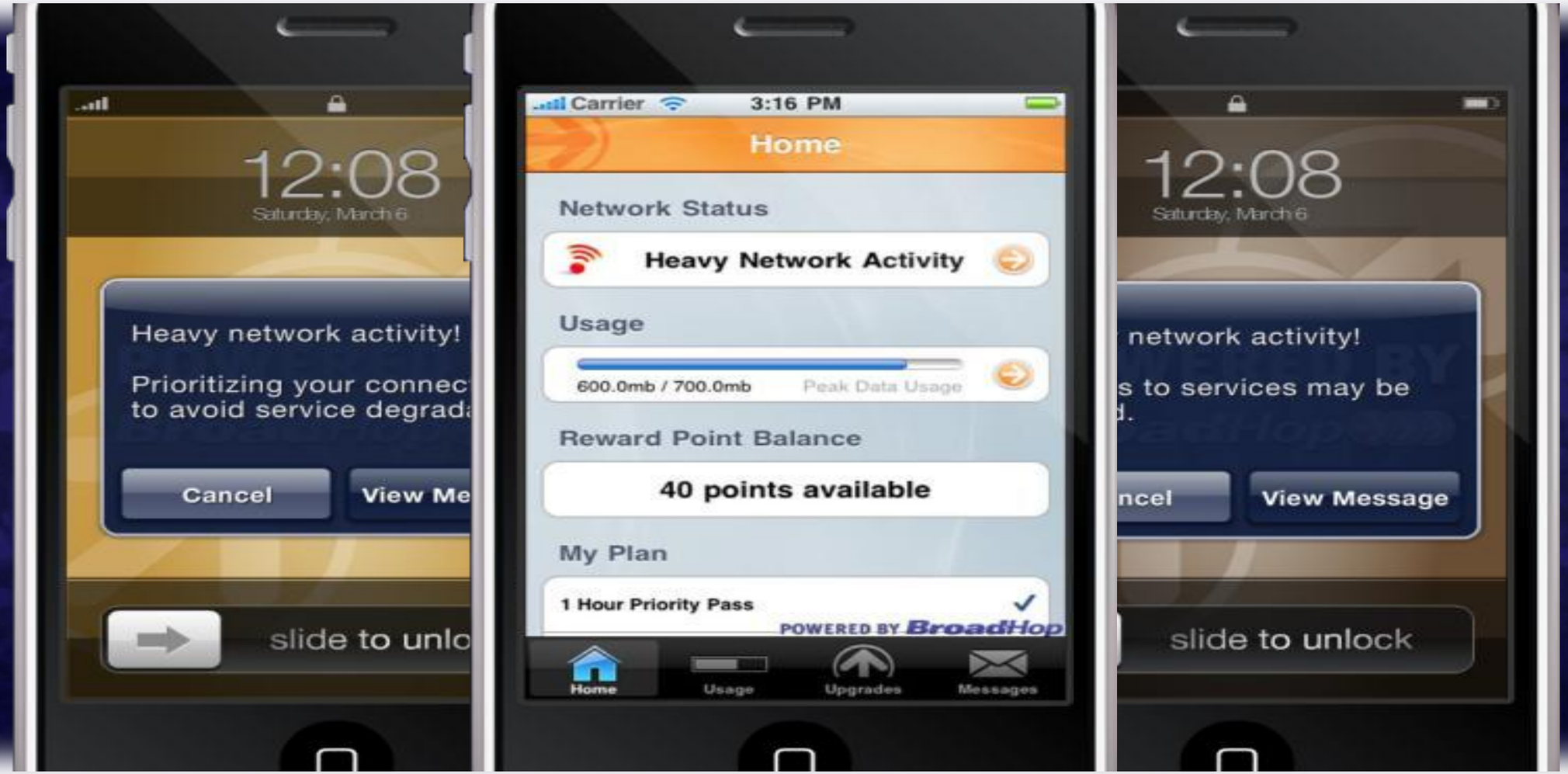
Use Case: Third-Party Sponsored Services

Service provider acts as intermediary between subscriber and content provider

- Third-party's content is not charged against subscriber's quota and content may be prioritised
- Service provider is compensated by third party for content distribution



Example:
User Differentiated Congestion Management



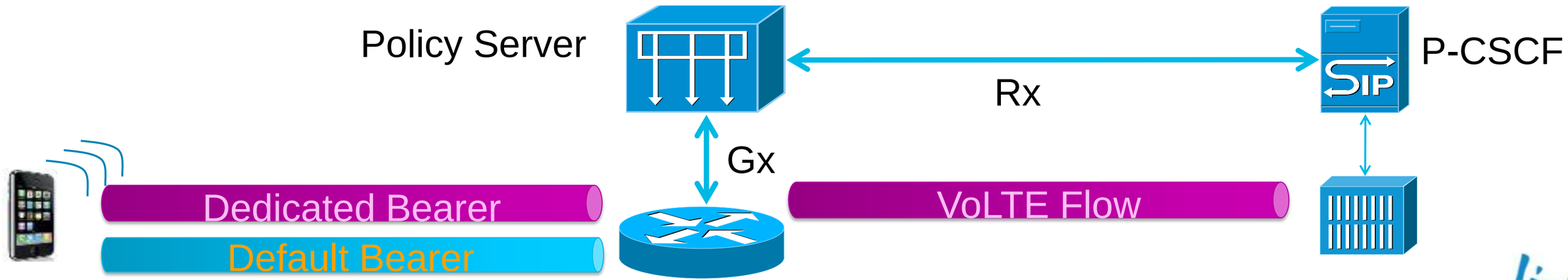
Example: RAN Congestion Control

Manage localised RAN congestion, maintaining the best quality of experience during congested periods

