

Automated Orchestration of a Site Plan using IBM Cloud Pak for Network Automation

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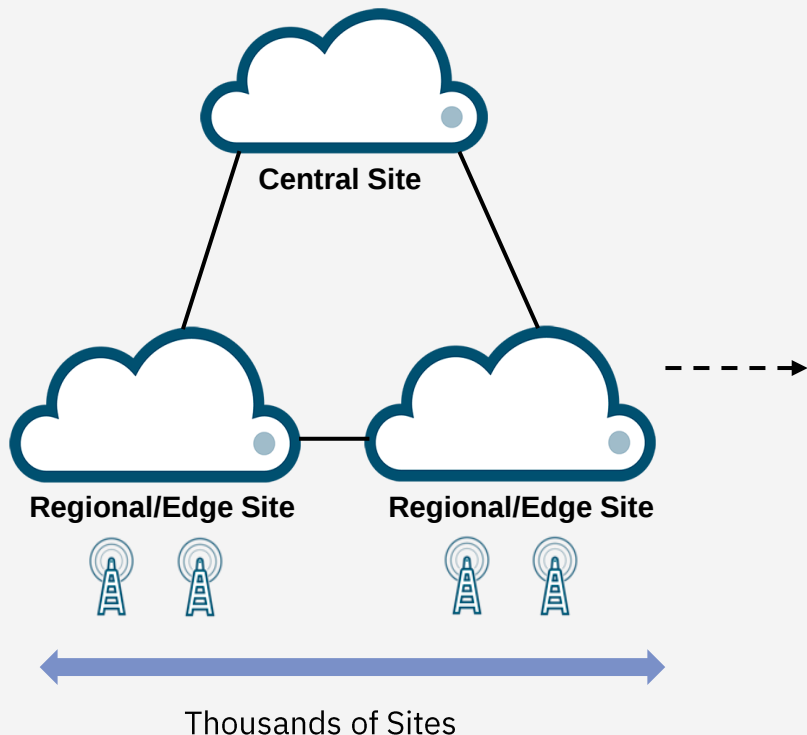
Software Engineer

IBM Software Defined Networking

Thursday 6th May, 2021

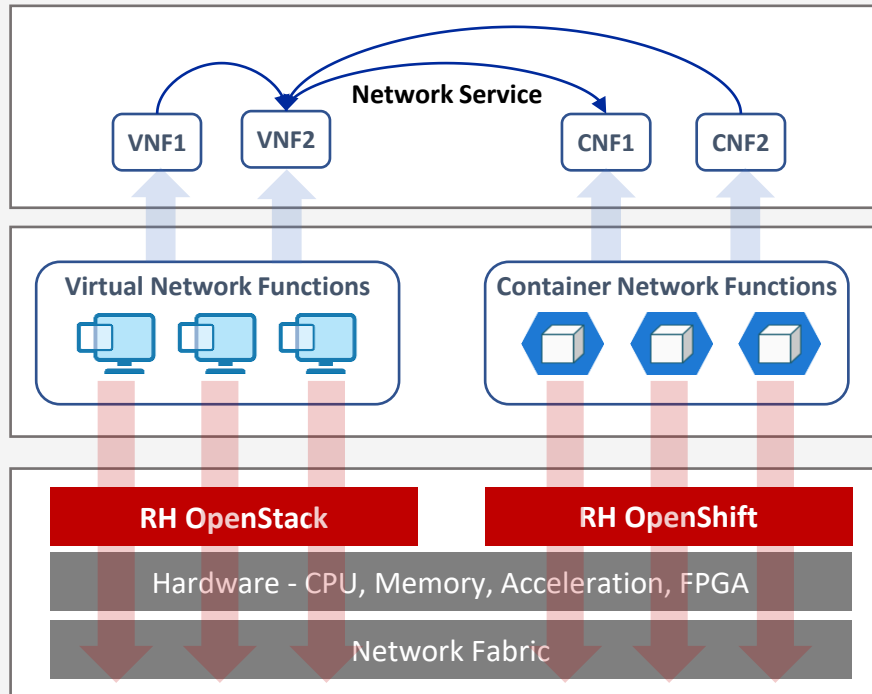


Telco Network Cloud Stack



Massive scale

Hundreds of thousands of network functions must be orchestrated in real time to deliver a holistic network service



Highly accelerated workloads

All network workloads are accelerated to deliver *high performance very low latency packet processing* and analog to digital signal processing

