VoD (Arroyo) Overview

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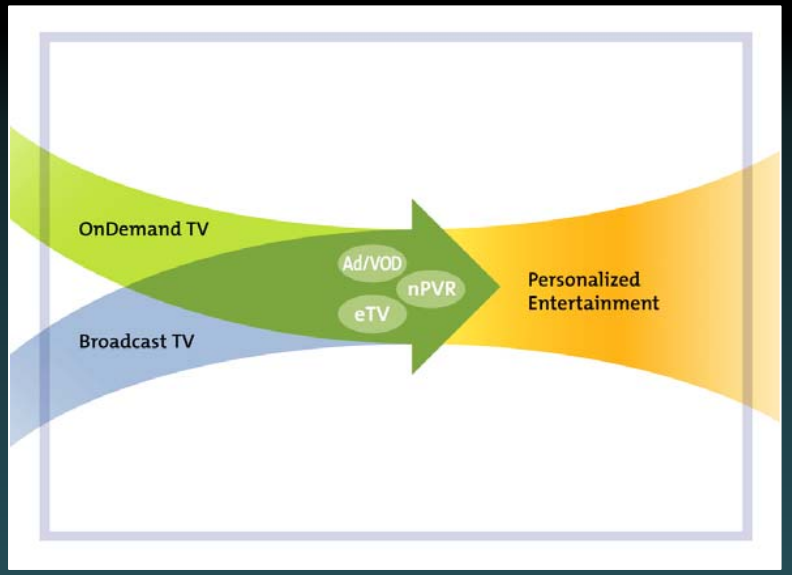
Arroyo Now Part of Cisco Video & Content Networking BU (VCNBU)

- Timeline
  - 2002: Founded
  - 2004: Field trials
  - 2005-2006: Production deployments serving 1M streams/month
- Strong customer base
  - 11 deployments at 6 of North American top 10 MSO's
  - VOD and nPVR trials in other top Telco's and MSO's
- Impressive networking heritage
  - Paul Sherer – CTO (former CTO of 3Com)
    - Originated many current Ethernet technologies/standards
  - Drew Major – Chief Scientist (author of Novell Netware)
    - Pioneered "networking operating system" and "many as one"
    - Now a Cisco Fellow

Personalized Entertainment

Blend of On-Demand and Broadcast Content Delivery

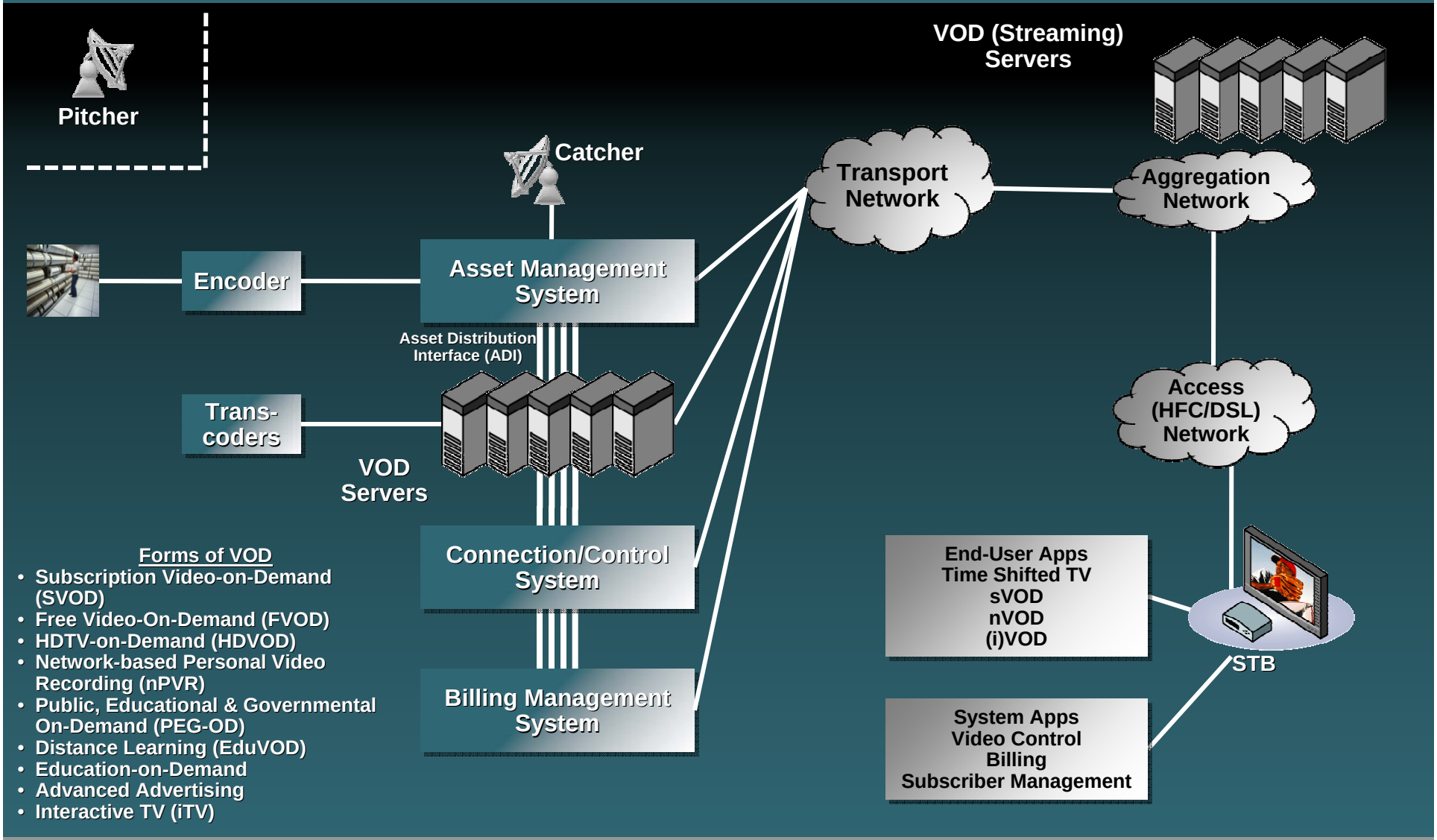
- On Demand TV is top selling MSO service & table stakes for telco IPTV offering
  - Driven by host of new applications
  - Comcast delivered 1.5B streams in 2005
- Broadcast TV becoming more "personal"
  - New "Broadcast" applications are driving this further
- Puts a host of new demands on the video platform



