SDN orchestration across single converged networks for uncompressed and compressed media flows

Thomas Gunkel



dataminer











CASE STUDY - RALWAY

- Italian state-owned telecommunications and broadcast company
- TV (DVB-T2) and radio (FM, DAB+) transmission services for RAI and local broadcasters
- operates fiber network (6200 km) for contribution and distribution
- 2300+ DTT transmission sites
- DTH satellite infrastructure with footprint in Europe, Middle East and Africa
- multiple NOCs

Rai Way

SHOWCASE





THE "IP MATRIX" PROJECT





CUSTOMER ARCHITECTURE



PSHOWCASE[®]

HIGH-LEVEL ARCHITECTURE





converged RED & BLUE network

non-blocking spine-leaf at each location blocking (capacity-constraint) WAN connections

DEPLOYMENT - SECURE ONBOARDING (IP SHOWCASE

Infrastructure Discovery & Provisioning (IDP) \bigwedge \bigcirc \bigcirc \sim provisioning discovery software $\langle \rangle$ update automatic managed creation of objects scanning and integration upload of software detection of with 3rd-party zero-touch images to managed databases provisioning resources elements **NMOS** IS-04

CI-TYPES (CONFIGURATION ITEM)

- defines
 behavior &
 properties for
 each
 configuration
 item type
- not limited to switches

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0a	🔀 DataMiner IDP 🗙								
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			Imagine SNP	Edit					
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			Magic DAB Encoder	Edit					
			Magic DAB MUX	Edit					
			Meinberg Lantime M3000	Edit					
			TestTree StreamProbe	Edit					

SHOWCASE

CONNECTIVITY DETECTION

(IP SHOWCASE

- automatically detects physical network connectivity
 - Arista: LLDP
 - Cisco: CDP
- option to import connectivity via external topology DB





AUTO-PROVISONING / FW / CONFIG

- new elements are automatically added to DataMiner
- connector (w/ version)
- firmware upgrade
- base configuration
- alarm and trend templates

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System Description System Description Cisco NX-OS(tim) roos.9.3.7.bit, Software (roos.). Version 9.3/b, RELEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RELEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RELEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RELEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RELEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RELEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.3/b, RelEASE. SOFTWARE Copyright (p. 202-202) the full state (roos.). Version 9.	MM-HE-CS12-LEAF1 MM-HE-CS12-LEAF1 MM-HE-CS32-LEAF1 MM-HE-CS32-LEAF2 MM-HE-CS33-LEAF2 MM-HE-CS33-LEAF2 MM-HE-CS33-LEAF2	GENERAL INFORMATION	_	HISTORY – TOTAL PROCESSOR LOAD – 24 HC	DURS
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(IP SHOWCASE

FOR THE USER

- set up a complete service chain with a few clicks
- support compressed & uncompressed flows on same user interface
- one connection is more than a simple x-point

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RADIO 2 - CLASSICA	DISTRIBUTION	RADIO 2 - CLASSICA - ISORADIO	AS-IG	CONSEGNE RAI	SDI		MM-HE-HE1-ENC-B1-IN2 MM-HE-HE1-ENC-B1-IN3	RAI NEWS B	Connected			
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RAUTHD M	DISTRIBUTION	RAI 1 HD	SX-100	CONSEGNE RAI NAZ	SDI		MM-HE-HE1-ENC-B2-IN6	RAJ 3 RM B	Connected			
RAJ 2 DTH M	DISTRIBUTION	RAI 2 DTH	SX-100	CONSEGNE RAI EST	SDI		MM-HE-HE1-ENC-B2-IN8					
RAJ 2 DIT B RAJ 2 DIT M	DISTRIBUTION	RAI 2 DIT RAI 2 DIT	SX-266 SX-100	CONSEGNE RAI NAZ CONSEGNE RAI NAZ	SDI		MM-HE-HE1-ENC-M1-IN1 MM-HE-HE1-ENC-M1-IN2	RAU 1 HD M RAU 2 HD M	Connected			
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RAI 3 CA B RAI 3 CA M	DISTRIBUTION	RAJ 3 CA RAJ 3 CA	SX-200 RM-SM	CONSEGNE RW REG	SDI		MM		• • • • • • • • • • • • • • • • • • •			
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RAI 3 CS B RAI 3 CS M	DISTRIBUTION	RAI 3 CS RAI 3 CS	SX-266 RM-SM	CONSEGNE RW REG CONSEGNE RW REG	SDI SDI		MM		SNP Chassis SX-100-SNP1		SNP Chassis MM-HE-SNP1	
RAI 3 DTH B RAI 3 DTH M	DISTRIBUTION	RAI 3 DTH RAI 3 DTH	SX-266 SX-100	CONSEGNE RAI EST CONSEGNE RAI EST	SDI SDI		MM		SNP Stream 5		SNP Stream 1	
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RAI1 HD contribution

