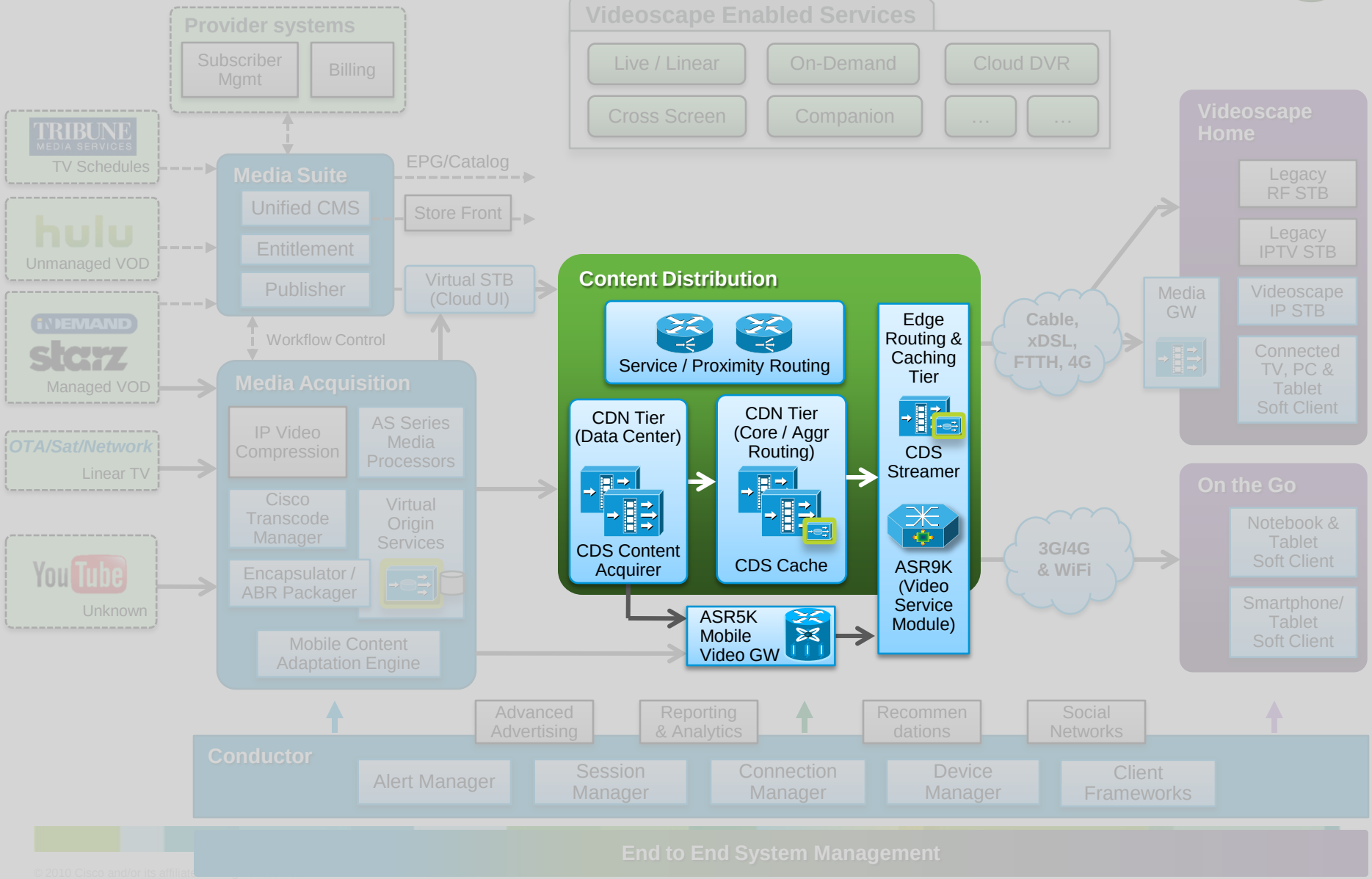
Mastering Content Delivery Network Systems