Site Design and Implementation – it's complex

Spreadsheets with 20+ tabs, including:

- Rack Layout
- Hostname Details
- BIOS Settings (for 54 Devices)
- Port Map Bonding
- Port Mapping & Bond Details
- VM Layout
- Disk Placement
- Server Ports
- Network Architecture
- Operating System and Repository requirements
- Tenants
- VM Flavours
- Compute Details
- Compute Roles
- IP Address Plan
- Openshift/Openstack Parameters
- Storage Volumes
- Applications (xNFs)

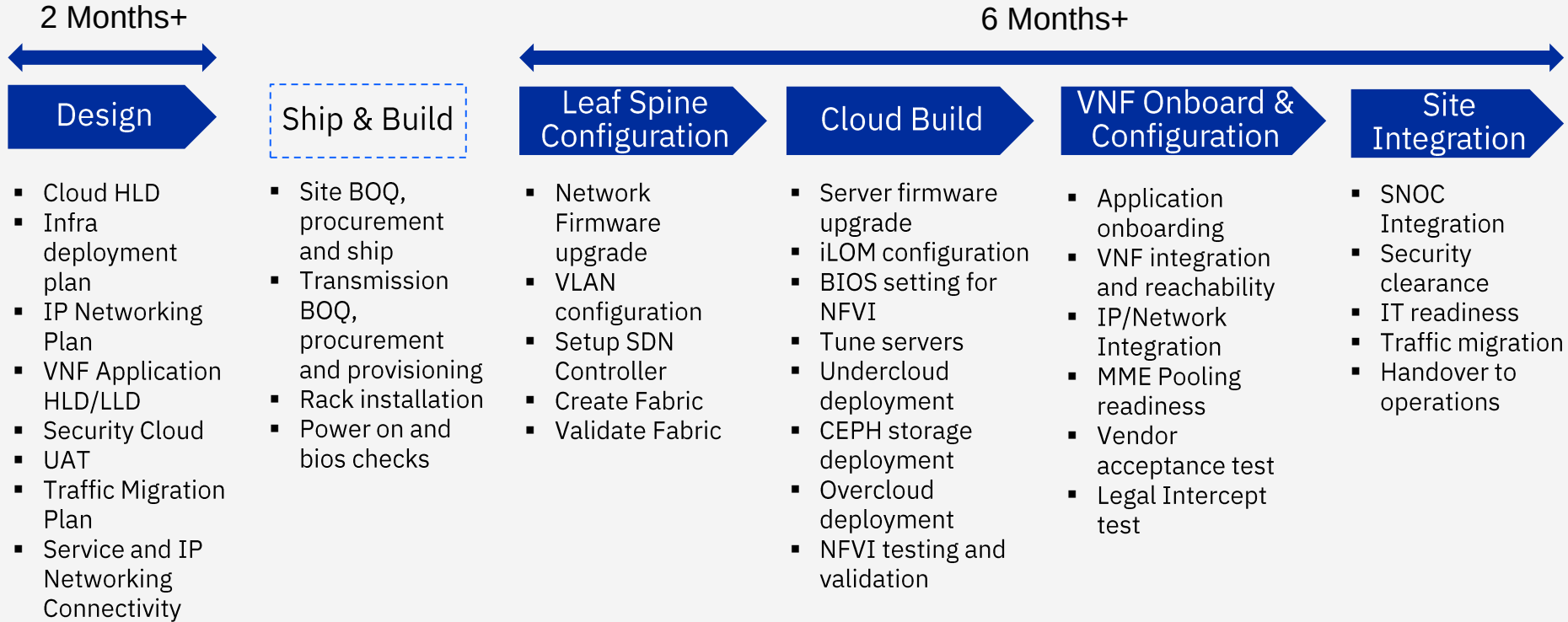
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	XG	XH	XI	XJ	XK	XL	XM	XN	XO	XP	XQ	XR	XS	XT	XU	XV	XW	XX	XY	XZ	YA	YB	YC	YD	YE	YF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
U	Size		RACK-1	5407				RACK-2	4941				RACK-3	4705				RACK-4	5211																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