New Video Platform Demands

- *Real-time ingest rates*
- *Massive stream scale*
- *Flexible content distribution*
- *High availability*

Typical VOD System



Forms of VOD

- Subscription Video-on-Demand (SVOD)
- Free Video-On-Demand (FVOD)
- HDTV-on-Demand (HDVOD)
- Network-based Personal Video Recording (nPVR)
- Public, Educational & Governmental On-Demand (PEG-OD)
- Distance Learning (EduVOD)
- Education-on-Demand
- Advanced Advertising
- Interactive TV (iTV)

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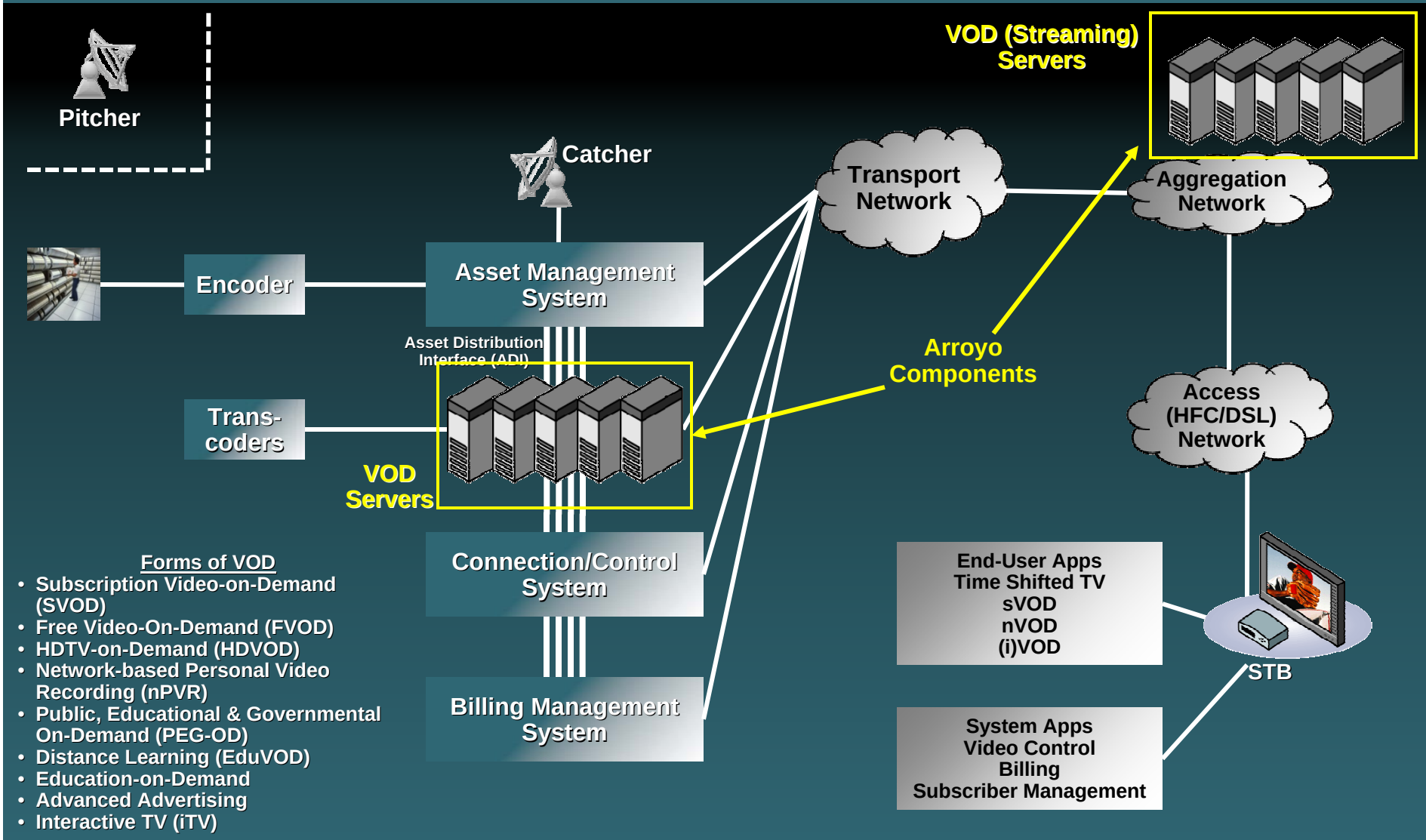

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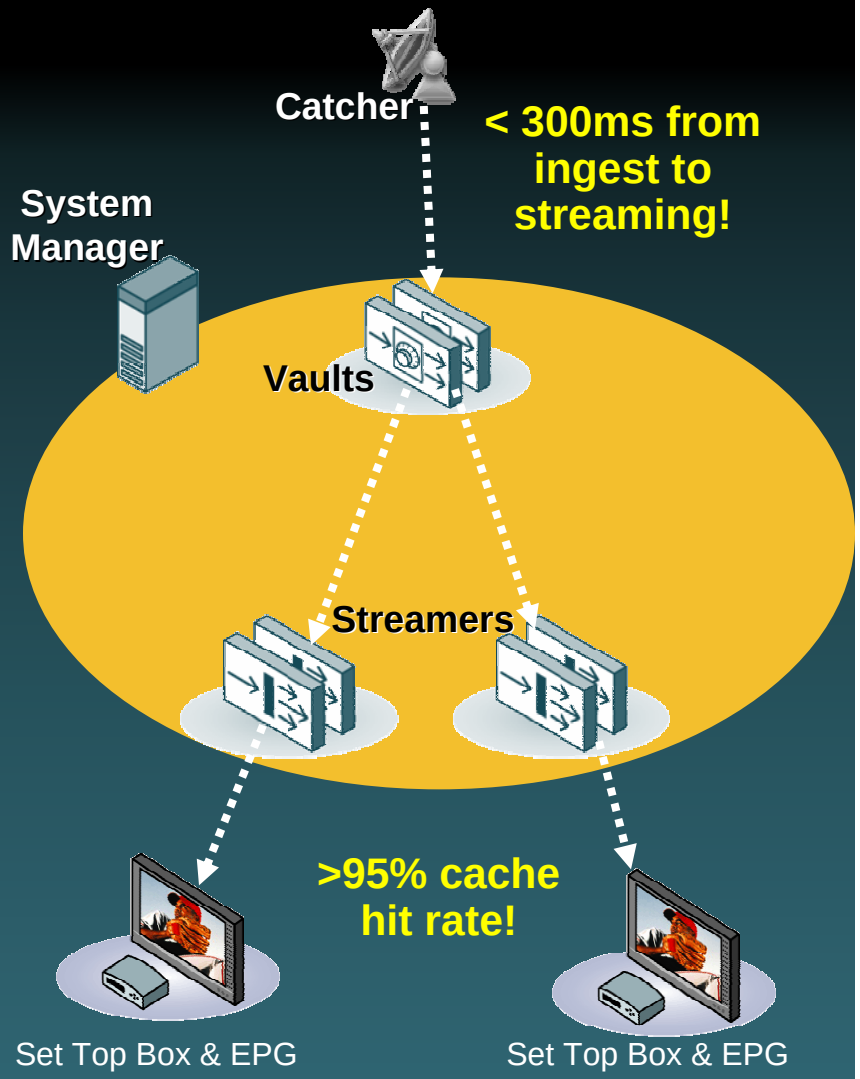
Cisco Content Delivery System (CCDS)