Introduction

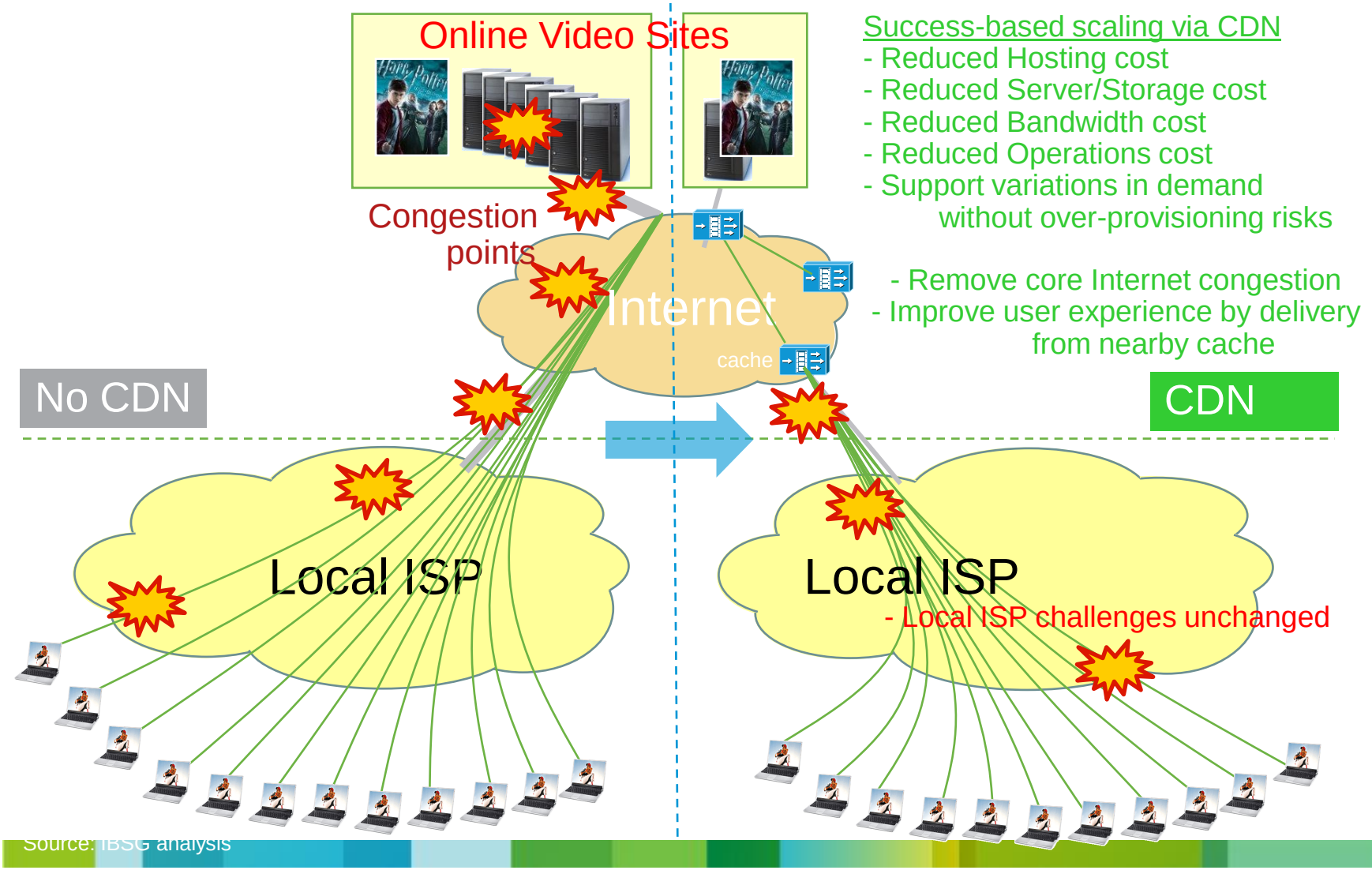
End-state Videoscape Architecture & CDN



Video CDN market dynamics

CDN Drivers: Enable Content Providers

Scale and improve performance

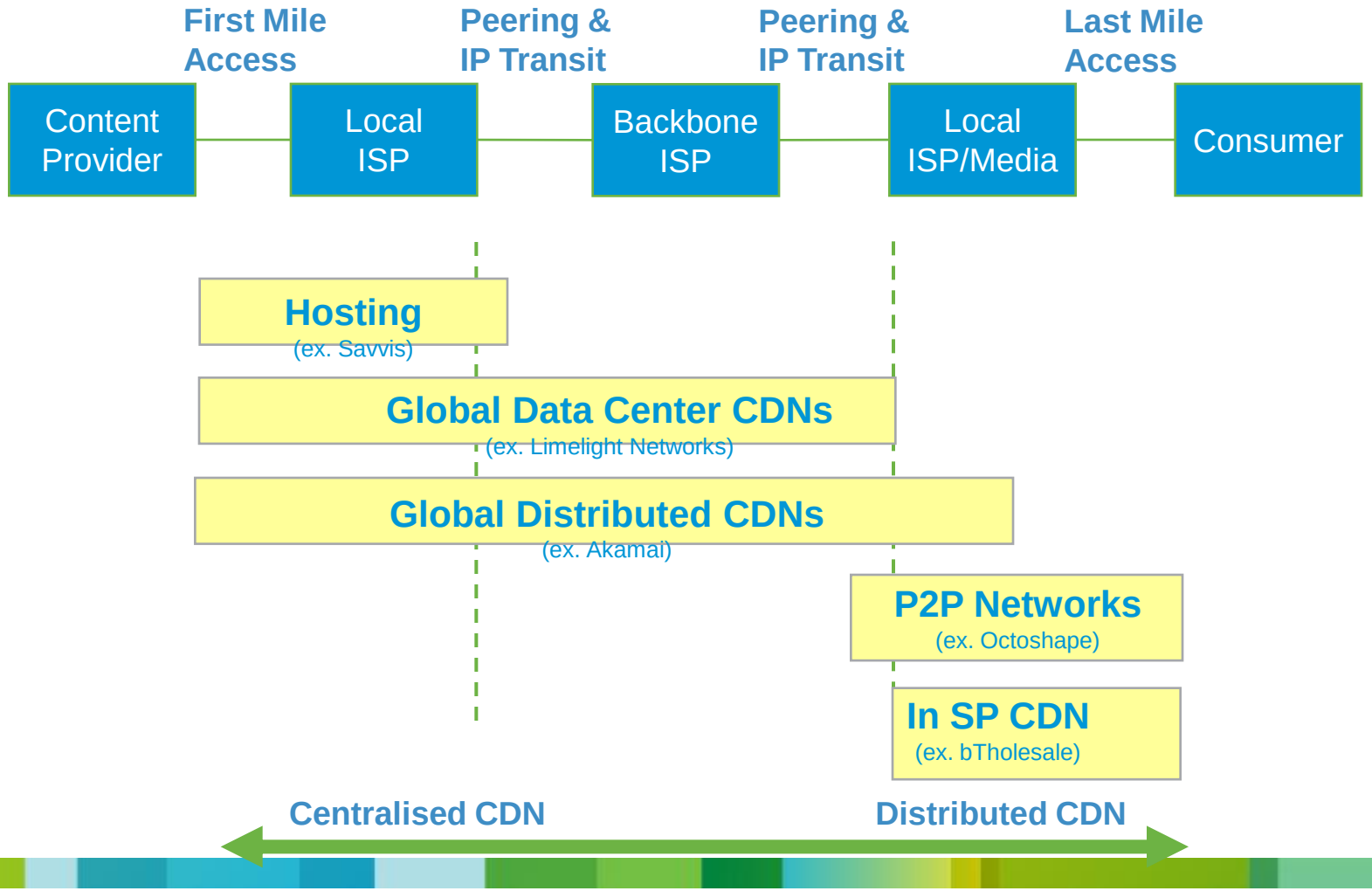


Success-based scaling via CDN
- Reduced Hosting cost
- Reduced Server/Storage cost
- Reduced Bandwidth cost
- Reduced Operations cost
- Support variations in demand without over-provisioning risks

- Remove core Internet congestion
- Improve user experience by delivery from nearby cache

Source: IBSG analysis

Online Video CDN Architectures
Centralised vs Distributed



Source: IBSG analysis

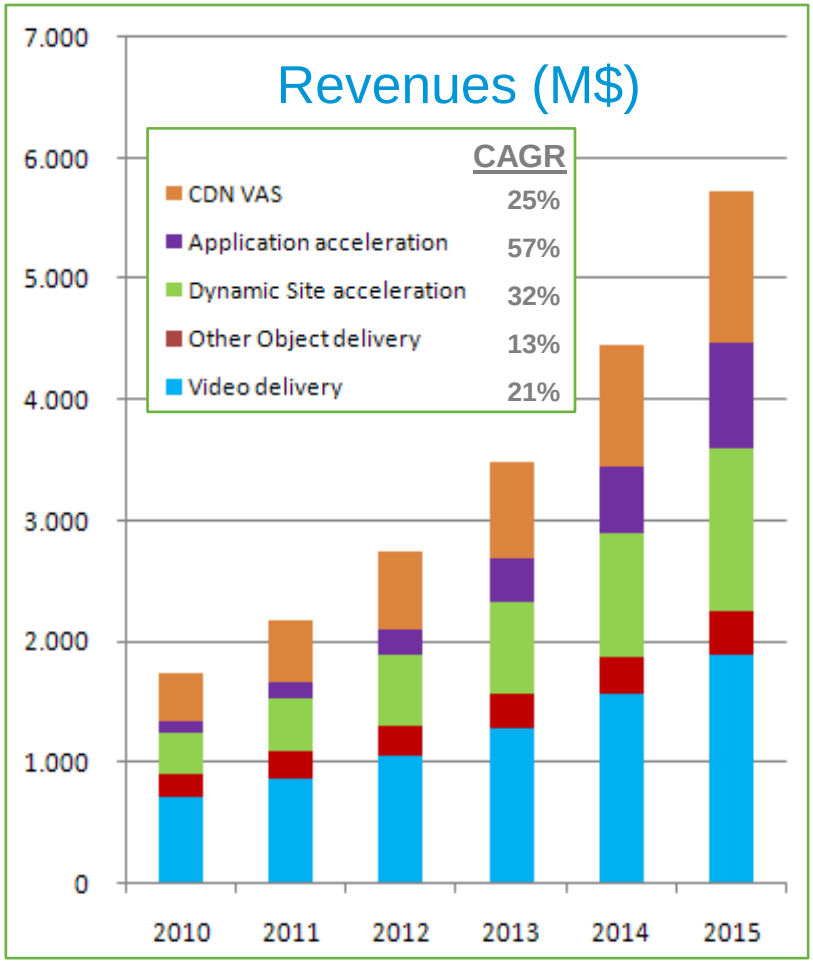
Online Video CDN Services
Main requirements

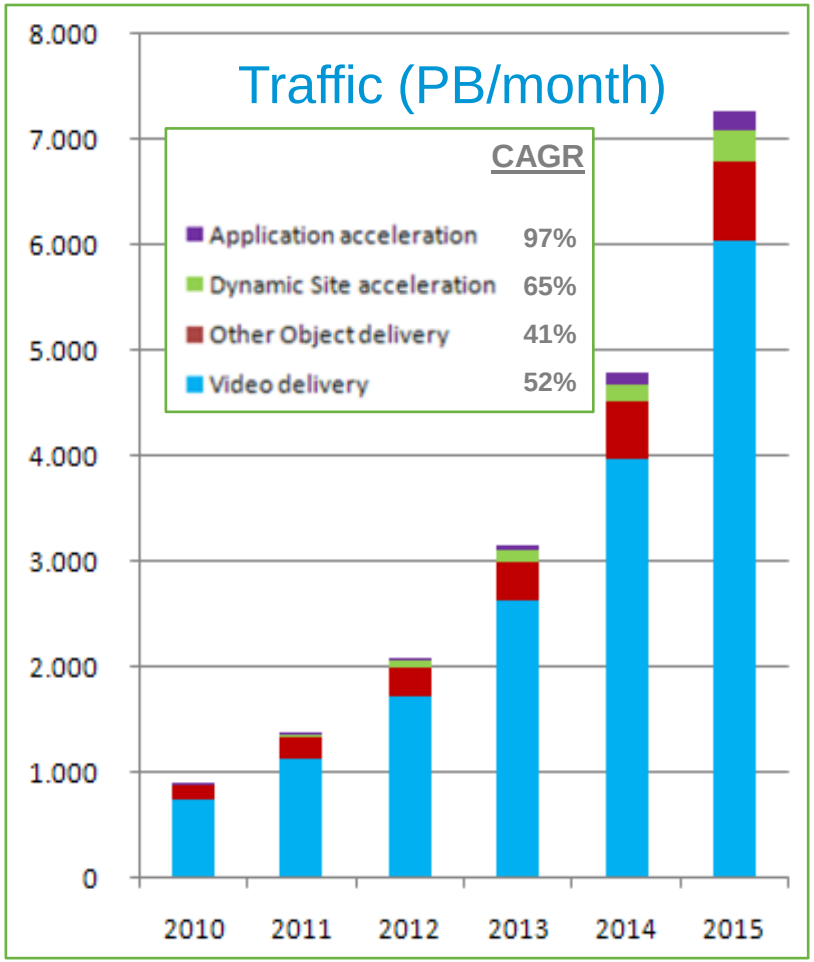
- Price
  - Typically in $/GB (or in $/Mbit/sec/month), highly volume dependent, different billing methods
- Geographic Reach – Local versus Global
  - Depends on content provider Geographical constrains
- Scalability (100's Gbit/sec – peak surge traffic)
- Protocols , Formats & Screens
- Content Security & Control (DRM, Geo-localisation)
- Reporting & Accounting
  - Detailed analystics are key for monetisation and capacity planning
- Customer Service & SLA (Quality of end user experience)
- Value Added Services:
  - Encoding, Origin Storage, Transcoding, Geofiltering, Ad insertion, DRM, content management , …

Source: IBSG analysis, 2010

Global Internet CDN Market Forecasts

Video ~35% of Revenues and ~85% of Traffic



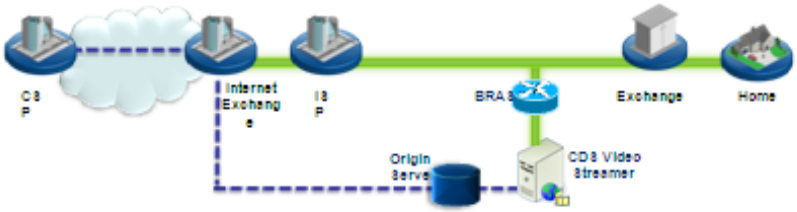


Video delivery revenue growth based on unit price decline of 20%/year
Most CDNs categorise Application and Dynamic Site acceleration as VAS.