- ST2022-6
- **ST2022-7**
- point-tomultipoint connections

from two source sites to three headends (main, backup, DR)



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RAI1 UHD contribution

- **ST2110-20**
- ST2110-30/-31
- ST2110-40
- ST2022-7

behind the scenes:

DataMiner Virtual Signal Groups (any format, type, combination, etc.)



MUX A distribution

- ST2022-2/3
- **ST2022-7**
- connect multiple sources (main, protect, DR) to single destination



(IP SHOWCASE

FULL SERVICE CONNECT

 manage connections based on pre-configured service definitions (for operators)

SINGLE FLOW CONNECT

 make single x-points anywhere in the network e.g. to set up a new type of service on the fly (for engineers) or route to a MV

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	Arista Transport DR HE-DIST						

TIME AWARENESS

- Connections can be:
 - made ad hoc or planned in the future
 - permanent or have an end date
- SDN controller knows current capacity AND future capacity

dataminer • • • RAIWAY (via CheckPoint VPN)																• 🕕 – 🗗	\times
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		Service Active	RAI 2 HD M_IN		Source SDI		START	68	13/12/2021 12:01:49	No date	00:00:00	00:00:00		13/12/2021 12:01:51	Leander	8/03/2022 4:25:54	
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		Service Active	RAI 3 AO B to MM-HE-HE4-ENC-B2-IN	13_110336	SDI to IP		START	- 68	13/12/2021 12:03:36	No date	00:00:00	00:00:00		13/12/2021 12:03:55	Leander	13/12/2021 12:03:57	
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SHOWCASE

HOW DOES IT WORK? – BASICS

IP SHOWCASE

DATAMINER NETWORK MANAGER

- detects input format and configures sender
- calculates most efficient network path based on:
 - device availability
 - shortest path & lowest cost (Dijkstra)
 - required & available bandwidth for the scheduled time
- sets static multicast routes and flow policies on each switch (running in passive mode)
- configures receiver

full SDN control

over hybrid Arista & Cisco network

prevent network oversubscription

supports NMOS IS-05 & vendor-specific APIs

HOW DOES IT WORK? – ADVANCED

DATAMINER NETWORK MANAGER

- sets diverse paths for main, protect and DR flows
- routes flows that belong to one source on the same network paths (customer rule)
- knows about device limitations (e.g. licensed bandwidth per device, interface bandwidth)
- manages NATing functions & change-over units
- controls multiviewers
- adds multiple A/V probes to each service
- comes with comprehensive service-aware monitoring

full SDN control

OWCASE

over hybrid Arista & Cisco network

prevent network oversubscription

supports NMOS IS-05 & vendor-specific APIs

MONITORING

CONTROL & MONITORING GO TOGETHER

- automatically starts monitoring services & connections
- dynamically creates comprehensive service visuals and dashboards across compressed (MUX) and uncompressed connections