Next Generation Application & Media Processing Platform

- "The network is the platform"
  - Internet-proven approach
- Distributed architecture
  - Hierarchical network storage
  - Streaming at the network edge
  - Multi level cache
- CCDS Elements
  - Vault
    - Ingest & reliable storage of video (or other) assets
  - Streamer
    - "Personalized" video streaming
    - Pulls content from Vault on demand & caches at network edge
  - System Manager
    - Element Management System
    - Single system manages all of CCDS

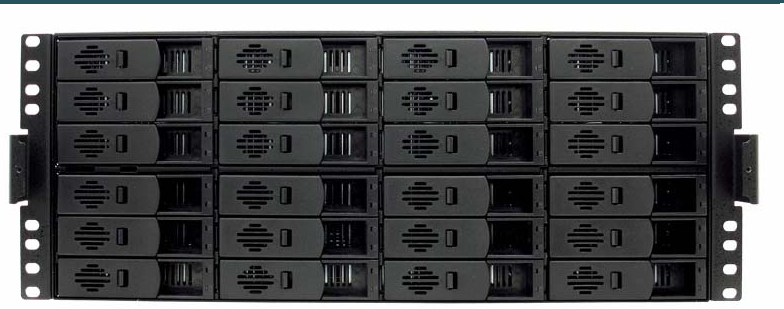


CCDS Products

- Content Delivery Engines (CDEs)
  - Appliances for Vault and Streamer applications
  - 4 types:
    - 4U SATA, 3U SCSI, 2U SATA, 1U System Manager
  - Purchase includes base CDA license
- Content Delivery Applications (CDAs)
  - 1 software application per appliance
  - 4 types:
    - Vault, Streaming, SSV (mixture of vault & streaming), “Play-Out” application (e.g. for barker channel)
- License Upgrades
  - Additional S/D Stream Licenses
  - Stream resiliency option
  - Vault upgrade, additional hours S/D
  - Playout, NVOD, Barker application

Content Delivery Engine Specifications

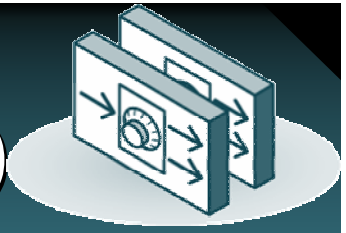
- 4U SATA Appliance
  - For Vault & SSV
  - Up to 12 TB of content storage
    - ~6000 hours MPEG2
  - 16 GB DRAM
  - ~1 Gbps simultaneous ingest
    - ~200 channels MPEG2
  - 6 Gbps output
    - Rapid re-mirrors
- 3U SCSI Appliance
  - For Streamer & Playout
  - 12-24 Gbps output
    - Up to 6000 streams MPEG2
  - 1.7 TB of SCSI cache
  - 16 GB DRAM



Content Delivery Engine Specifications

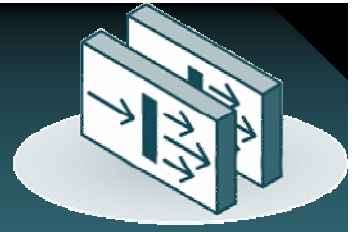
- 2U SATA Appliance
  - For Vault & SSV
  - Up to 6TB of content storage
    - ~6000 hours MPEG2
  - ~1Gbps simultaneous ingest
    - ~200 channels MPEG2
  - 6Gbps output
    - Rapid re-mirrors
- 1U SCSI Appliance
  - For Application System Manager
  - 4 GB RAM
  - 4 x 73GB SCSI drives
  - AC power

Vault Content Delivery Application (CDA)



- Content can be ingested via an Asset Distribution Interface (ADI) that includes asset data or via FTP
- Content ingestion is easy – each asset only needs to be ingested once and can be ingested at any location in the server group
- Content (video assets) are reliably stored on at least two of the vault servers
- Configured as an array of servers for reliability & scalability
- Arrays can be co-located or geographically dispersed
- Content distribution process
  - The first time a title is requested by a subscriber it is delivered from the Vault to the Stream Array serving that subscriber
  - At the same time it is cached so that subsequent viewings by any subscriber serviced by that array are satisfied locally
  - OnDemand handles content as a series of short segments, so the only data moved around the network are the portions actually viewed
    - Unlike other VOD solutions which waste bandwidth by transmitting entire titles even if the requesting subscriber ends up only watching part of it
  - There's no need to predict what titles subscribers will watch more than others and preemptively push them to the network edge
- Trick play modes are created upon ingest – this means trick play resource usage is the same as normal usage i.e., thousands of users could all hit Fast-Forward at the same time