Source: Frost/Sullivan, Cisco VNI, Akamai, Limelight, IBSG analysis

BT WHOLESALE & CISCO COLLABORATION

Working with CISCO



- **Content Connect's unique capabilities**
  - Routes traffic deep in our network based on proximity, network health & resources
  - Integrates with our OSS, DNS systems & bandwidth management systems
  - 'Virtualises' the service to both CSPs & ISPs
- **Cisco's solution**
  - Creating a highly flexible, open architecture, deep deployment product
  - Open architecture, rich API catalogue
  - Facilitates and enables QoS
  - A sustainable wholesaler solution

CONTENT PROVIDERS VALUE CONTROL OVER THE USER EXPERIENCE

Working with CISCO

	Examples	Requirement for Assured QoS
Paid for programming	• Catch-up • Movies/series • Other paid-for content	●
Free VoD/ catch-up	• Catch-up • Movies/series • Clips	◔
Lower quality streaming	• Streamed & peer-to-peer music services • User-generated video content	◑

Lead commercial broadcaster:
"Once you begin to charge for content, consumers expect a DVD quality experience"

● High
○ Low

CONTENT CONNECT IS FULLY SCALABLE
- Reduces cost risk & improves time to market for operators

Working with CISCO

- Optimising content traffic over ISPs & MNOs' networks – a strategic decision
- Build, buy or partner options provide a very different set of outcomes

	Build your own	Buy a service	Partner with a CDN
Timing	◑	●	●
Cost	○	●	◑
Resources	○	●	◑
Risk	●	●	○
Integration	◑	●	○
Assured QoS	◑	●	○
Service roadmap Multicast, Ad Insertion			

● High
○ Low

CONTENT CONNECT AS A SERVICE

Working with CISCO

- BT Wholesale has created a rich service management wrap around Cisco's CDS technology
- Enables ISPs to monetise CDN as a service to the CSP
- Content Connect will offer:
  - Service Portal
  - Asset Management
  - Network health
  - Self Service
  - Reporting & analytics
  - Billing
  - Product information

On Top of Executives' Minds… When it Comes to CDN

- Should I partner, build, defend or buy to capture my share of the Video CDN business and limit video traffic impact on my bottom line?
- How to enhance Video CDN business proposition to content providers?
- How to federate CDN service provider in a fragmented SP market?
- How to bring value-added video services to market faster?
- How to scale my network and control delivery costs while enabling a cost effective quality service?
- How to enable services on multiple screens, anywhere, anytime?
- How to ensure I securely manage content distribution?
- How to transform my broadband network into a TV platform?

CDN's perspectives for Service Providers

Online TV – Quality of experience matters

1. TV like quality of Service (Availability & Reliability)
   - Limited Frequency & severity of impairments
   - Well synchronized sound
2. Content Quality & Scope
   - Premium Content, live events, exclusivity, VoD catalogue quality etc..
3. Content Definition & Resolution
   - D1, HDTV, Dolby Surround, AAC, etc…
4. OTT Service Usability
   - Easiness & friendliness of service discovery & selection interface
   - foundation of a new TV viewing experience
5. TV like Channel change time
   - Satellite, Cable and DVB-T Benchmark
6. Customer Care & Management:
   - Time & way to solve end user video related problems

Source: Infonetics 2007 , Screen Digest, Cisco 2010

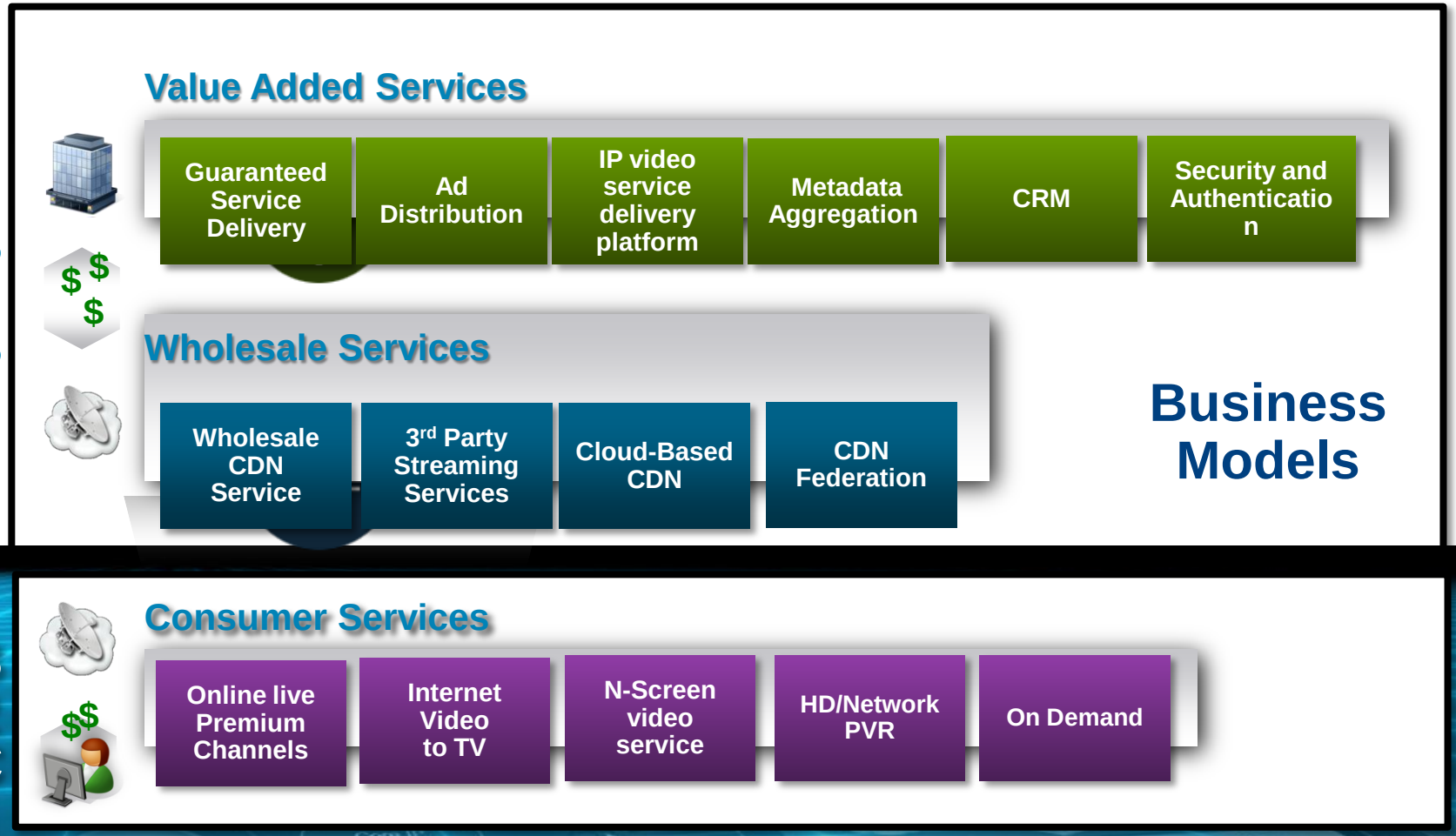
Enabling SP to Capitalize on the Two-Sided Market

Differentiated User Experience, Service Velocity and Monetization

SP Platform

Leverage Network and Data Assets

Enabling New Business Models and Services Step by Step Approach



SP Platform

Leverage Network and Data Assets

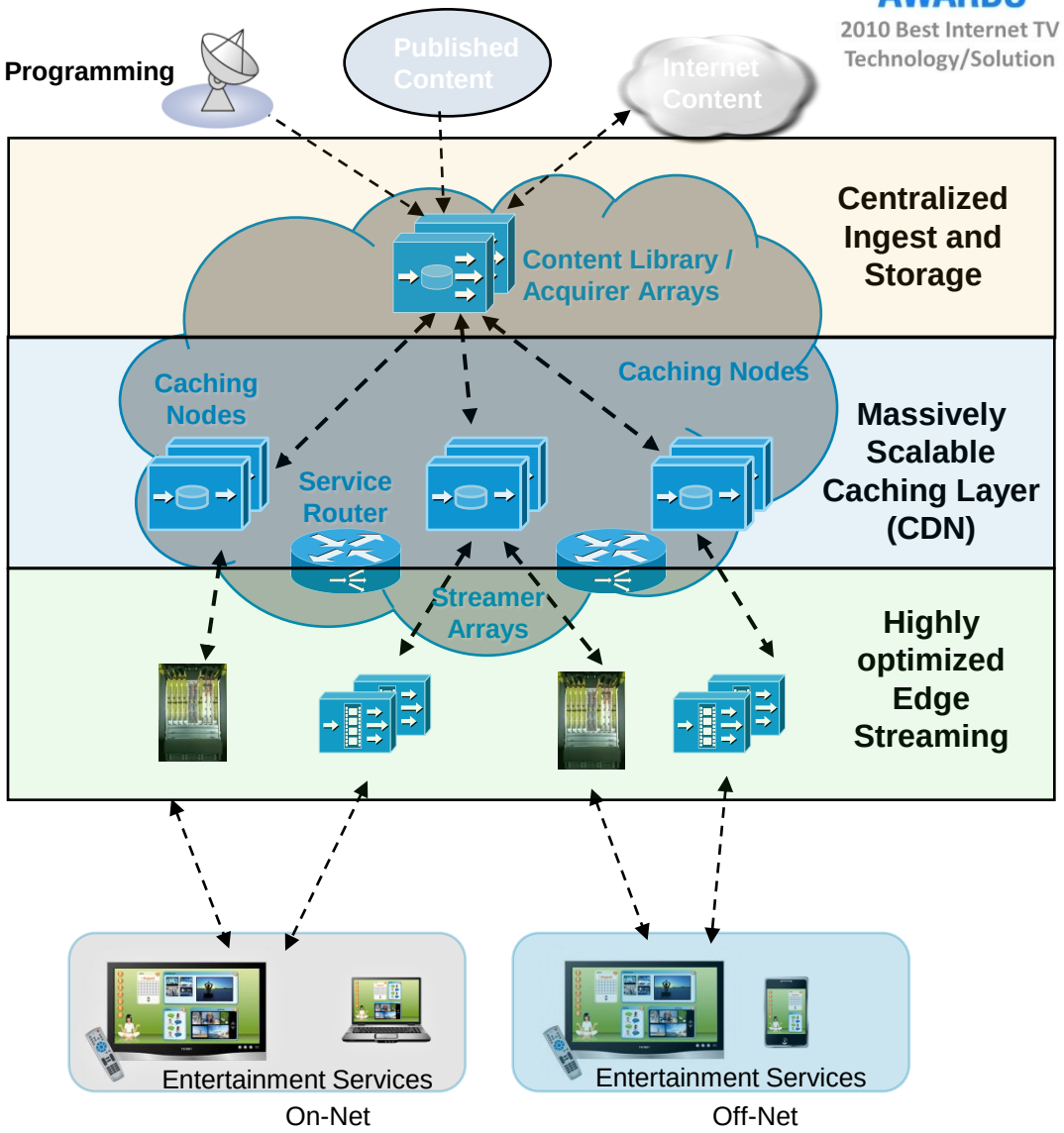
Cisco CDN solutions

Cisco Content Delivery System (CDS)