DASHBOARD IP MATRIX BOOKINGS CONFIG ADMIN SWITCH MM - DR SWITCH IPG CHO DAB ALL SERVICES SMALL ICON NAT & REG ____ -----

RAIWAY (via CheckPoint VPN)

dataminer

Nº4

RaiWay Rooking Manager X

Service Dashboard (MUX & all contributing feeds per MUX)

drill down to more details

IOWCASE



ACTIVE ALARMS: 0 ALARMS (0 UNREAD)

dat	taminer 🔳 🔹	RAIWAY (via CheckPoint VPN)	Search	٥	12/04/2022 14-39-12 ÷
	RaiWay Booking Manager	名和1HD X 名和1HD M_IN 名和1HD M to MM-HE-HE1-EN	C-M1-IN1 X		
Surveyor	≡ ← "I RaiWay ► ≺	1 - Connections I IP K RAI 1 HD M to MM-HE-HE1-ENC-M1-IN1			
Activity Apps		RAI 1 HD M to MM-HE-H	E1-ENC-M1-IN1		
+	G Cisco Transport ∨ ♦ Generic Destina [®] ∨ Source HF ×				
	(••) ALARMS		SX-100-SNP1 A-HD-5	ММ-НЕ-SNP1 А-НD-1 ● IP м 10.121.225.33@ 239.1.5.1	
		RAI1 HD	● IP B 10.122.225.33@ 239.1.5.1	● IP B 10.122.225.33@ 239.1.5.1	
	DOCUMENTS	single ST2022-6/7	SNP Chassis SX-100-SNP1	SNP Chassis MM-HE-SNP1	
	NOTES	connection	SNP Stream 5	SNP Stream 1	RAI1 HD
			Transmitter Mode ST2022-6	Receiver Mode ST2022-6	HEADEND
		SDI > SDI-to-IP GW >	Video Input Present	Video Input Present Input Video Standard 1080i/50	ST2022-6 / ST2110
		NAI > ENC	Input Frozen Status	 Input Frozen Status OK 	512022 07 512110
				Switch Status Ready	
				Seamless Status	
			ſ		
		source Rai 1HD +	• SX-100-SNP1 A-HD-5		MM-HE-HE1-ENC-M1-IN1

Workspace



Cisco Nexus

calculated path across two spine-leaf networks between two sites

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ACTIVE ALARMS: 2 ALARMS (2 UNREAD)

Community

Q 12/04/2022 14:56:07 🗧 🕒 — 🗇 🗙 dataminer

 RAIWAY (via CheckPoint VPN) 🕞 🔁 RaiWay Booking Manager 🗙 🖧 MUX R04 🗙 Surveyor _____ 📙 RaiWay 🔸 🔋 1 - Connections 🔸 🏮 Service Overview 🔸 🖧 MUX R04 🔸 MUX R04 Apps DATA 🖧 MUX R04 DR_RN 🗸 கூ MUX R04 DR_SX ∨ 🖧 MUX R04 MAIN 🗸 🗸 RM-SM 🖫 RM-SM 🛛 🔘 🗅 RM-SM - RM-SM (0) 🕞 RM-SM - RM-SM (0) 🕞 🖧 MUX R04 PROT_ 🗸 RM-SM-GC7-ASI-2 MUX R04 MAIN RM-SM-GC5-ASI-2 RM-SM-GC6-ASI-2 🖧 MUX R04 to RM 🗸 🗸 ____ 🖧 MUX R04 to RM 🗸 🗸 RM-SM 🖫 RM-SM 🛛 (🕬 🗅 🖧 MUX R04 to RM 🗸 🗸 🖧 MUX R04 to RM 🛛 🗸 RM-SM-GC8-ASI-2 🖧 MUX R04 to SX- 🗸 🗸 🖧 MUX R04 to SX- 🗸 _____ 🖧 MUX R04 to SX- 🗸 (0) ALARMS 1 **MUX R04** SX-266 里 SX-266 (の) 🕞 SX-266 - SX-266 (0) 🗔 SX-266 罢 SX-266 (0)口 **Summary** DASHBOARDS MUX R04 BU SX-266-GC6-ASI-2 SX-266-GC7-ASI-2 SX-266-GC8-ASI-2 DOCUMENTS NOTES Main + Protect + DR ANNOTATIONS multiple MPTS connections MUX R04 DR (0) 🗖