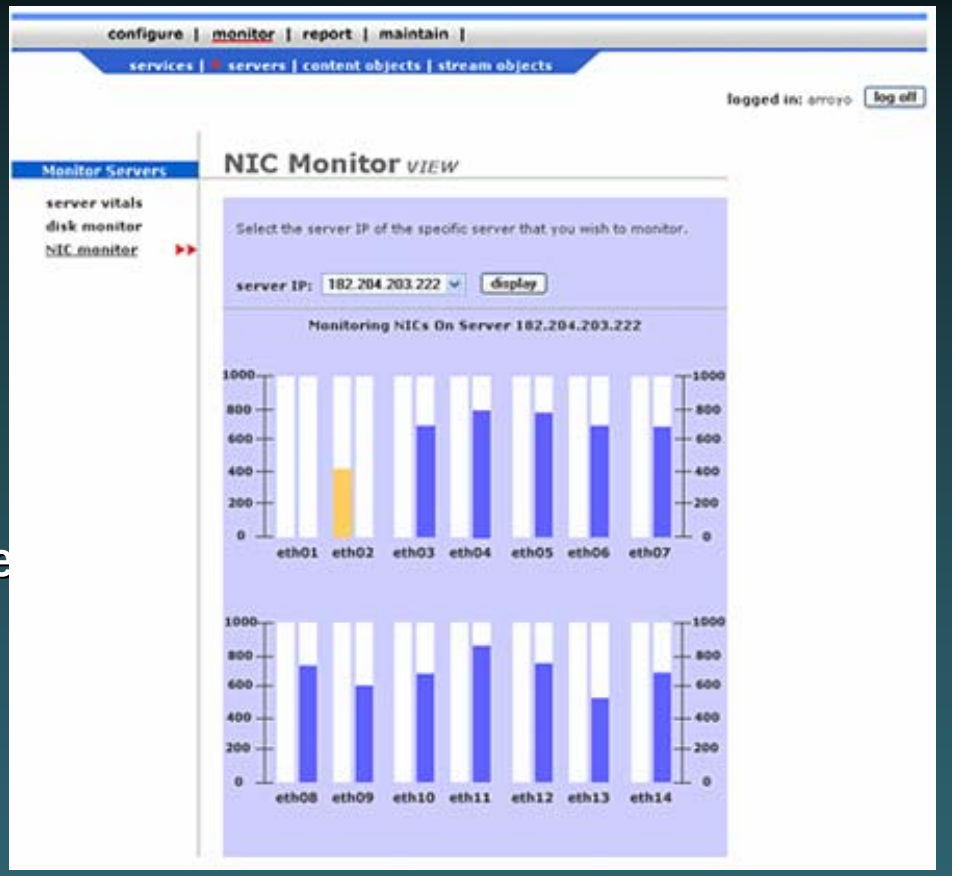
Stream CDA



- Streamers respond to user requests for VOD streams
- Content is distributed and cached in 8 KB segments
  - Rather than download an entire movie when a user requests a title, only the segments that are needed are distributed and cached
  - Streamers easily support personalized content e.g., inserting targeted advertising, and playing that content out (not) under subscriber control
- Streamers can be co-located with Vault Servers or distributed to remote locations
- Configured as an array of servers for reliability & scalability
- Arrays can be co-located or geographically dispersed
- Load balancing is also automatic; content is replicated and stream assignments are determined based on the shared state of the array

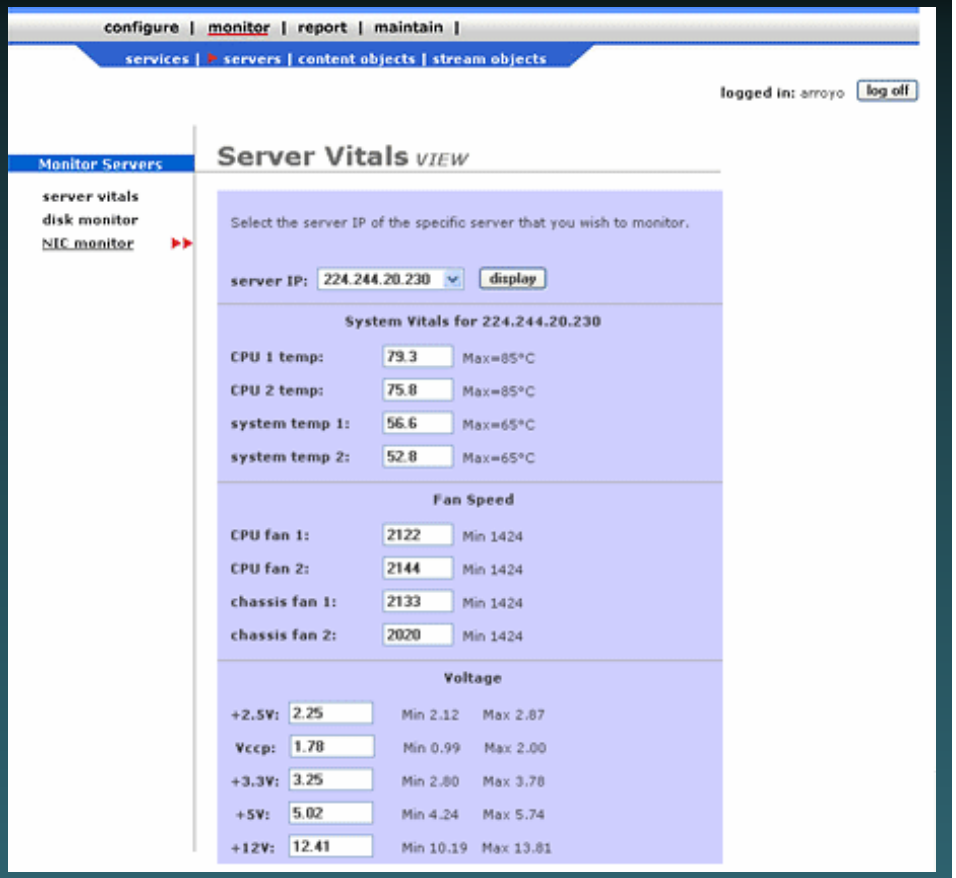
Content Delivery Management System

- The Content Delivery Management System (CDMS) has a GUI interface accessible via browser
- The CMDS network functions as a single virtual server that is extremely easy to manage
- As servers are added they self-configure so that storage and streaming capacity are automatically load balanced ensuring that network resources are always available exactly where they are needed
- When a disk is added to a server or a server is added to the network it contributes storage and/or streaming resources to the pool