Platform for IP "Virtual Video Infrastructure"

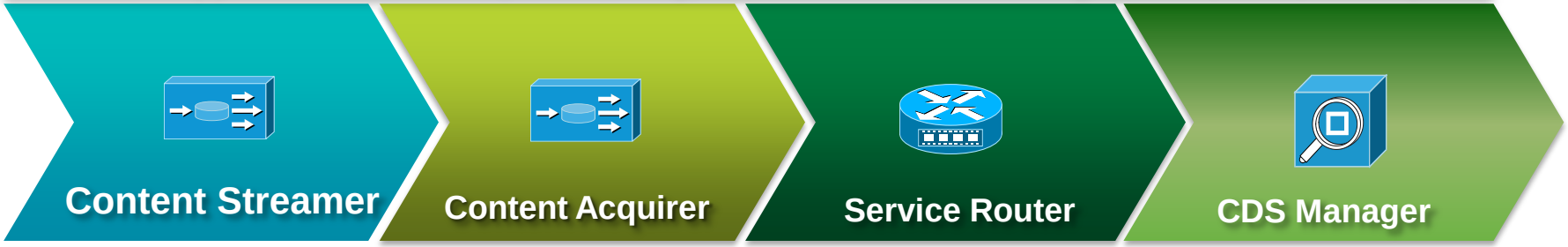
IPTV World Series AWARDS
2010 Best Internet TV Technology/Solution

- **Acquires Content in Multiple Formats from Multiple Sources, Live and On-Demand**
- **Independent Scalability of Content Delivery Functions – Adapts to Any Network Topology**
- **Very Low Latency Content Propagation for On-Demand and Real-Time applications**
- **Guarantees non-stop Service Availability through Advanced Resiliency Features**
- **Intelligent Service Routing for Global Network Routing and Service Extensions**



CDS Content Delivery Network

Video Application Network (VoD Library, Live Encoder, Streaming Clients, EPG, Portal)



IP Network (Core, Aggregation, Access, Wireline, WiFi, 3G, 4G)

Content Streamer

- VoD Streaming
- Live Streaming
- Concurrent Multi-Protocol
- Stream HTTP, RTSP, RTMP
- HTTP Download & PDL
- High Performance
- Detailed Reporting

Content Acquirer

- Ingest to Hierarchical CDN
- VoD Library Ingest
- Live Streams Ingest
- VoD Prepositioning
- Vod Dynamic Cache-Fill
- Live Dynamic Stream Split
- HTTP, FTP, CIFS, RTSP

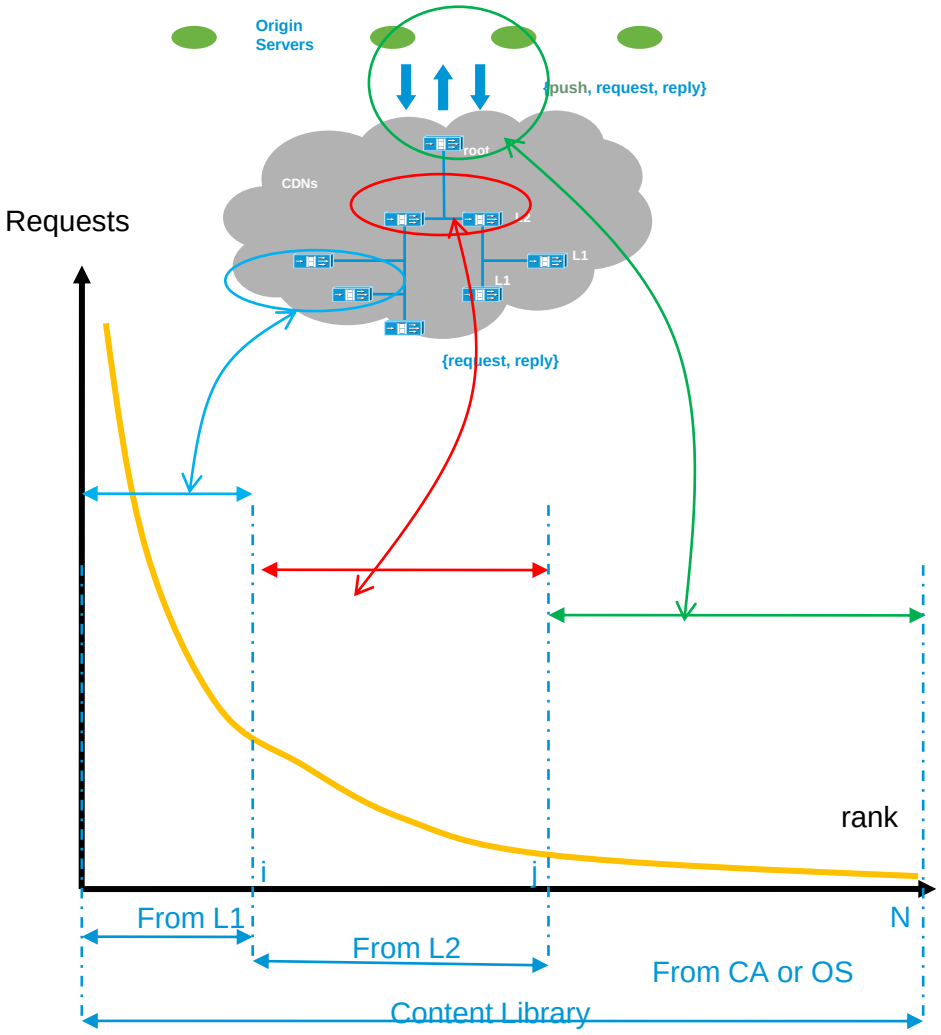
Service Router

- Content Request Routing
- Global Load Balancing
- HTTP, RTMP, RTSP, DNS
- Content and Load Aware
- Subscriber & Network Aware
- Integrates with BGP, OSPF

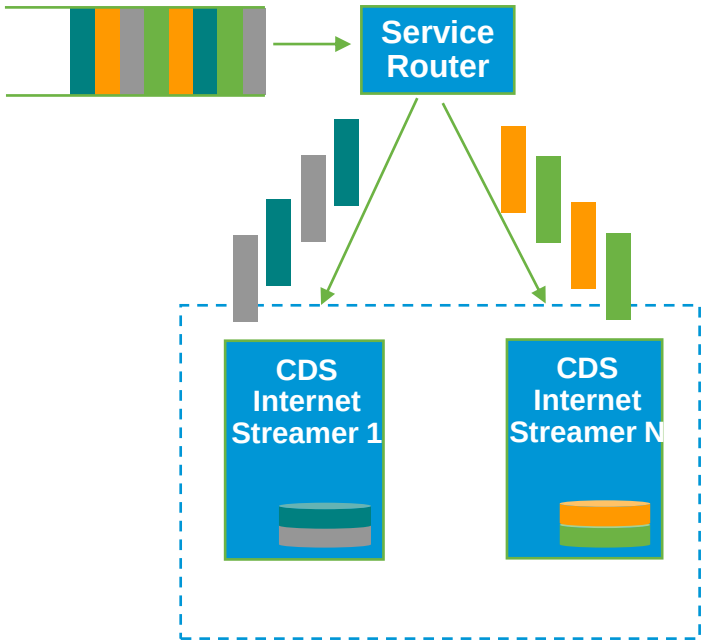
CDS Manager

- Centralized Element Mgmt
- WebGUI and HTTP API's
- VoD Delivery Service Mgt
- Live Delivery Service Mgt
- System Monitoring
- Capacity Monitoring
- AAA Server Integration

Caching and Content Affinity



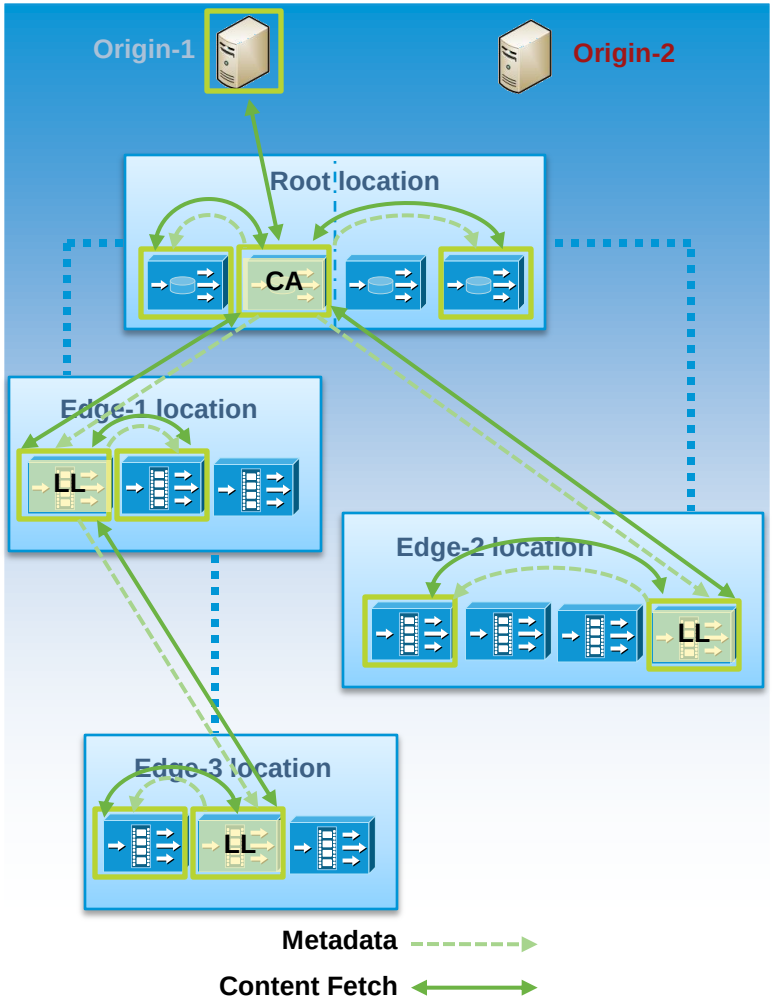
- Achieve the right balance between efficient service of requests and storage
- Affinity based caching allows for “Virtual Caches”