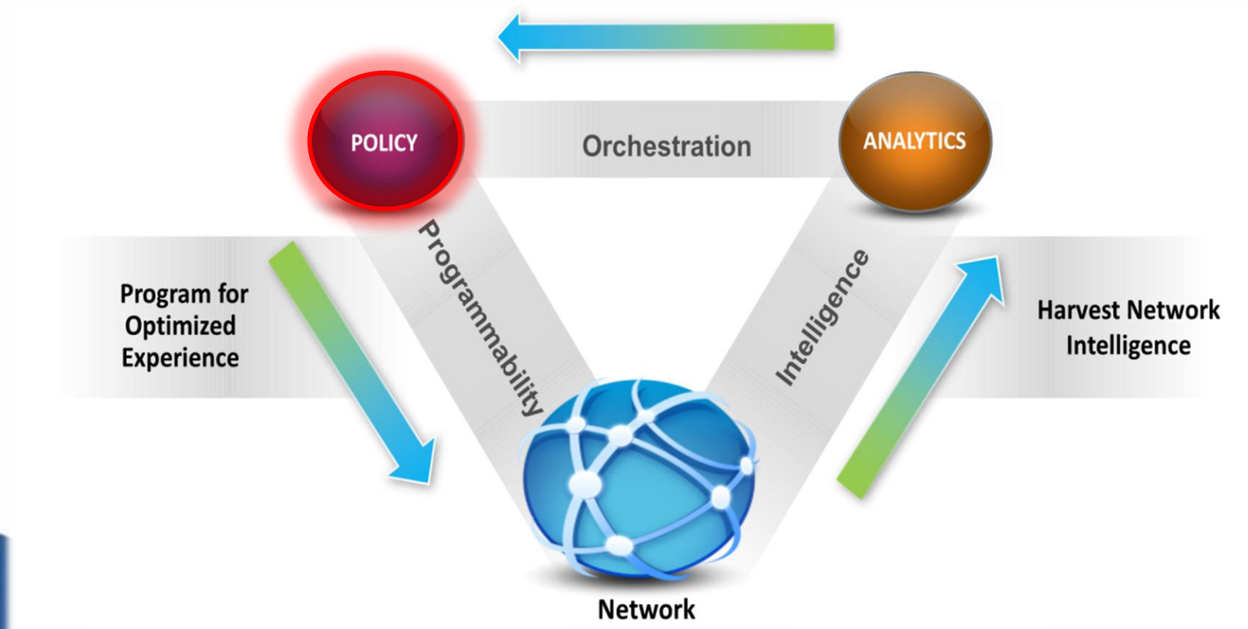
- Enforce or remove limits when subscriber enters or leaves congested area
- Identify subscribers and/or applications creating congestion
- Apply caps/downgrades or prioritised service as required
- Ensure fair access for all subscribers

Example: 4G VoLTE Use Case

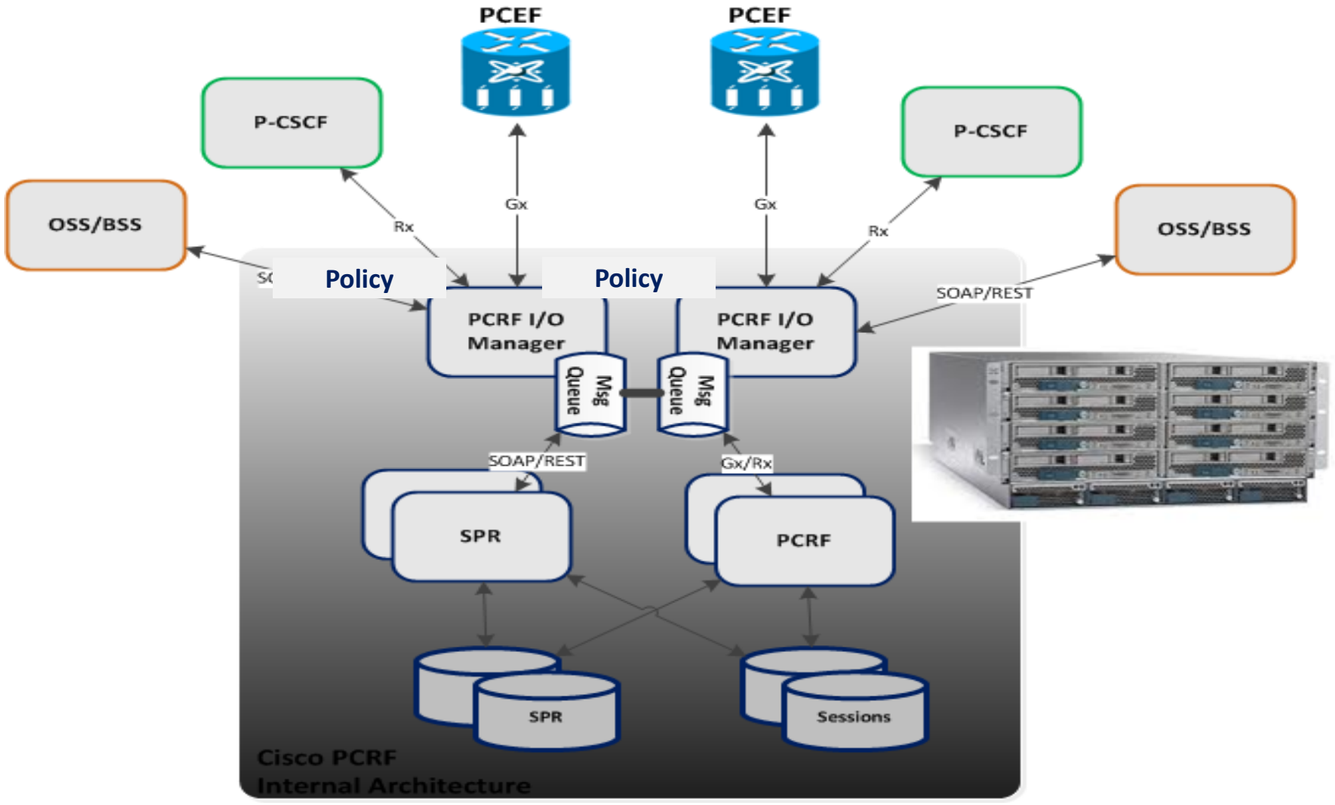
- The evolution to 4G LTE/EPC and IMS networks necessary to support VoLTE requires policy push capabilities from the service plane to the policy plane
- Given policy push the PCRF plays a key role in how policies are applied in real-time to support high quality end-to-end mobile originated and mobile terminated voice calls