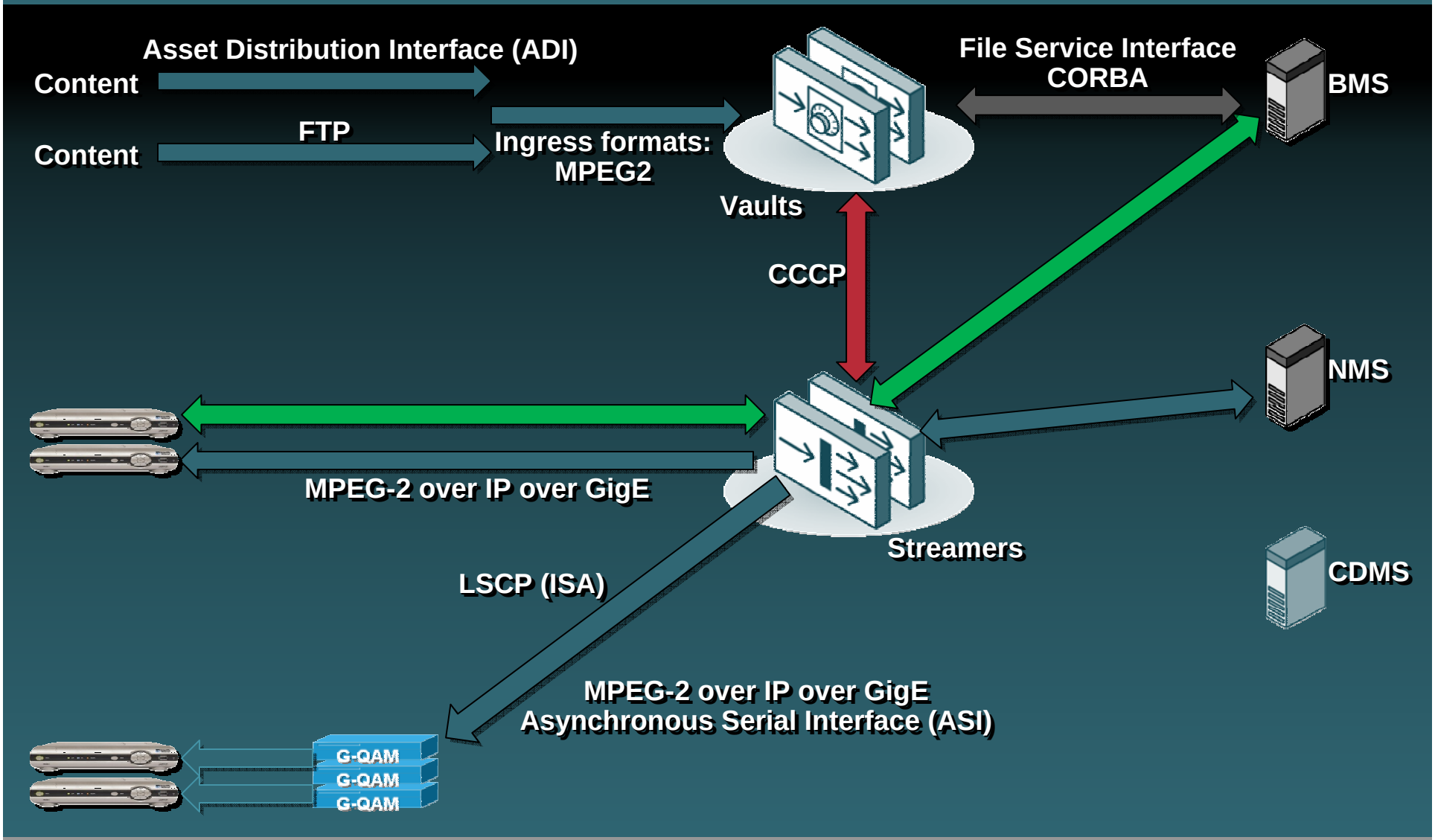


Content Delivery Management System

- CDMS is designed to be flexible:
  - It is simple enough to manage a small deployment,
  - while also being sophisticated enough to scale to manage a large complex service provider network
- CDMS uses a workflow-based approach, automating and centralizing the major system management functions:
  - Configuration
  - Monitoring
  - Troubleshooting
  - Reporting
  - Maintenance



Protocol Interfaces – TWC Example



3rd Party VOD System Interfaces

Streaming

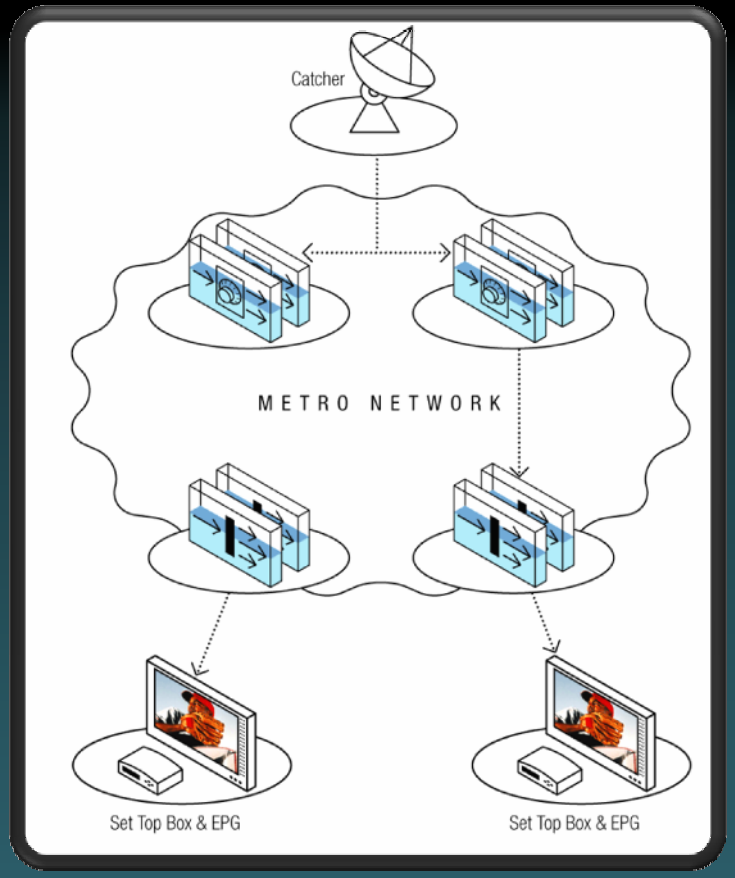
Partner	Session Control	RT Control
Openstream for SA and Mot environments	ISA CORBA	LSCP
TWC ISA Environment, Mot and SA	ISA CORBA	LSCP
CCOR nAble for Mot/SA	ISA CORBA	LSCP
NGOD	ISA CORBA	RTSP (Mot), LSCP (SA)
CV NPVR	SSP 2.3, ISA CORBA	LSCP
Myrio TotalManage	RTSP	RTSP
Shaw NPVR	RTSP	LSCP