VoD Ingest and Distribution

Pre-Positioning

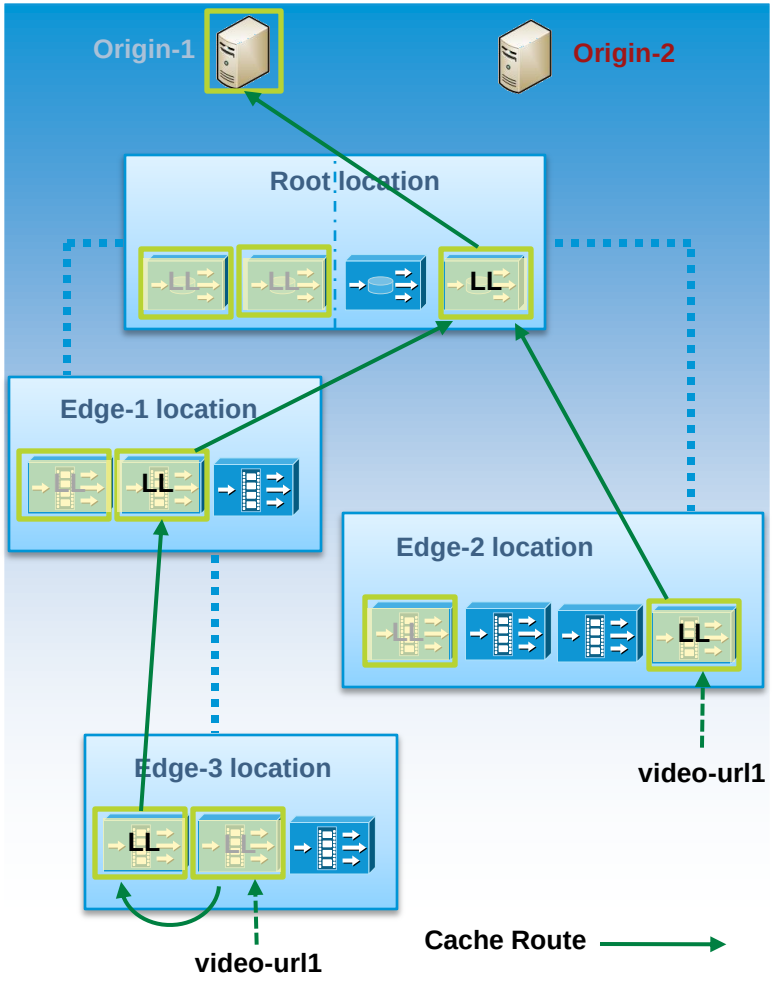
- Ingest via HTTP, HTTPS, FTP, CIFS, RTSP, FTP and Secure Distribution via HTTPS
- CDSM Delivery Service Configures:
  - Origin Server
  - Primary Content Acquirer
  - Streamers within Delivery Service
  - Pre-positioning Policy
- Multi-tenant Origin Servers Supported
- Multi-tiered Store and Forward Distribution
- Location Leader (LL) Ingests into Cluster for Local Replication
- XML Pre-Positioning Rules (API) Support:
  - Parallel Distribution via Intelligent Distribution Trees
  - OS Hot-Sync (Crawl) or Specific Item Enumeration
  - Time of Day Schedule, Bandwidth Limits
  - Distribution Priorities, QoS Markings



VoD Ingest and Distribution

Dynamic Ingest and Caching

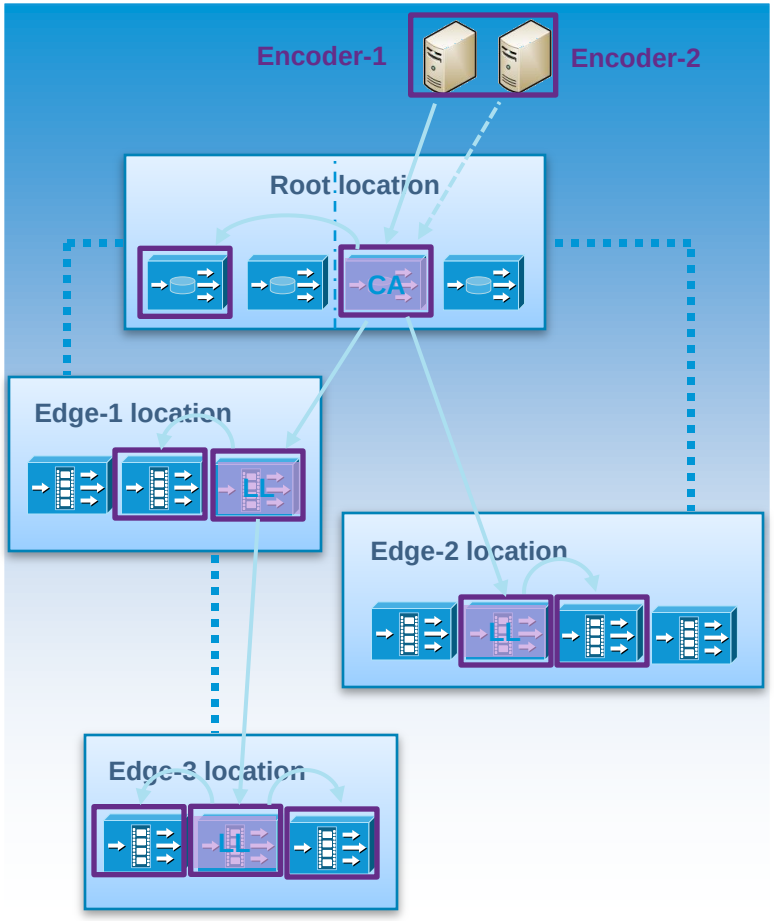
- Ingest Content upon CDN Cache-Miss
- Multi-tiered Popularity Based Caching
- Cache-Fill Routing from Parent Cache based on Content Affinity (URL Hash)



Live Programs

Stream Splitting

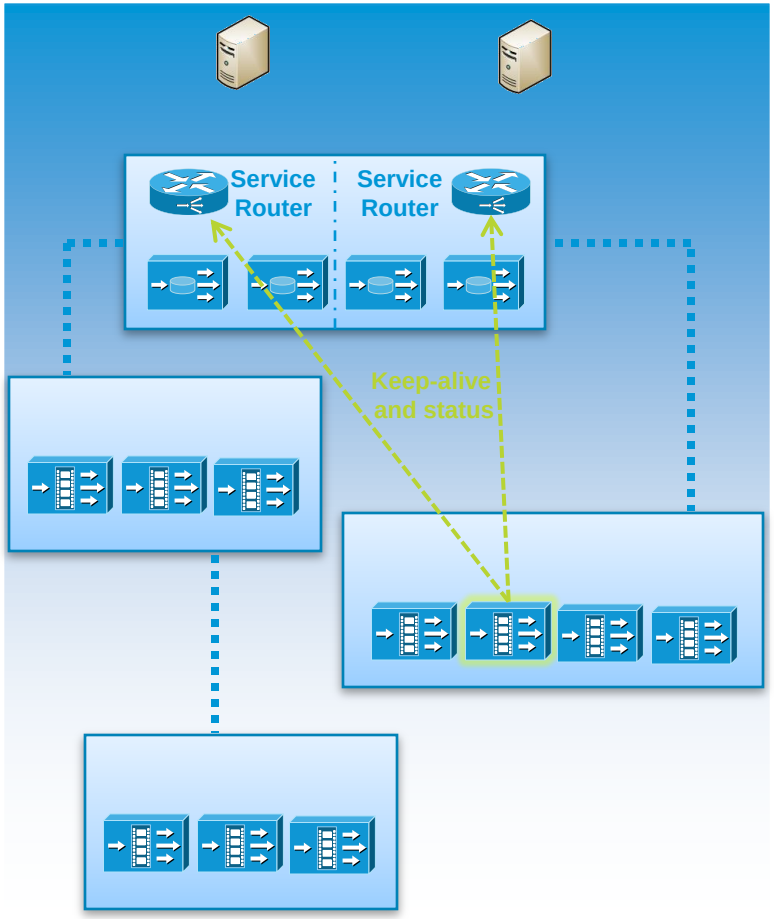
- Specialized Delivery Service for WM and MS Programs
  - Live and Rebroadcast
- Efficient delivery across locations, similar LL mechanism for pre-positioning
- On-demand or primed
- Unicast or Multicast delivery
- Play Forever or Scheduled
  - Program APIs