Workspace



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NETWORK MONITORING - DETAILS



WAN connectivity

PSHOWCASE

path highlighting

alarm aggregation



VIRTUAL SOURCES

NAME

RAI 2 HD M_IN RAI 2 HD M SAXA-HE



 virtual sources get created after every device

		Type here to search on source name	DESTINATIONS		Type here to search	
_ ▼ DE	EVICE SITE	▼ SERVICE CATEGO ▼ SERVICE GROUP ▼ SERVICE INSTANCE ▼ SIGNAL TY	NAME	△ ▼ CONNECTED INPUT	▼ CONNECTION STATUS	Ŧ
π	UELADA-LAB		SAXA-LAB-SNP2-PIP01	RAI 2 HD M_IN	Connected	
E1-ENC-M1-IN1_HE SA	AXA-HE-HE1-ENC-M1-IN1		SAXA-LAB-SNP2-PIP02	RAI 2 HD M_SAXA-HE-HE1-ENG	C-M1-IN1 Connected	
			SAXA-LAB-SNP2-PIP03			
			SAXA-LAB-SNP2-PIP04			
			SAXA-LAB-SNP2-PIP05			
			SAXA-LAB-SNP2-PIP06			
			SAXA-LAB-SNP2-PIP07			
			SAXA-LAB-SNP2-PIP08			

 route to probes & multiviewers



UNCOMPRESSED	TUELADA-LAB-SNP1 A-		SAXA-LAB-SNP1 C-HD-1	۹
	● IP M 10.121.246.99@ 239.1.4.1	Monitoring 🛛 🖓		Monitoring 🗠
		Stream Name RAI 2 HD M		
	● IP B 10.122.246.99@ 239.1.4.1	Bitrate 1565.140 Mbps		Bitrate 1 \$65.130 Mbps
	SNP Chassis TUELADA-LAB-SNP1	239.1.4.1 Port 3001 Stream ID 389 Status Present	INP Chassis SAXA-LAB-SNP1	• IP 2283.517.5 • Port 5 000 • Stream ID 487 • Status Present
	SNP Stream 4			
		Coding Type IRAW Scrambler No		
	Transmitter Mode ST2022-6		veceiver mode ST2022-6	No Audio N/A Octobal Audio Stert: N/A
	Video Input Present	TS Bittate 1565.163 Mikps Ø Stuff Bittate Dikbps	/ideo Input Present	
	Input Video Standard 1080i/50		Input Video Standard 1080i/50	
	Input Frozen Status OK	(Input Frozen Status OK	
			Switch Status Ready	
		CISCO ISCO NETWORK		CISCO GO NETWORK
Source Server	TUELADA-LAB-SNP1 A-HD-4	ARISTA CAQ	SAXA-LAB-SNPI C-HD-1	SAXA-HE-HEI-ENC-MI-INI

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DISASTER RECOVERY / MAINTENANCE (IP SHOWCASE

 e.g. switch ALL COMPRESSED
 FEEDS to DR site with a couple of clicks (free up one headend)





What's next?

(IP SHOWCASE

- expand system to manage DAB services
- add more UHD channels
- full headend management / IP migration
- transmitter site monitoring with IoT sensors / 5G



LESSONS LEARNED





- Cisco / Arista fabrics & media edge devices behave differently
- all teams need to deal with new (and still buggy) devices & changing APIs, you cannot wait for all fixes
- a properly managed lab system is a must to test all details and constantly evolve the system

 close relationship to all parties involved is essential (Skyline, tech partners, system integrator, end customer)

OWCASE

 complex projects can only be managed in an agile & DevOps style

Thank You Or Any Questions?

Thomas Gunkel