Asset Ingest

Partner	Control	Transport
ISA (Openstream)	CORBA	FTP
nABLE	XML	FTP
Condo nPVR	XML	MPEG SPTS
NGOD	NGOD A3 (XML)	FTP
Myrio VOD	XML	FTP
Myrio nPVR	XML	MPEG SPTS
Verimatrix (IPTV CA/DRM)	SOAP	AnyIn/SambaFS
Manual ingest	AIM	Tape/DVD/CD

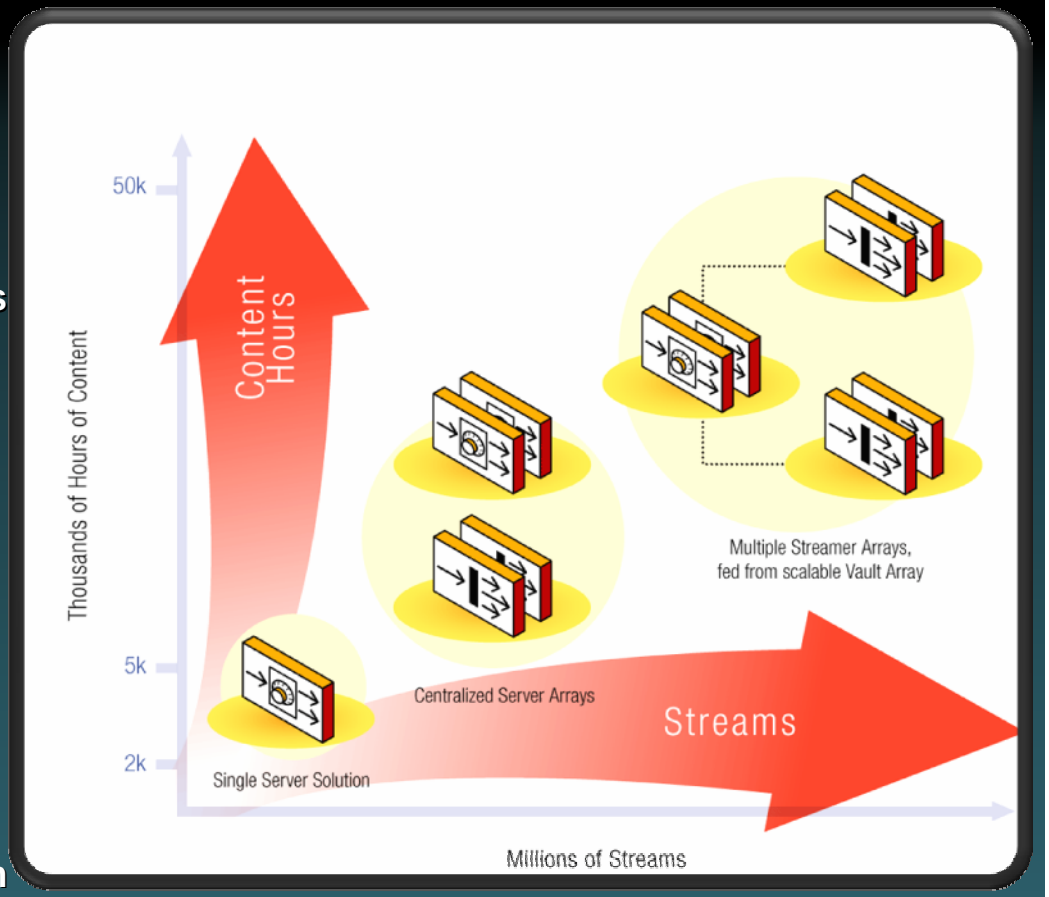
CCDS Network Load Leveling

- Services are distributed and load-leveled across the array
  - Multiple servers function as one logical array
  - Services are distributed across the network
  - Applications can be added without disruption
  - Expand without disruption – servers once configured, will broadcast their capabilities and join the array
- All functions are load-leveled
  - Ingest
  - Storage
  - Streaming



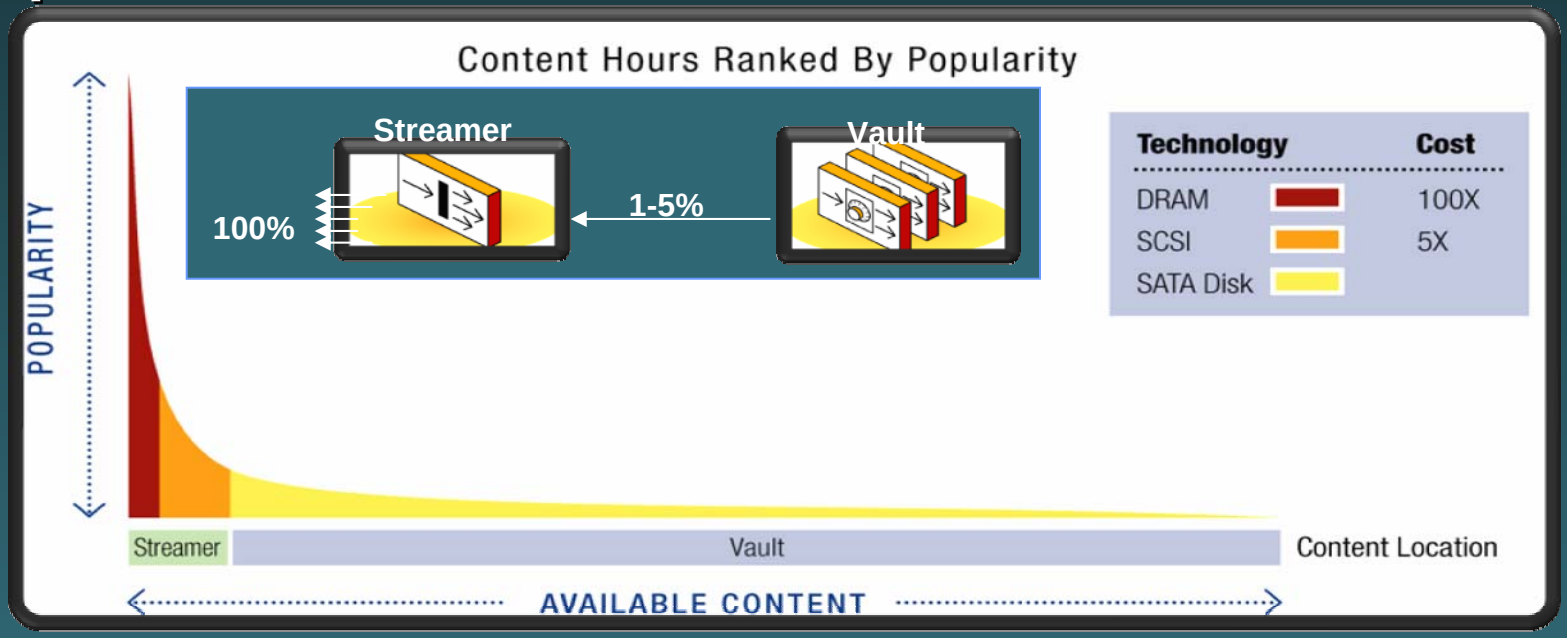
Non-disruptive, Cost-effective Scalability