Cisco Policy Solution



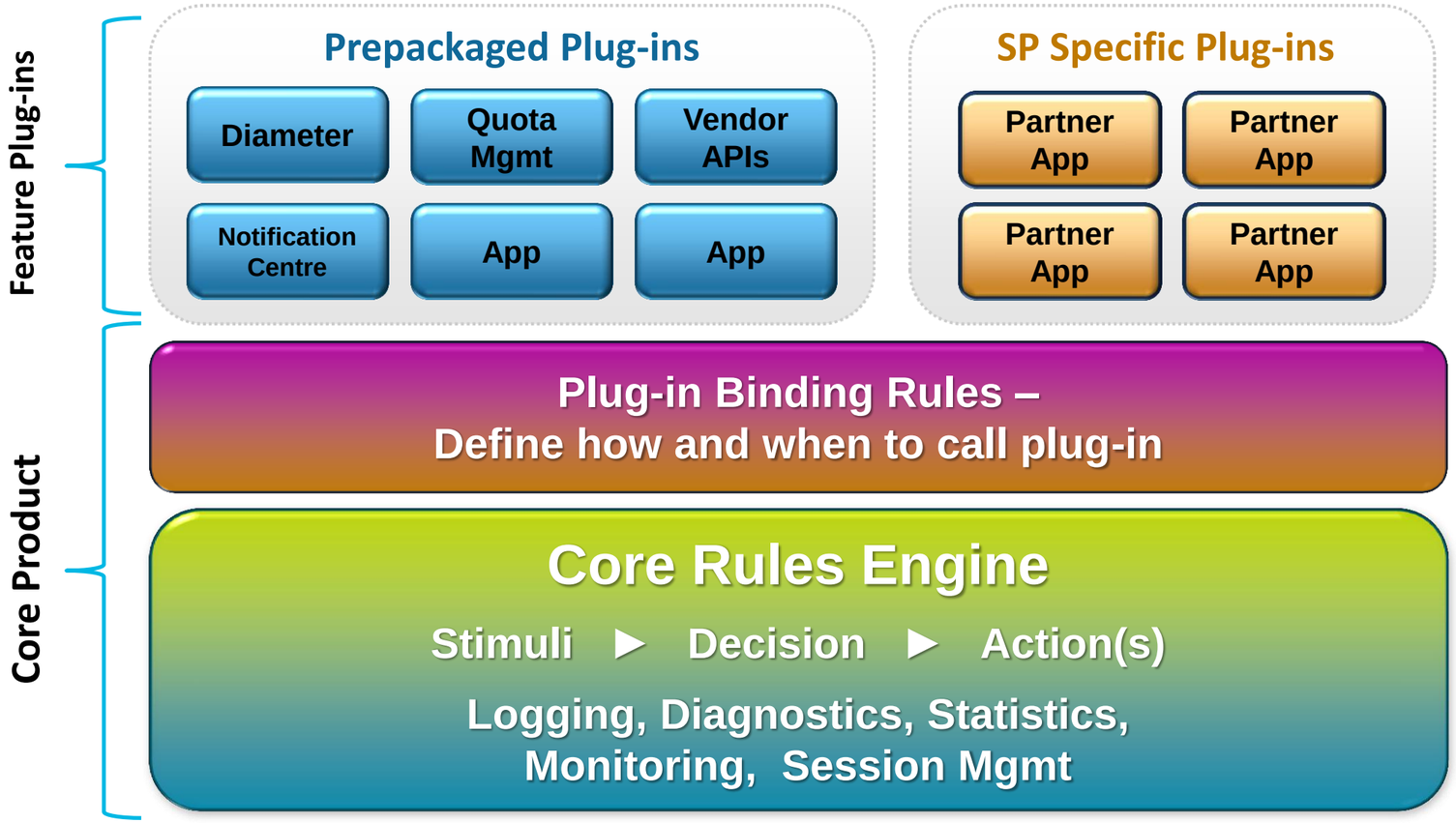
Cisco Policy 3-Tier Architecture



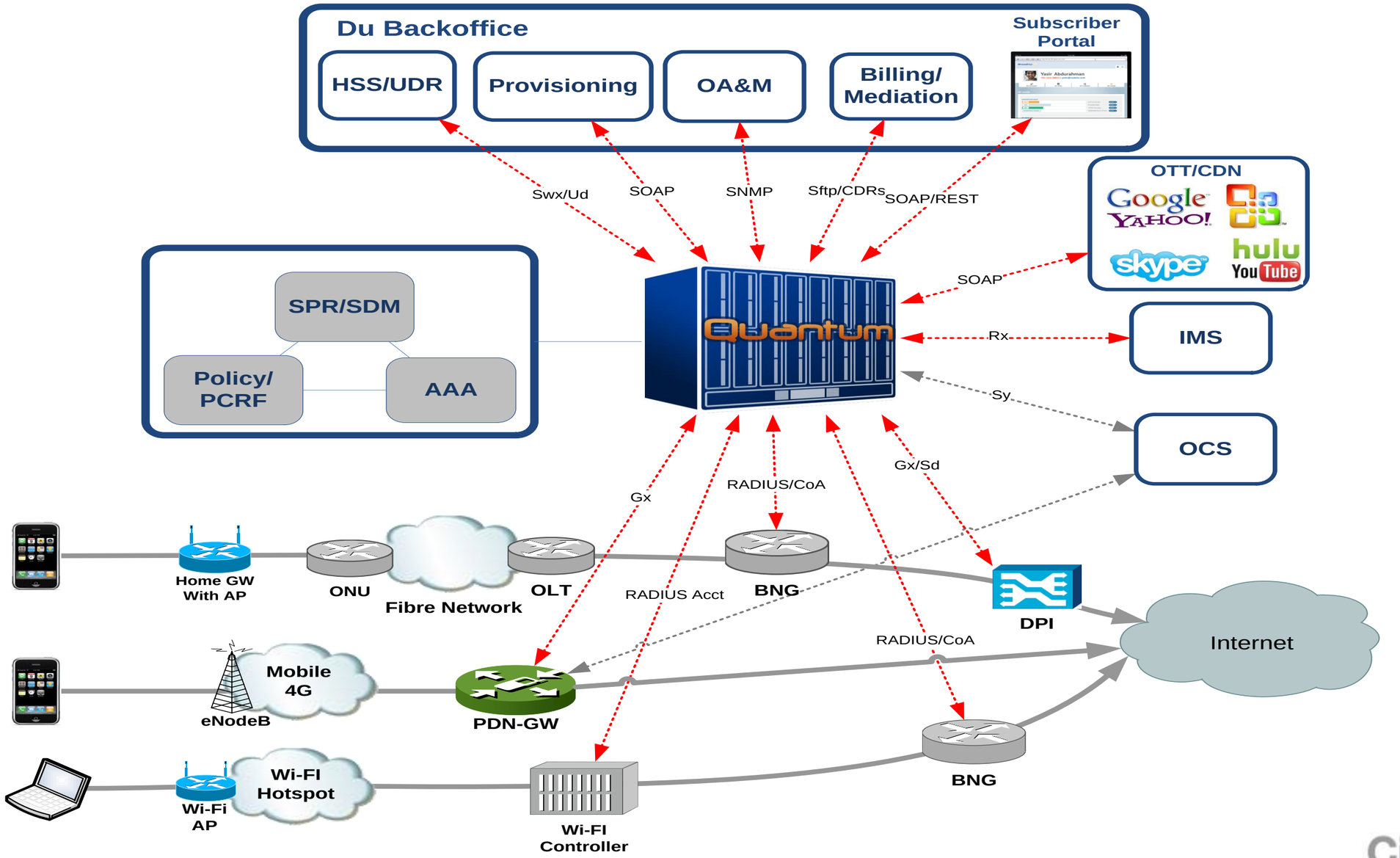
- Policy Manager
  - I/O Management
  - Diameter Peer Endpoint
  - Distributes policy requests
  - Load balances across multiple PCRF/SPR virtual instances
- PCRF/SPR
  - Processes policy transactions
  - Stateless
- Persistence Layer
  - Stores session, subscriber profile and balance data
  - Sharded across multiple database partitions
  - Accessible from any PCRF/SPR virtual instance in cluster

Policy Platform Extensibility

- Modular Plug-in Architecture
  - Extend the PCRF/SPRF with value added functionality
  - Integrate at any point in the policy execution
    - Not limited to pre-defined call outs or proprietary APIs
  - Service Definition GUI Screens automatically generated
  - Independent testing and upgrades
  - Core Product not impacted