Site Design and Implementation – it's complex

BIOS Settings

Physical	Compute	Comment	SRIOV (off in system settings, on in NIC)	PXE (only on 2, 1G Ports)	Shared memory (NIC)	C3 Power state	C6 Power state	MLC Steam	MLC spatial prefetcher	DDO data prefetcher	DCA	CPU power and performance	Memory HAS and Performance Config → NUMA Optimized	Virtualization Technology	Intel VT-D	DL380 & DL380 OS Disk RAID configuration (on All nodes) -RAID1	DL380 Disk configurati on -RAID0	DL380 NVMe disk	Boot Mode	Boot Order
HPE-DL38	Director	Compute-1	Director	Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Controller-1	Controller-1		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Controller-2	Controller-2		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Controller-3	Controller-3		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Ceph-1	Ceph-1		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Ceph-2	Ceph-2		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Ceph-3	Ceph-3		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-8	Compute-8		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-9	Compute-9		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-10	Compute-10		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-11	Compute-11		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-12	Compute-12		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-13	Compute-13		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-14	Compute-14		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-15	Compute-15		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-16	Compute-16		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-17	Compute-17		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-18	Compute-18		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-19	Compute-19		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-20	Compute-20		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-21	Compute-21		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-22	Compute-22		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-23	Compute-23		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-24	Compute-24		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-25	Compute-25		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-26	Compute-26		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-27	Compute-27		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-28	Compute-28		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-29	Compute-29		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-30	Compute-30		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-31	Compute-31		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-32	Compute-32		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-33	Compute-33		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-34	Compute-34		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-35	Compute-35		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c
HPE-DL38	Compute-36	Compute-36		Off System, On NIC	Y	Disabled	Disabled	Enabled	Enabled	Enabled	Enabled	High Perf.	Enabled	Enabled	Enabled	RAID1 (960'2)	RAID0	No RAID	Legacy Bo	1st RAID Disk, 2nd PXE Boot Port. eno5 on c

Site Design and Implementation – it's time consuming



IBM Cloud Pak for Network Automation Approach



Normalized Lifecycle Model

Standardized lifecycle operations for all **xNFs** to enable model-driven automation with CI/CD toolchains



Service Design & Testing

Combine xNFs to build **Network Services** designs. Behaviour driven testing validates and certifies the xNFs and service are ready for production



Intent driven Orchestration

Model the **desired service** operational state rather than pre-programming workflows



Closed-Loop Operations

Apply AIOps to proactively respond in dynamic environments

Apply same principles to infrastructure



Normalized Lifecycle Model

Standardized lifecycle operations for all **infrastructure components** to enable model-driven automation with CI/CD toolchains



Infrastructure Design & Testing

Combine infrastructure components to build **site designs**. Behaviour driven testing validates and certifies the components are ready for production



Intent driven Orchestration

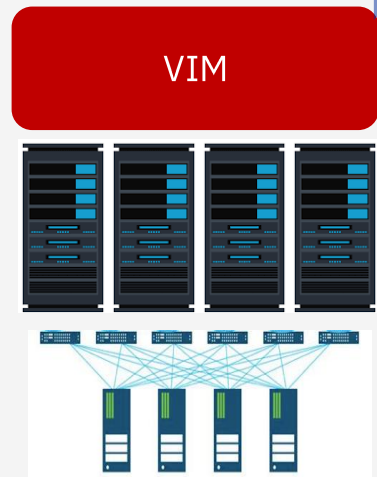
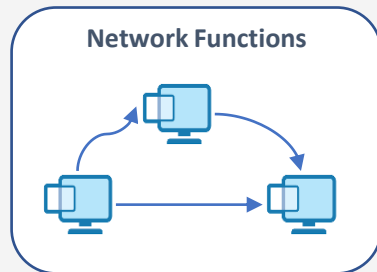
Model the **desired data center** operational state rather than pre-programming workflows (or manual activity)