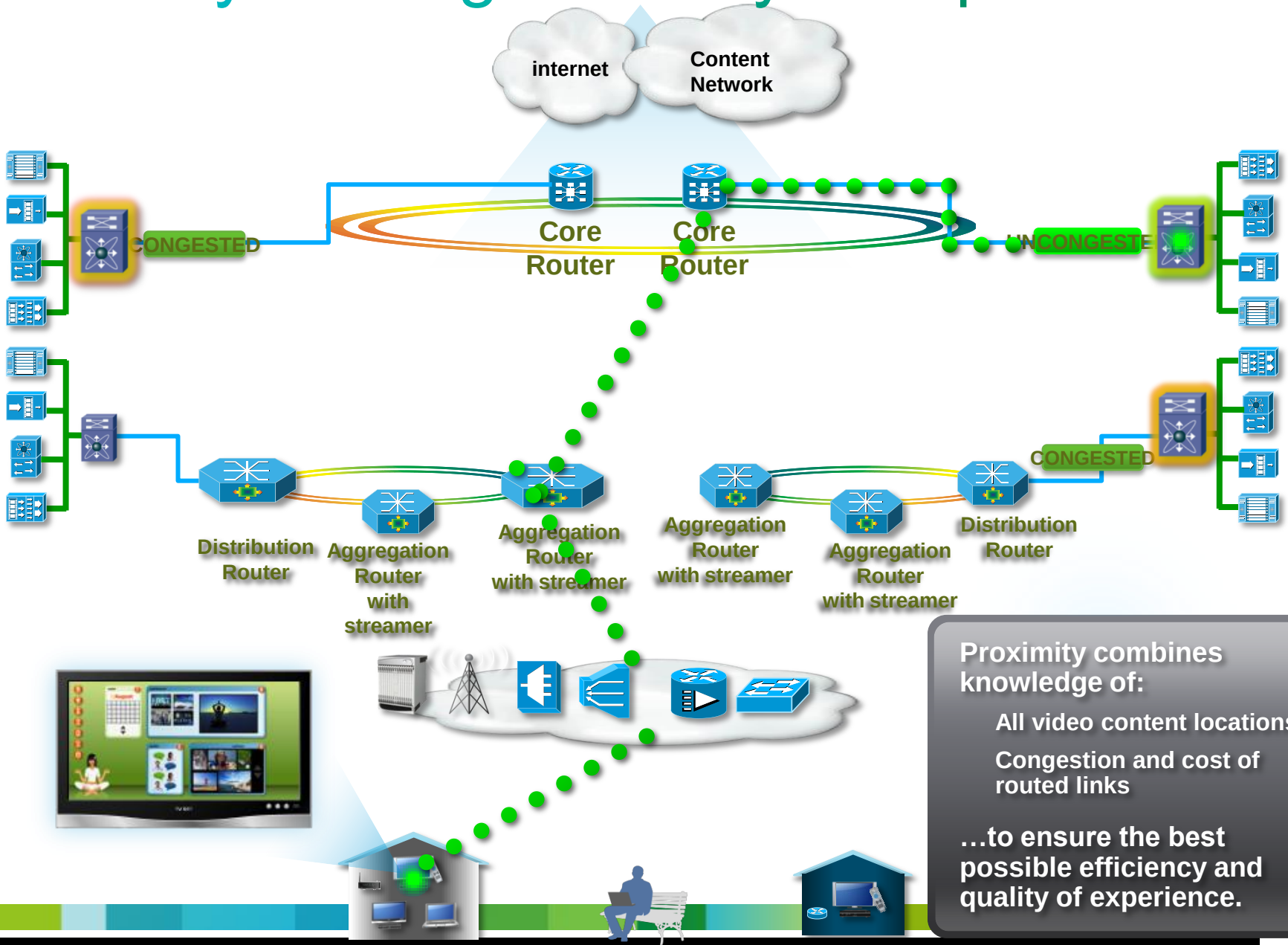
Service Routing

SR Functions

- Directs clients to most appropriate streaming resource
  - Stateless HTTP, RTSP, RTMP Load-balancing and Redirection
- Using:
  - Client IP address and/or location
  - Requested Content
  - Availability and Performance Information from Streamers
  - Streamer
- Streamer Keep-alive
  - Configurable/2-second default
  - Utilizations and thresholds – network, engine, memory, etc.



Proximity Routing & Quality of Experience

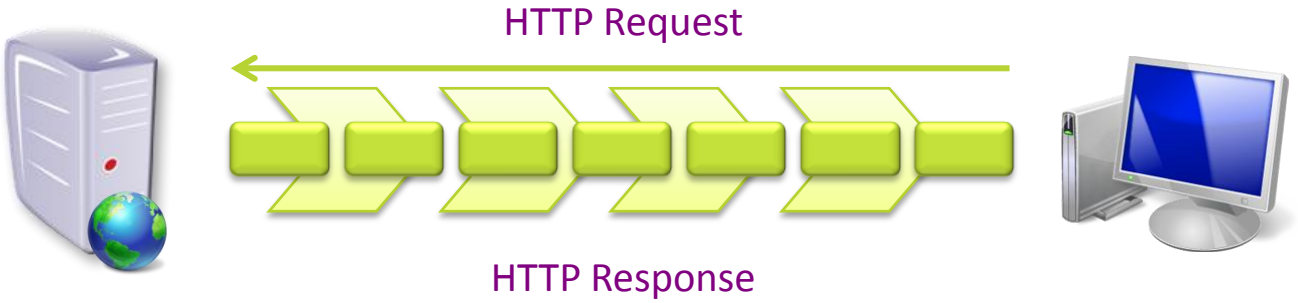


Proximity combines knowledge of:

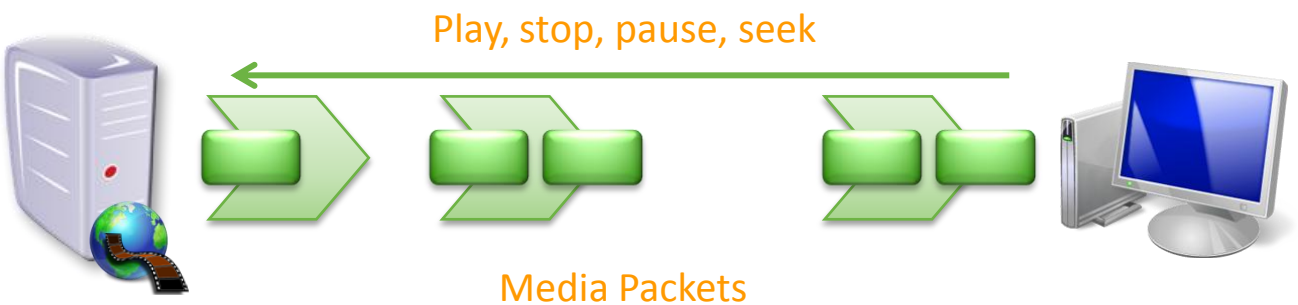
- All video content locations
- Congestion and cost of routed links

…to ensure the best possible efficiency and quality of experience.

Adaptive Streaming
Progressive Download vs. Streaming



Progressive Download



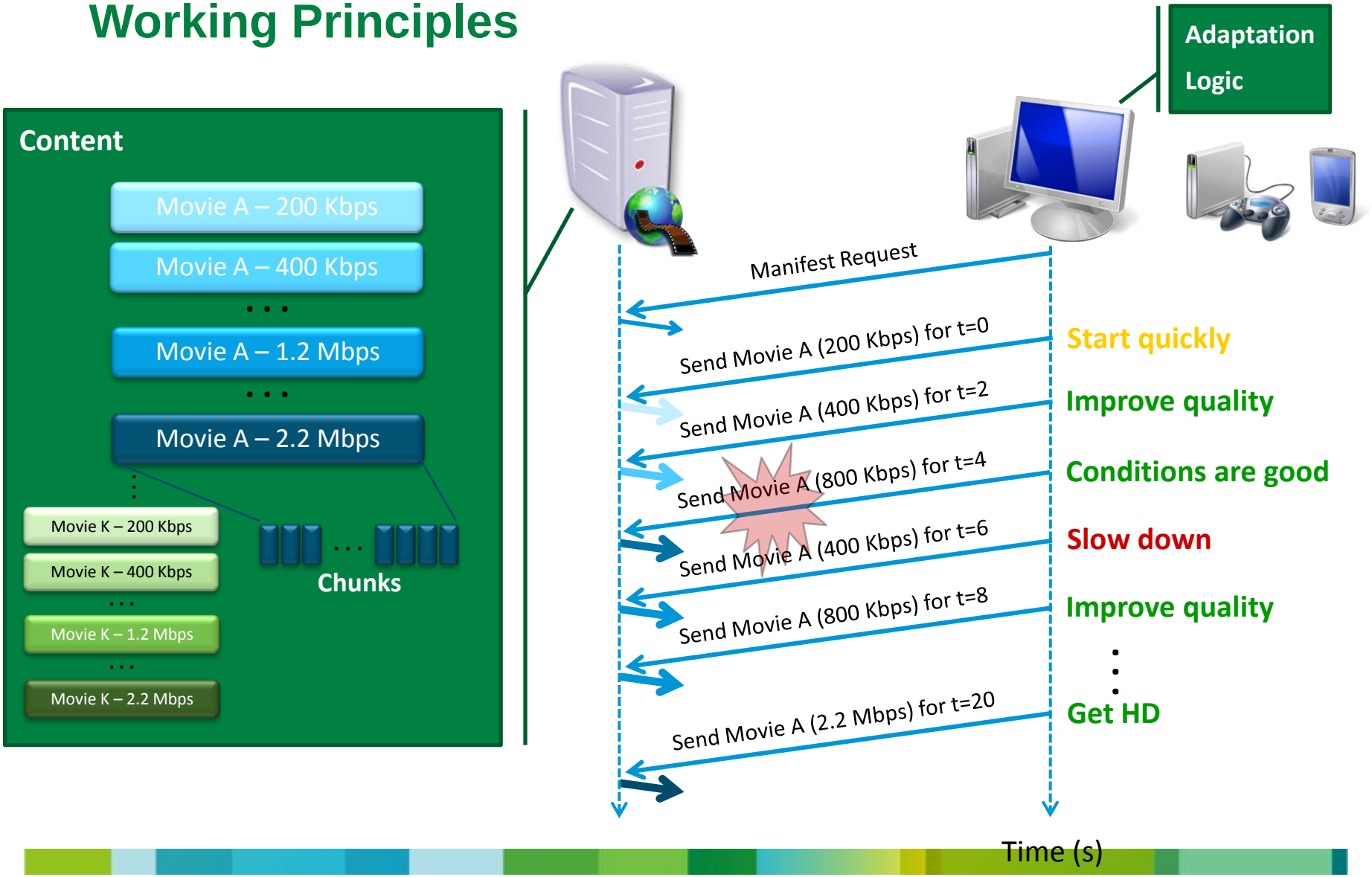
Streaming

Adaptive Bit Rate / Adaptive Streaming
Features

- **A Hybrid of Progressive Download and Streaming**
  - Imitates streaming via short progressive downloads
    - Clients download progressively in small chunks so bandwidth is not wasted
    - Clients stream so we can monitor consumption and track them
- **Use of HTTP**
  - Provides easy NAT traversal
  - Leverages existing HTTP caching infrastructure (Cheaper CDN costs)
- **Adaptation to Dynamic Conditions and Device Capabilities**
  - Adapts to dynamic Internet conditions and home-network contentions
  - Adapts to display resolution, CPU and memory resources
- **Improved Quality of Experience**
  - Enables faster start-up, seeking and quicker buffer fills
  - Reduces skips, freezes and stutters