- Adapt to your needs
  - Start centralized & evolve
  - Add adjacent markets by simply adding a streamer
  - Content from a single ingest point is available throughout the array
- System & Bandwidth Scaling
  - Systems optimized for unmatched performance
  - Load is distributed throughout an array
  - Extensible platform software architecture
- Distributed streaming
  - Save $25-200/stream on aggregation network bandwidth costs
  - Distribute rack space use



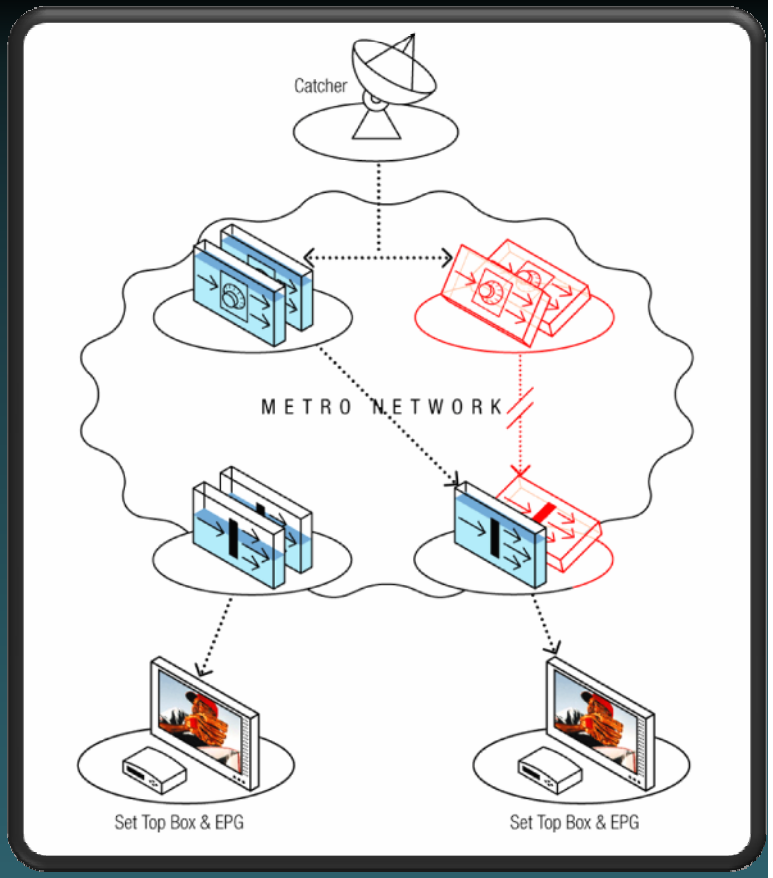
Content Distribution Algorithms

- Minimize total storage cost – DRAM, SCSI, SATA
- Minimize OpEx – content management, streamer disk cache
- Optimize Network Utilization – offer more content