Closed-Loop Operations

Apply AIOps to proactively respond in dynamic environments

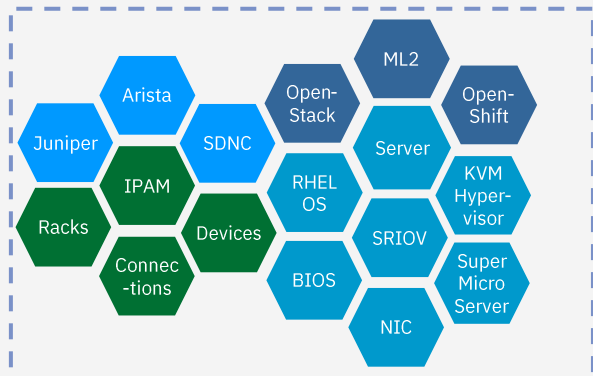
Telco Network Cloud Stack



IBM Cloud Pak for Network Automation Factory Operating Model

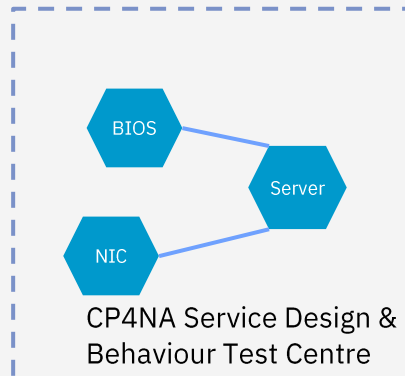
Reusable Automations

Create full lifecycle automation for each network, server, VNF and site integration component



Orchestration Models

Combine automations to build pre-integrated, reusable infrastructure



Site Plan and Build

Site design tooling integrated with Automation components and CP4NA orchestration engine to automate the deployment of the complete stack

CP4NA Site Planner

CP4NA Intent Orchestration Engine

Network Functions

VIM

Published library of Automation components

Git Based CI Pipeline

Site Planner Walkthrough

The screenshot displays the IBM Site Planner web application interface. At the top, there is a navigation bar with the IBM logo and a series of dropdown menus: Organization, Devices, IPAM, Virtualization, Circuits, Power, Secrets, and Other. To the right of these menus is a search bar with a magnifying glass icon and a user profile icon labeled 'admin'.

Below the navigation bar, the main content area is divided into several sections. On the left, there is a sidebar with a search bar and a dropdown menu labeled 'All Objects'. The sidebar contains the following sections:

- Organization**
 - [Sites](#) (1): Geographic locations
 - [Tenants](#) (0): Customers or departments
- DCIM**
 - [Racks](#) (1): Equipment racks, optionally organized by group
 - [Device Types](#) (1): Physical hardware models by manufacturer
 - [Devices](#) (3): Rack-mounted network equipment, servers, and other devices
 - Connections**
 - [Cables](#) (0)
 - [Interfaces](#) (0)
 - [Console](#) (0)
 - [Power](#) (0)
- Power**
 - [Power Feeds](#) (0)

The main content area is divided into three columns. The first column contains the following sections:

- Virtualization**
 - [Clusters](#) (0): Clusters of physical hosts in which VMs reside
 - [Virtual Machines](#) (0): Virtual compute instances running inside clusters
 - [Virtual Infrastructures](#) (0): Virtual infrastructure running data centre workloads
 - [Managed Entities](#) (3): Applications and/or services running at the network application layer
- IPAM**
 - [VRFs](#) (0): Virtual routing and forwarding tables
 - [Aggregates](#) (0): Top-level IP allocations
 - [Prefixes](#) (0): IPv4 and IPv6 network assignments
 - [IP Addresses](#) (0): Individual IPv4 and IPv6 addresses
 - [VLANs](#) (0): Layer two domains, identified by VLAN ID

The second column contains the following sections:

- Secrets**
 - [Secrets](#) (0): Cryptographically secured secret data
- Change Log**
 - [Device Compute3](#) (admin - 2021-04-26 10:22)
 - [Device Compute2](#) (admin - 2021-04-26 10:21)
 - [Device Compute1](#) (admin - 2021-04-26 10:21)
 - [Device Compute1](#) (admin - 2021-04-26 10:21)
 - [Tag eNB](#) (admin - 2021-04-26 10:18)
 - [Tag production](#) (admin - 2021-04-26 10:18)
 - [Managed Entity NB-A1](#)