  - Policy SDK uses industry standard framework
- Value Add Examples
  - Application APIs
  - Integrate proprietary subscriber database so that info can drive customised behaviour
  - Proprietary notification mechanism, e.g. to CSR terminal
  - Proprietary policy logic



Converged Network Architecture



Fixed Mobile Convergence

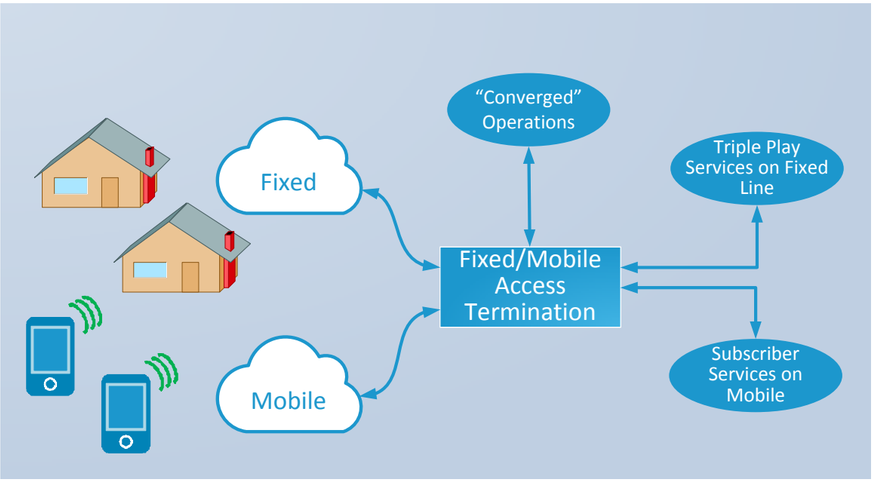
A Common Subscriber Model for Fixed and Mobile

	Fixed	Mobile
Capacity per Element	Multiples of 10s of thousands of access lines	Multiples of millions of subscribers
Protocol Model	PPPoE or IPoE	GTP and PMIP
Authentication	Access line is authenticated	Subscriber is authenticated
Deployment Model	Edge Deployments are in favor	Centralised Deployments (but some pressure to distribute)
Monetisation model	Per service (data, video, voice)	Transaction-based services, high-touch packet processing, pre-paid, etc.