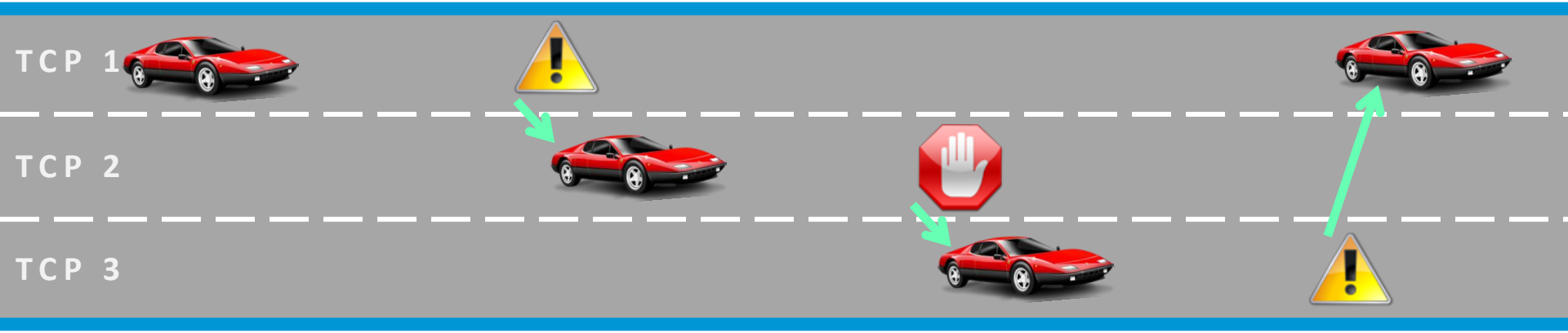
ABR/ Adaptive Streaming

Working Principles



ABR/ Adaptive Streaming with Multiple TCP Connections

Similar to Driving on a Multi-Lane Highway

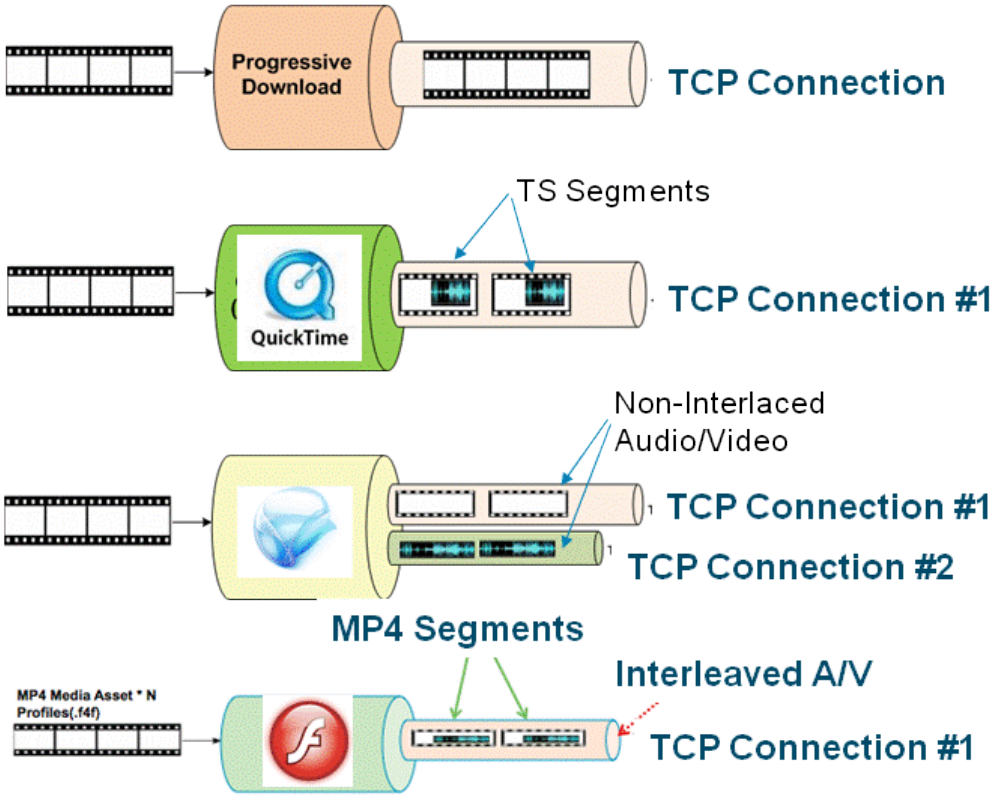


Using multiple concurrent TCP connections helps mitigate the HOL blocking and allows to fetch multiple (sub-)fragments in parallel

HOL : Head-of-line

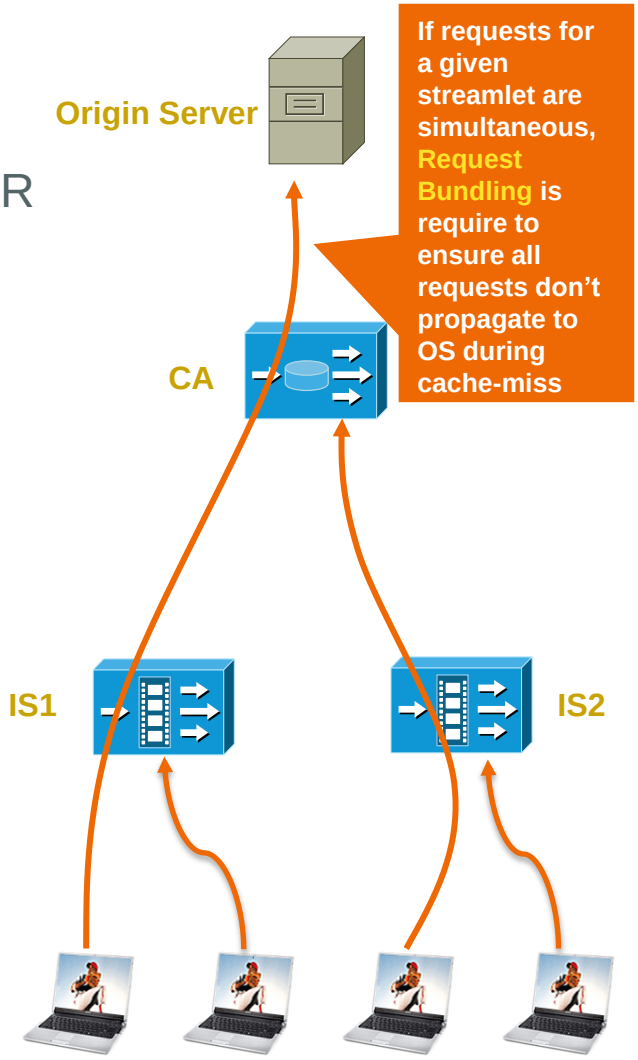
Adaptive Bit Rate Streaming and CDN Considerations

- Small Object Cache Throughput Optimizations
  - Small objects written to memory, delayed write to disk
  - Large objects continue to be cached on disk
  - SSD support and optimizations
- Live ABR and Client Request Optimizations
  - Request Bundling
  - Range Request Caching
  - Client/Streamer Affinity (Content Affinity)
  - Application Security Support
- HTTP Protocol Tuning
  - (Client) Keep-alive Headers
  - Cache control Headers

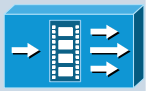
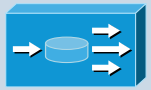


ABR Performance Optimizations with CDS

- Optimized TCP connection handling
  - Scaling to support the *large # of connections* for ABR
- Optimized HTTP transaction handling
  - Scaling to support the *high transaction rate* of ABR
- Optimized Caching
  - Intelligent cache fill and data source selection to provide *fastest possible response time*
- Request Bundling
  - For live streaming, on cache-miss aggregates multiple cache-fill requests for same content into a single request from next cache-tier or Origin Server



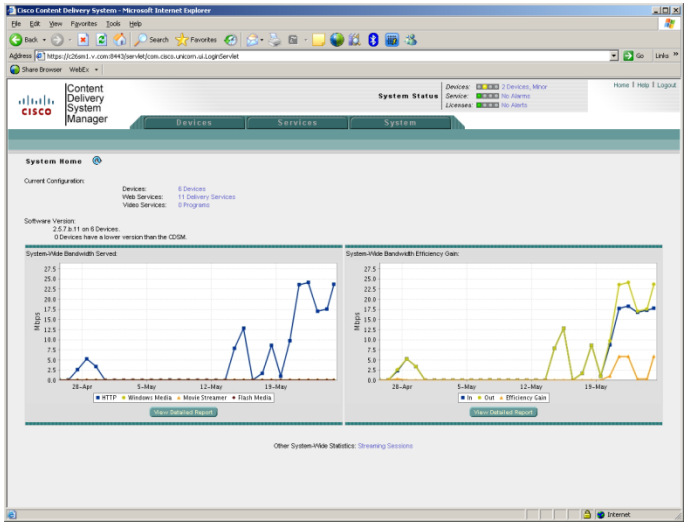
Resiliency and Failover

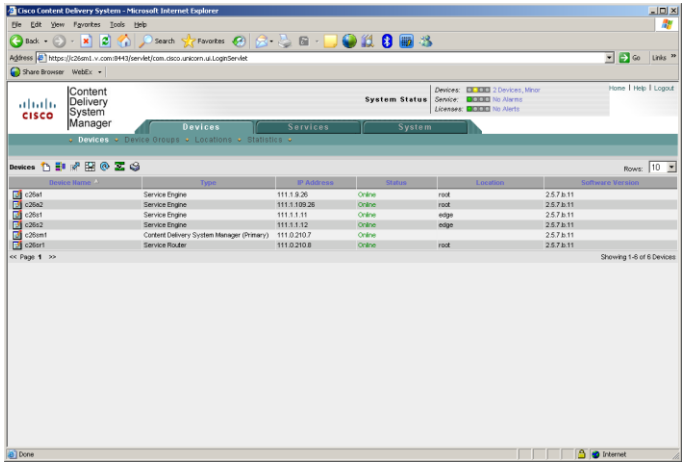
Node	Recovery Mechanism
Internet Streamer 	Keep-Alive heartbeat monitored by SRs. SR will stop forwarding new requests to down node. If LL, new LL election.
Service Router 	DNS Servers detects non-responsive SR. Other SR(s) can respond and provide SR functions.
Content Acquirer 	Pre-Positioning: Peer(s) periodically check health, take over per configuration. Dynamic Cache: new cache route calculated.
CDS Manager 	Primary/Standby, automatic synchronization. Primary failure, continued system operation Operation controlled failover to restore management