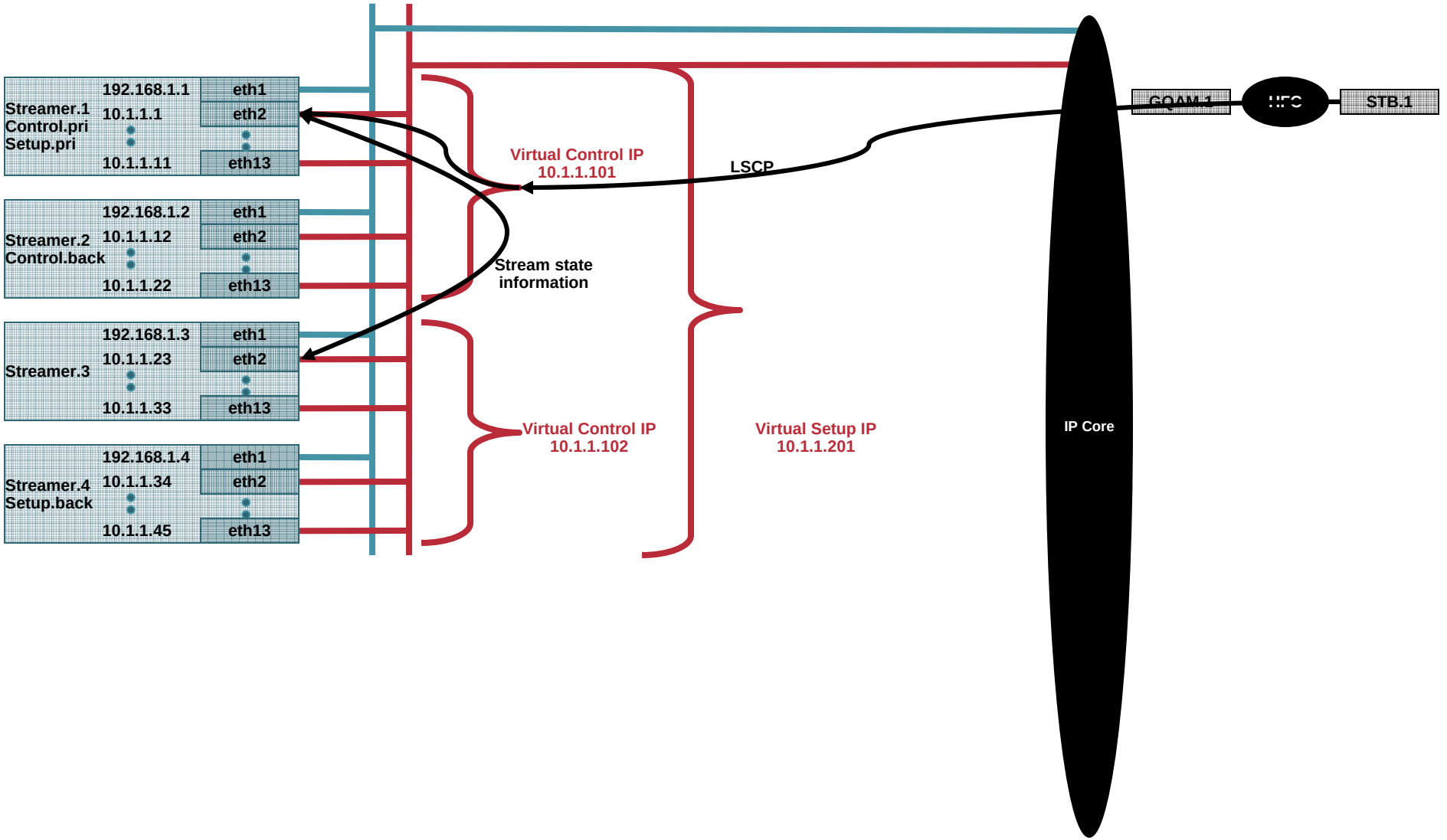


CCDS Availability

- There is a stateful switchover in the event one of the systems in the array goes out of service which means
  - Software upgrades can be performed without disruption
  - Trickledown – servers can be gracefully shutdown for upgrade by having the system stop sending new streams to that server
  - "Stream steering" allows you to move the streams manually for a faster (yet still graceful) shutdown of a server
- Content is never lost – there are duplicate copies in the array and when a server, disk, etc. is OOS the content it hosted is replicated elsewhere in the array
- The level of resiliency for content and services is operator configurable i.e.,
  - You can configure how many (backup) copies of an individual piece of content are stored in the array
  - The number of stream and/or vault servers can be increased as desired for M:N redundancy
- If a server loses capacity e.g., loses a network interface, it dynamically informs all other servers in the array to take over the streams it was serving off that interface



Switchover Process for an Active Stream Following a Streamer Switchover



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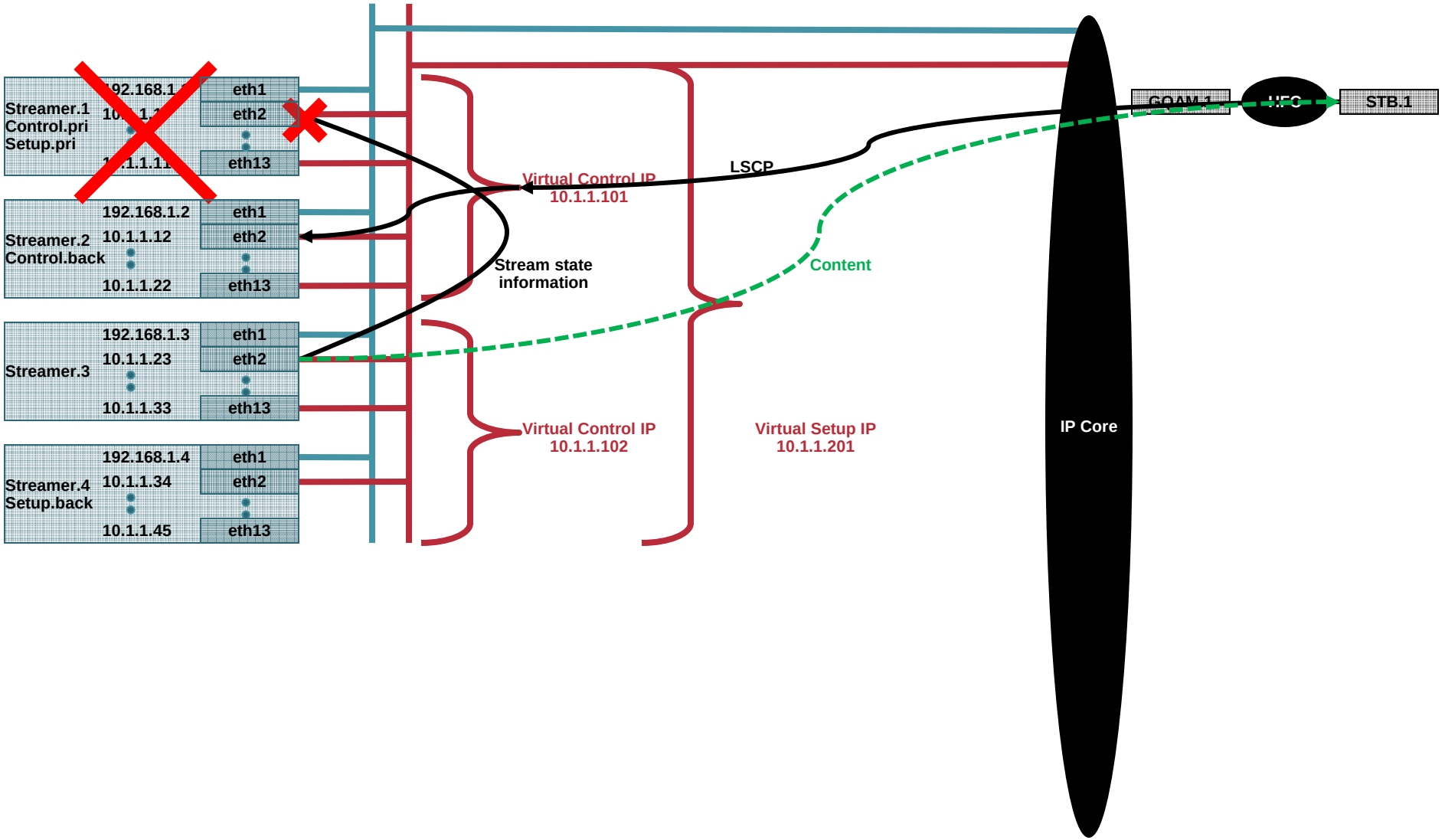

Q & A