- *The Fixed GW (BNG) manages an access line with multiple services deployed over it*
- *The Mobile GW (GGSN/PGW) is about personalised subscriber services*

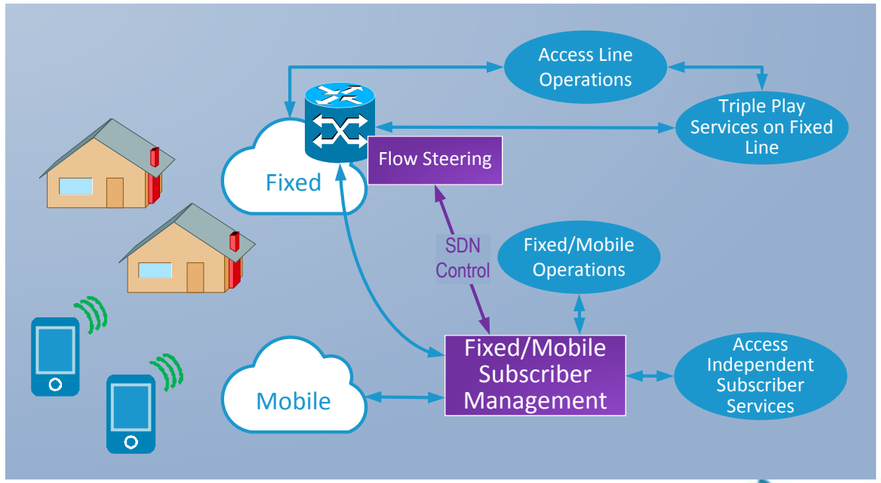
Operations Model for Fixed/Mobile Networks

- Achieving a “converged” operations model
- An access line in fixed networks is different to a subscriber in mobile
- Practices and OSSs may be dissimilar across fixed and mobile
- Requirements for “converging” disparate organisation domains

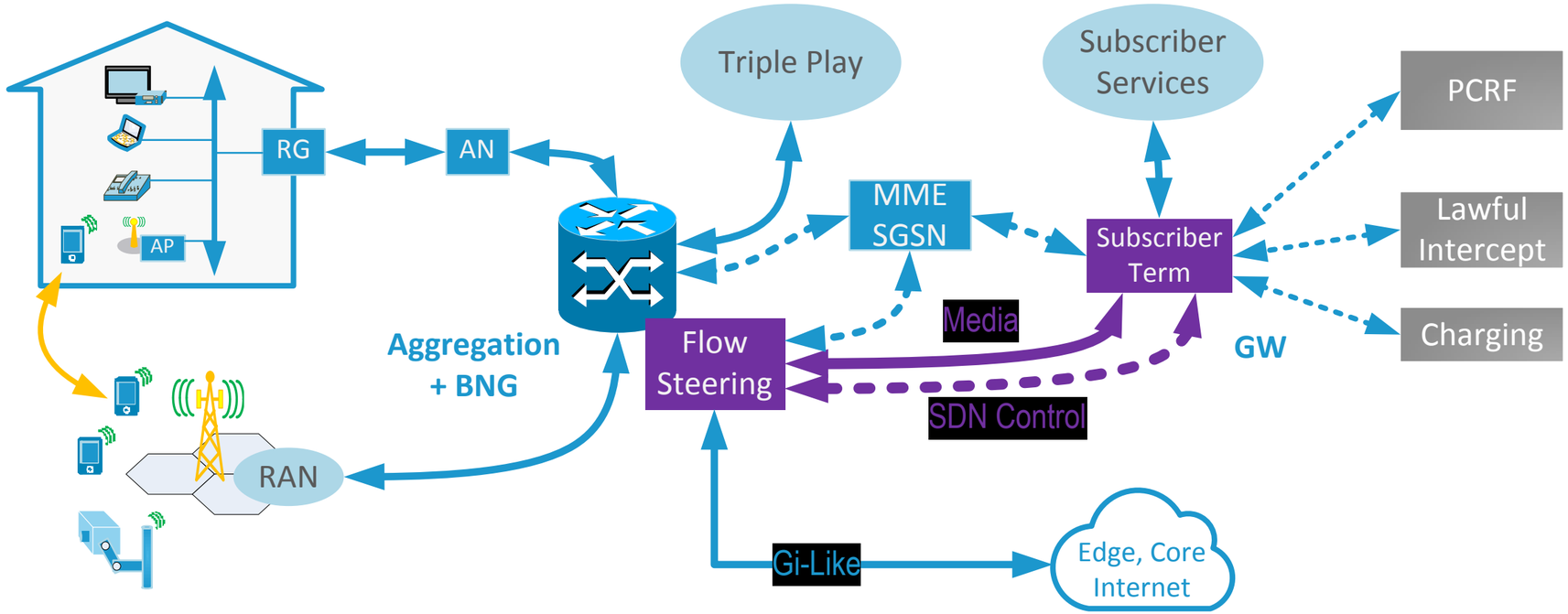


<u>Possible Scenario</u>:

- Fixed access terminations remain in purposed BNGs, however personalised subscriber management becomes a common function across access networks, even for triple play functions
- Common flow offload, load balancing, service steering, regulatory, billing approach for subscribers independent of access
- Integrated “cloud-style” operations and networking across edge and centralised locations via SDN Control



SDN Management of Flows at the Edge from the Core

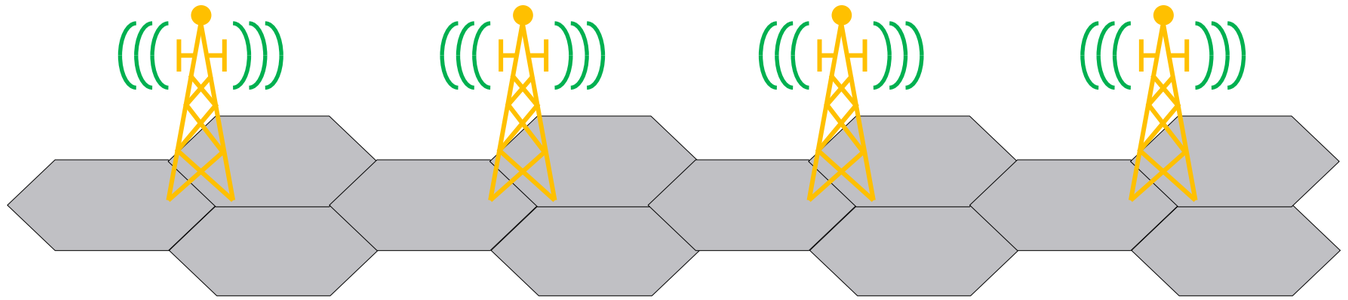


- Centralised deployments have cost advantages over distributed deployments in that the cost of some functions can be shared across the subscriber base (LI, PCRF, Charging, Gi Services, etc.)
- Possible approach of using SDN that allows the centralised core to flow-manage the edge gateway where it can conveniently steer traffic
- Subscriber management (charging, services, subscriber policy, LI, IP addr. Management, etc.) remain centralised