CDS Manager

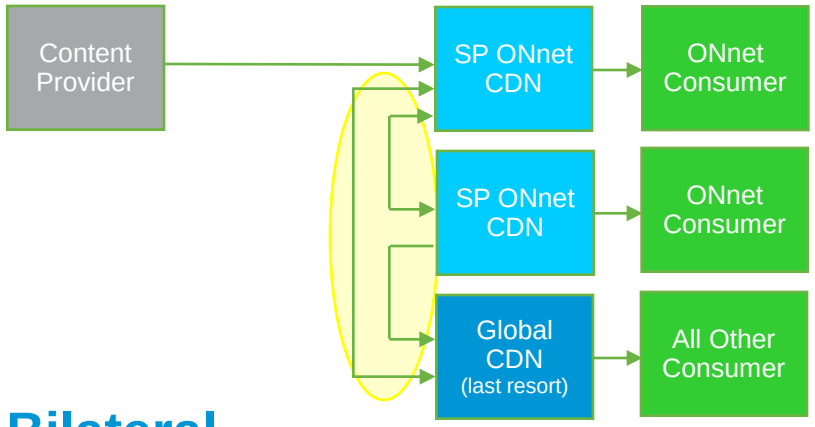
Continuous non-stop operations center

- Browser-based UI for CDN operations
- Implement Locations and Levels
- Configure and manage all Streamers, SRs, and CAs
  - Device Groups
- Configure and manage Delivery Services and programs
- Statistics and Reports
- Alarms
- Managing Content
- Software Management
- User Management

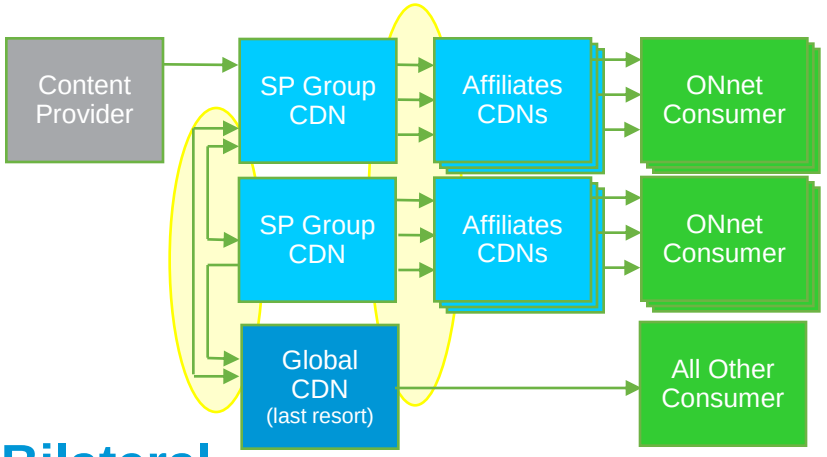




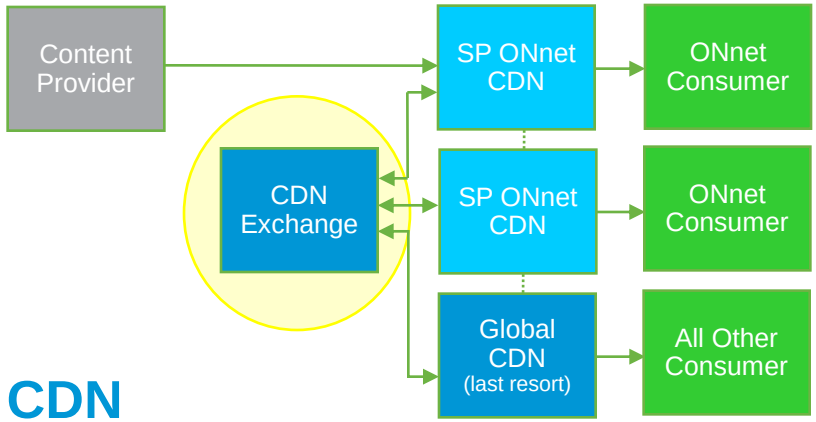
CDN Federation models



Bilateral Agreements

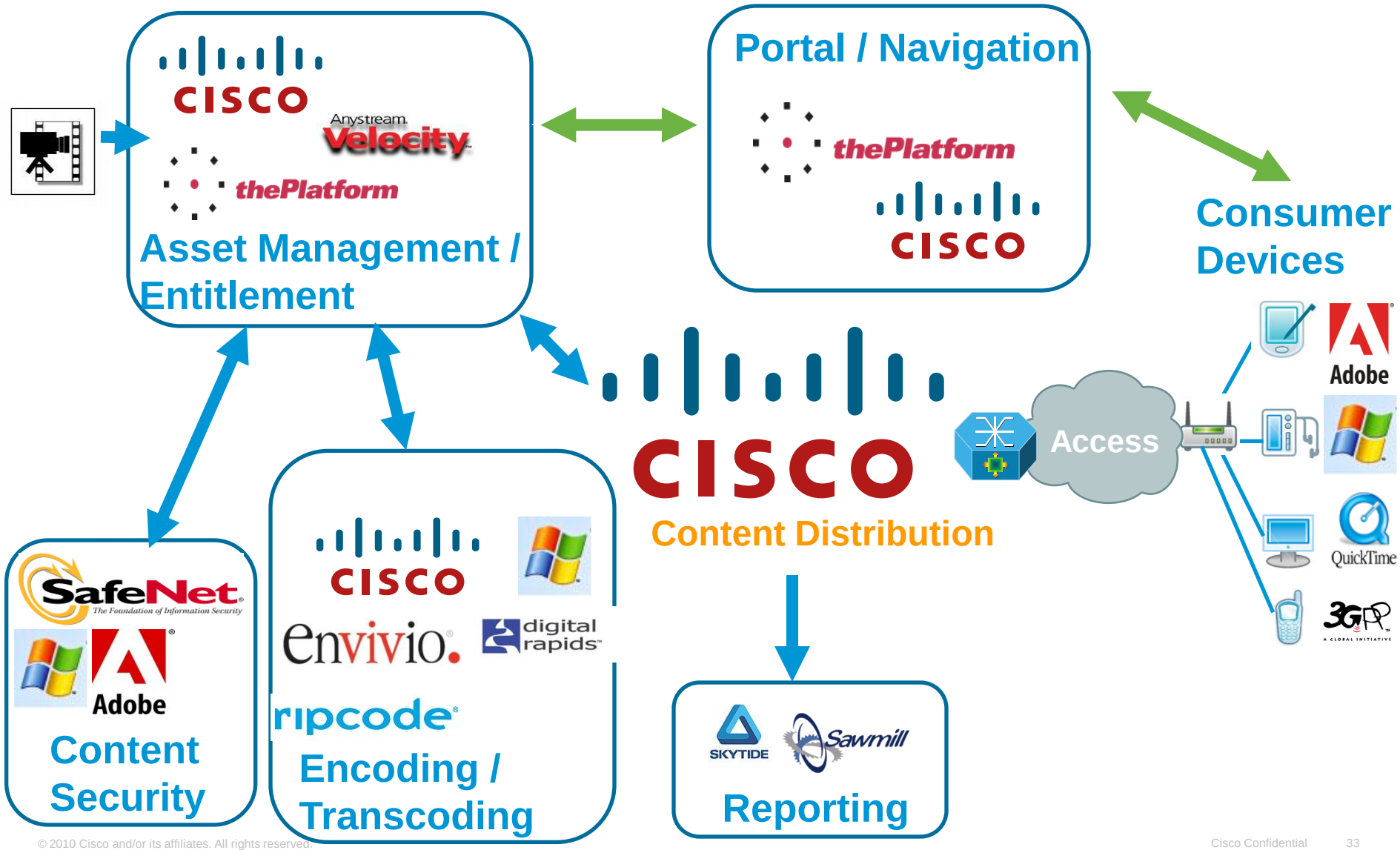


Bilateral, Hierarchical Agreements



CDN Exchange

Cisco CDS Open Ecosystem



Summary

Key Take Aways

- With growing online video quality demand fueled by new connected screens and user experience and quality, content providers are increasingly looking at regional video CDN providers
- Key considerations when designing/building a CDN.

  There is increasing value in an SP's building their own CDNs – Public/private CDNs are not enough – tieing into the infrastructure

  Cooperation with CPs and SPs

  CDN success is about a foundational end-to-end network-based content enabled, flexible, scalable and open CDN architecture that can sustain quality of experience and service differentiation
- Cisco CDS Deployed by 4 of the top 5 SPs in Europe, including BT & TI
- Cisco CDS provides industry-tested and recognized CDN solutions foundational to Cisco Videoscape

Thank you.