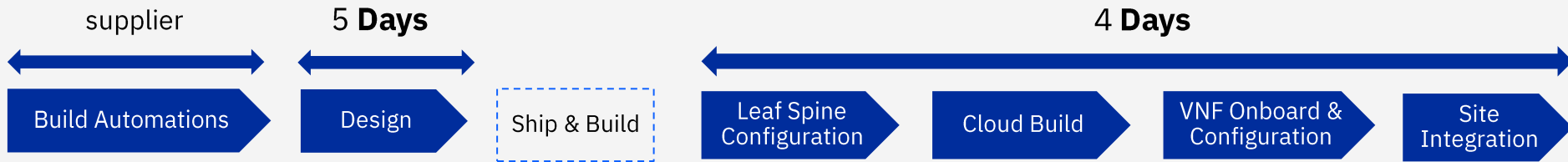
Site Design and Implementation

Before



With IBM Cloud Pak for Network Automation

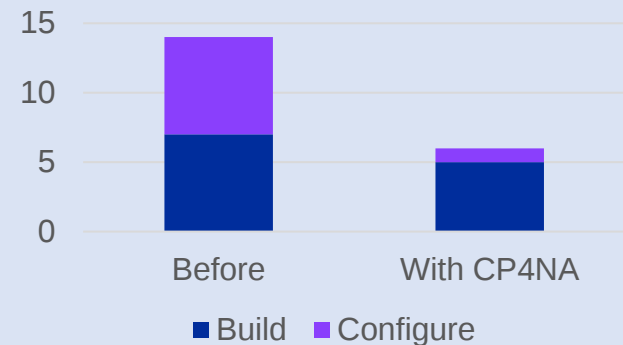
~5-20 days to create automations for new supplier



One time cost as automations are reusable for future sites

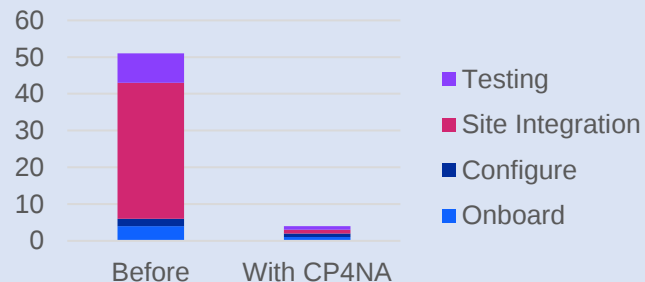
Benefits

Build & Configure Site



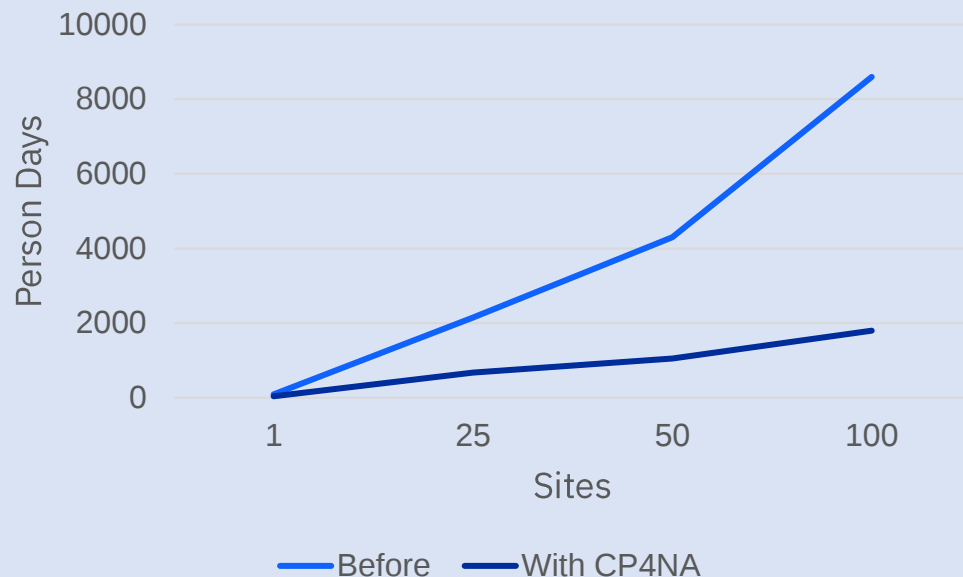
57% Reduction from 14 to 6 days

Integrate & Test VNFs



92% Reduction from 51 to 4 days

Cumulative person days effort for 100 site rollout



79% reduction in person days for software configurable tasks

Assumed 45 new supplier equipment/software are automated in batches of 15 throughout the site rollout. New suppliers include leaf spine, SDN Controllers, VIM, servers, hardware OEMs, VNFs

Get started

[Explore](#)

and schedule a free
virtual consultation
with an expert



With IBM Cloud Pak for Network Automation, you can evolve to zero-touch network operations with AI-powered automation

Lower Costs

Improves business process and service assurance while lowering operations costs

Deploy Faster

Accelerates the delivery of networks and services through AI-powered automation

Run Anywhere

Runs on any cloud, anywhere, and manages any network vendor infrastructure

Daniel Vaccaro-Senna
Software Engineer
IBM Software Defined Networking

www.ibm.com/cloud/cloud-pak-for-network-automation