Heterogeneous Networks

Interference Mitigation

Macro layer
Frequency f_1 - True seamless mobility



Dense Small Cell layer
Frequency f_2 - Nomadic data

Multiple Access Networks (3G, LTE, Wi-Fi)

Policy based Access Network Selection (ANDSF)

Analytics: Network and Application

Seamless Mobility IP Address Preservation

Traffic Optimisation and Security

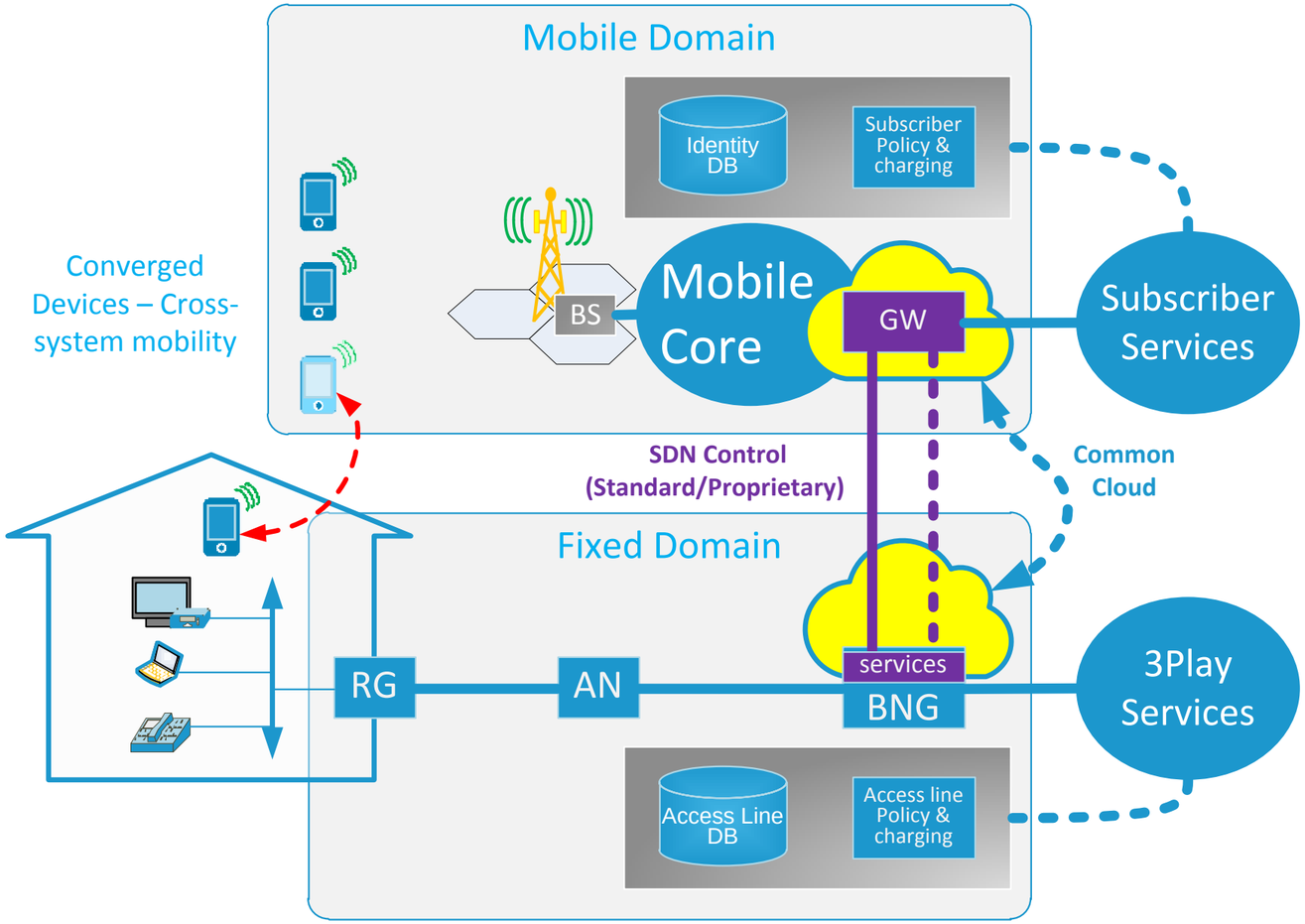
Subscriber Services Convergence

Subscriber services: are personalised service products that are delivered transparently across fixed and mobile networks

Delivery of converged services requires identity and subscriber policy/QoS management even in fixed network

Example use cases subscriber services are:

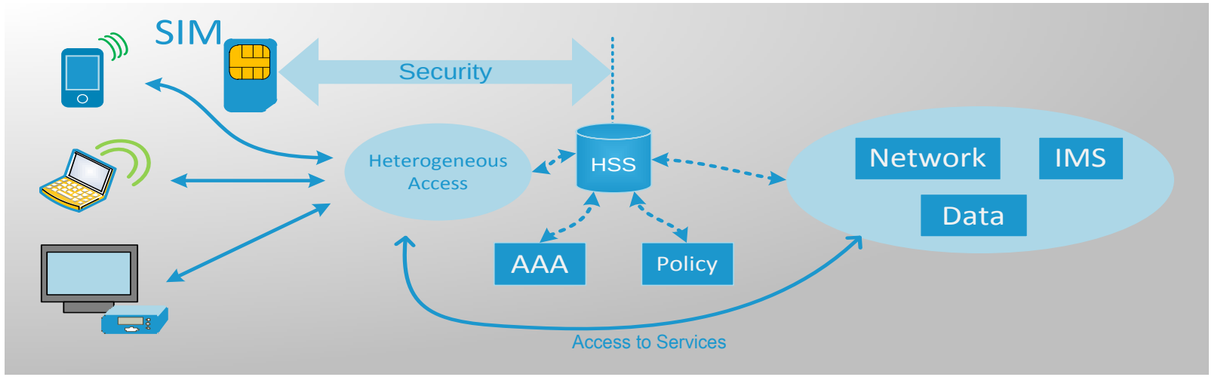
- Multi-media communications
- Firewall/Parental controls
- Video and other application mobility
- Indoor femto



Identity Services

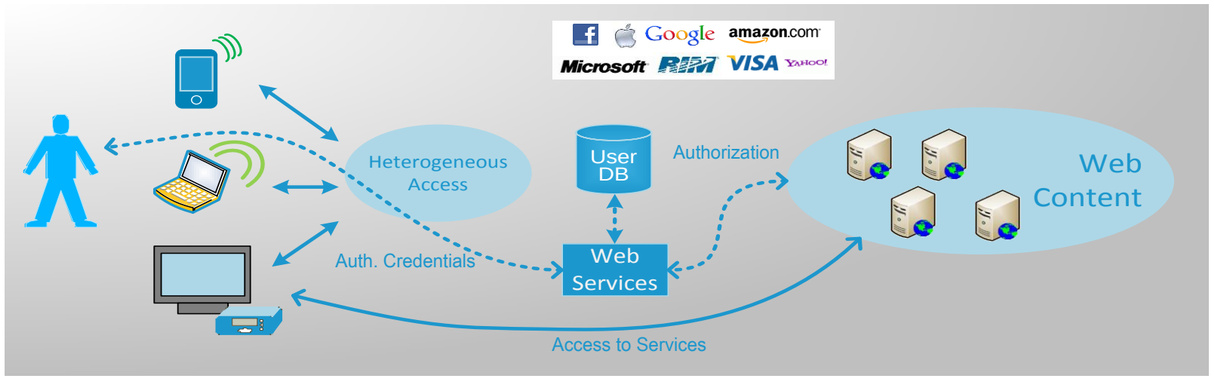
3GPP Identity:

- Secure identification enabled by SIM card interacting with HSS – no human intervention
- Not easily deployed in a web environment



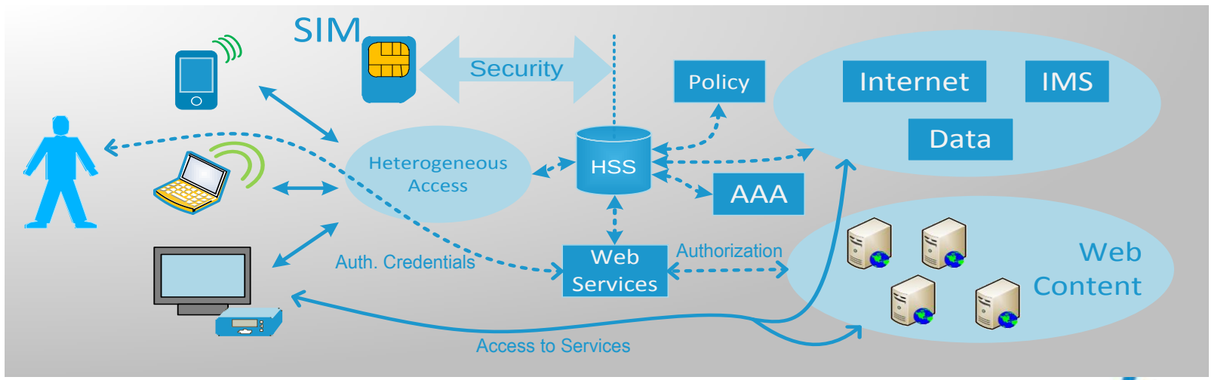
Web Identity:

- Completely dis-intermediated access (username/password or certificates) bypasses the network
- Requires separate network access
- Ample support for federation
- Strong competition !!



Synthesis - HotSpot 2.0 Identity: (Wi-Fi Alliance)

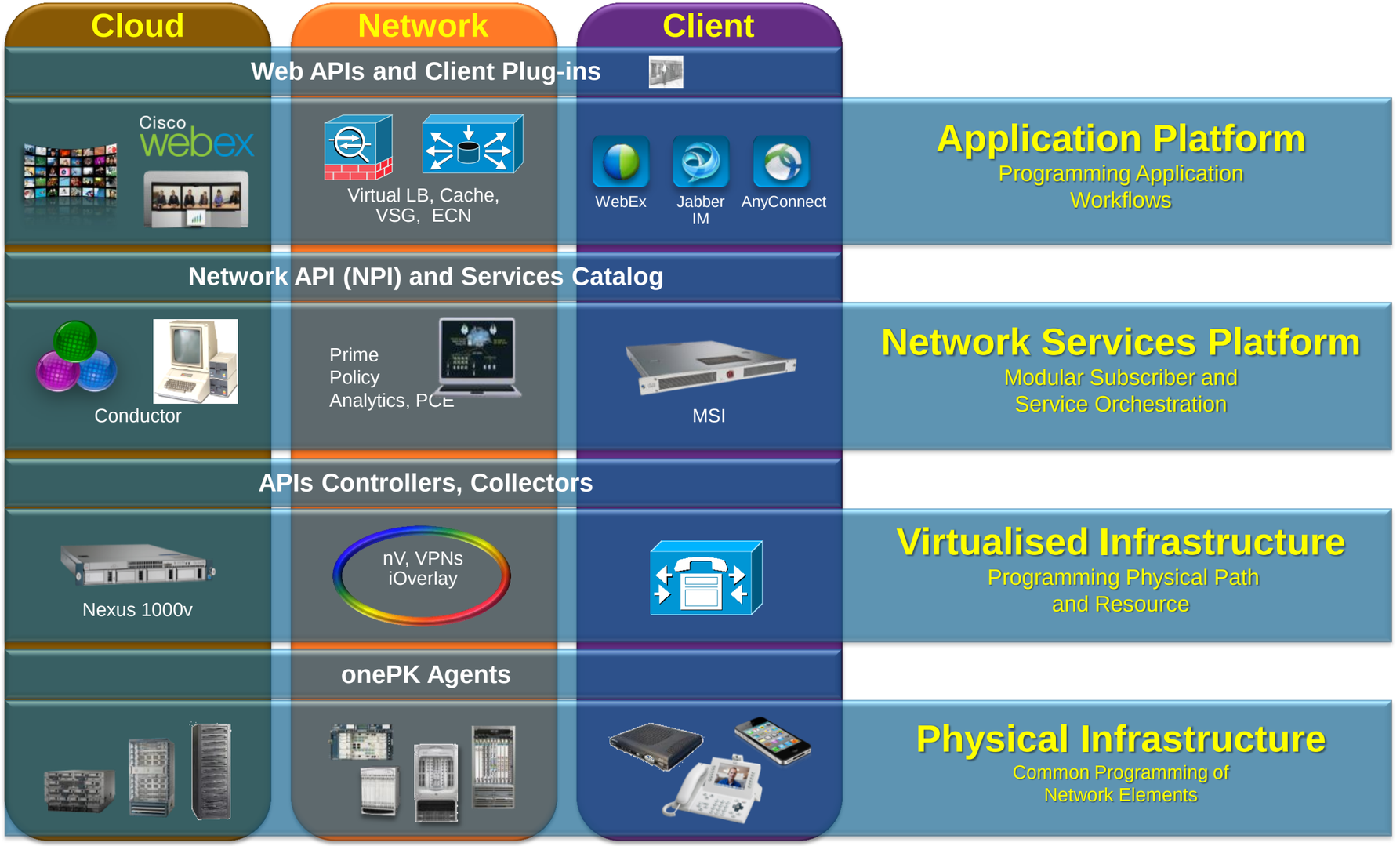
- Option of SIM-based, certificate-based, or user/password authentication
- Supports heterogeneous network access, beginning with Wi-Fi
- SP Identity as a service revenue model



Summary

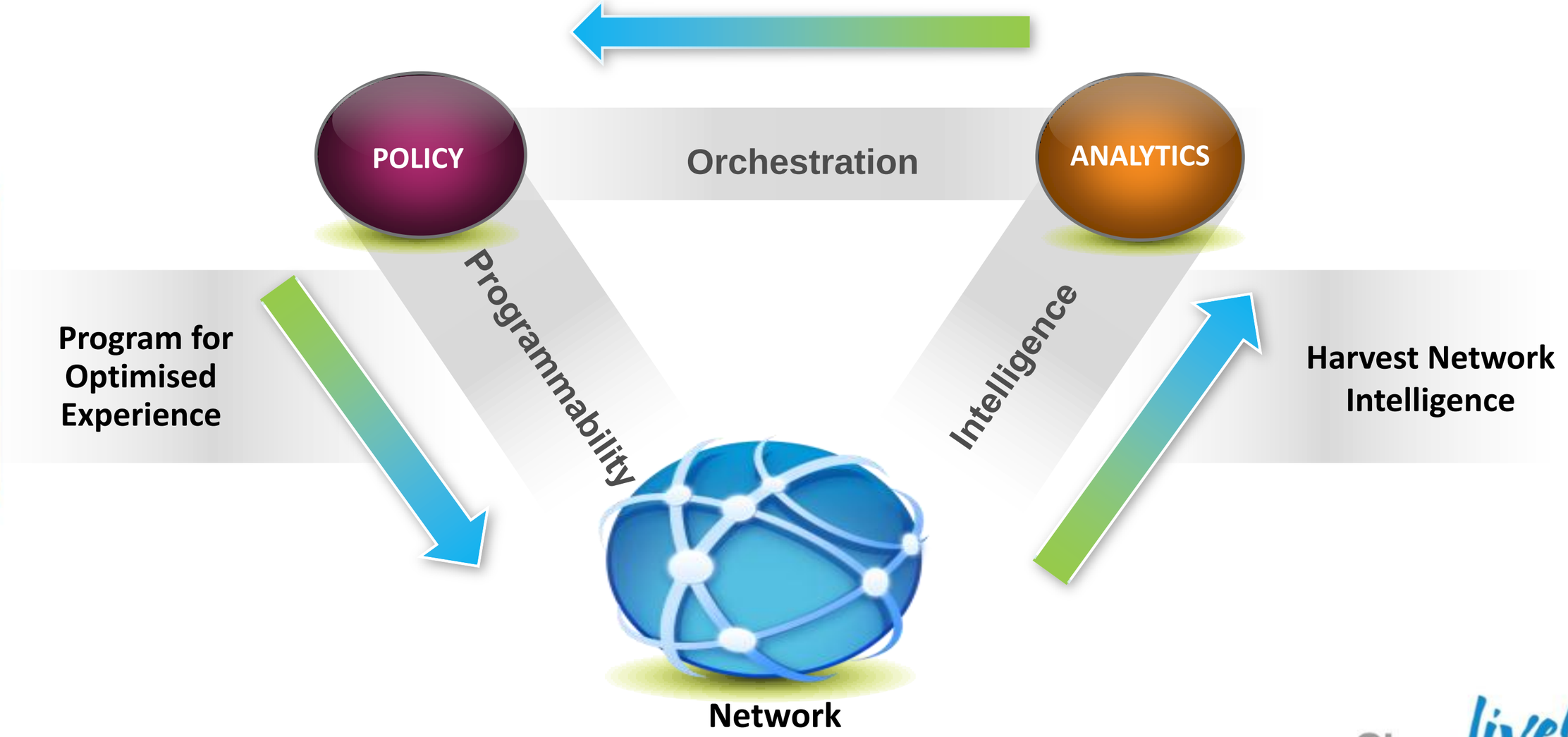
Next Generation Services Architecture

Elastic, Intelligent, Programmable



Services Architecture Framework

Leverage Network Value



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