Examining the Impact on Total Cost of Ownership when Deploying Telecom Infrastructure Blocks for Red Hat from Core to RAN

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EXECUTIVE SUMMARY

This whitepaper examines the economic benefits that can be derived from utilizing Dell Telecom Infrastructure Blocks for Red Hat in 5G Core and Open Radio Access Network (O-RAN) deployments. Communication service providers (CSPs) are shifting to cloud-native networks to enhance service agility, automate operations, and foster a diverse ecosystem. Although this move to cloud-native architectures will provide real benefits, it also introduces new integration challenges that increase risk and complexity. Dell Telecom Infrastructure Blocks simplify the integration of complex multivendor systems, thus reducing risk and complexity.

The introduction of Dell PowerEdge XR5610, XR8620, R760, and R660 servers marks a significant advancement in 5G virtual core and virtual radio access networks (vRAN) deployment. These servers, equipped with 4th Gen Intel® Xeon® Scalable processors, deliver remarkable performance improvements and ensure efficient operations in telecom environments. This leads to both reduced total cost of ownership (TCO) and enhanced power efficiency for network operators.

This document underlines the TCO benefits and the importance of expediting the deployment of Dell's Infrastructure Blocks, demonstrating that quicker deployment results in considerable TCO savings. ACG Research's total cost of ownership model supports these claims, providing data-driven insights into the operational and economic advantages of adopting Dell's preintegrated solutions.

Journey to vRAN/Open RAN and 5G Core Cloud-Native Networks

CSPs around the world are in the process of migrating their networks from proprietary, vertically integrated hardware and software to disaggregated networks based on cloud-native technologies running combinations of virtualized and containerized network functions. This paper focuses on the cloud infrastructure needed to run Open RAN and virtual 5G core applications in a modern mobile network. There are several drivers for CSPs to move toward cloud-native networks with network software running on standard servers to:

- Improve service agility, allowing for the rapid introduction of new 5G services,
- Automate network operations,
- Create an ecosystem with multiple vendors and open-source software.

Although cloud-native networks are scalable, flexible, and allow for rapid service creation, there are also challenges associated with integrating complex multivendor systems. CSPs and their systems integration partners must take on the responsibility of integrating multiple layers of software and hardware from multiple vendors. Dell Telecom Infrastructure Blocks provide preintegration and life-cycle management of Dell telecom optimized servers to reduce the risk and complexity associated with software and hardware integration for the CSP. The solution integrates Dell PowerEdge servers and Dell Telecom Infrastructure Automation Suite with Red Hat ® OpenShift®, Red Hat Advanced Cluster Management for Kubernetes and Red Hat OpenShift Data Foundation to deliver a resilient, highly scalable cloud platform for 5G mobile networks.

Dell is at the forefront of providing CSPs with a cost-effective pathway to deploying virtual infrastructure to support 5G Core, vRAN and Open RAN networks at scale worldwide. With the introduction of the next-generation PowerEdge XR5610 and XR8620 servers, significant performance improvements have been achieved, leading to reduced TCO. Dell Telecom Infrastructure Blocks offer a streamlined approach for CSPs to deploy these new servers in production networks, further reducing network TCO.

This paper focuses on the TCO benefits of Dell Telecom Infrastructure Blocks with Red Hat software for Open RAN and 5G core networks. It also considers the impact of accelerating the rollout of new technology with Dell Telecom Infrastructure Blocks. The ACG TCO model is used to show how accelerating the introduction of the next generation of servers can result in a dramatic reduction in network TCO.

Current Industry Problem: Vertically Integrated Stacks

Many virtual 5G core deployments, today, use vertically integrated stacks. In a vertical architecture the vendor provides or specifies the configuration of all components of the stack including:

- 5G core software
- Cloud software (Kubernetes and/or VIM)
- Bare metal layer (compute, networking, and storage)

In the early days of virtual 5G core deployments, vendors needed to control all the components of the stack to ensure that the system would meet performance specifications and KPIs. Vendors essentially replaced integrated custom hardware platforms with integrated NFV platforms. However, from the CSP's point of view there was no difference because both the customer hardware and NFV systems were black boxes.

In vertical architectures, the vendor is responsible for integration, testing, and life-cycle operation of the entire stack. This simplifies the job of the operator and reduces deployment risks. However, the fundamental problem with a vertical stack is that you need to deploy multiple and isolated cloud stacks from multiple vendors, which is complex to deploy and operate. These vertical stacks do not allow sharing of servers and other resources, which leads to poor resource utilization that directly results in increased CapEx and OpEx. Underutilization of servers increases many additional expenses:

- Server CapEx
- Power and cooling expenses
- CO^2 emissions
- Cloud software expenses (priced per server)
- Floorspace expenses
- Labor expenses

Underutilization occurs because vertical stacks are frequently overprovisioned to ensure that demand never exceeds server capacity. In a horizontal architecture, it is possible to provide a smaller amount of extra capacity that can be shared among multiple vendors' CNFs and VNFs, which results in better overall server utilization.

An example of the vertically integrated stacks is depicted in Figure 1. In this example each vendor specifies a complete stack consisting of orchestration, network functions, Kubernetes, VIM, and hardware. Generally, the configurations of each stack are incompatible with each other and do not support any additional network functions or applications. This requires continuous validation and life-cycle management of each stack, which introduces complexity.

Some network function providers sell and maintain their own distribution of Kubernetes for running their network functions. As industry leaders, such as Red Hat, that offer and support commercial distributions of Kubernetes at scale continue to gain traction with CSPs, the cost of building and maintaining their own version of Kubernetes becomes less viable for these network function providers, raising longevity concerns for operators using this model.

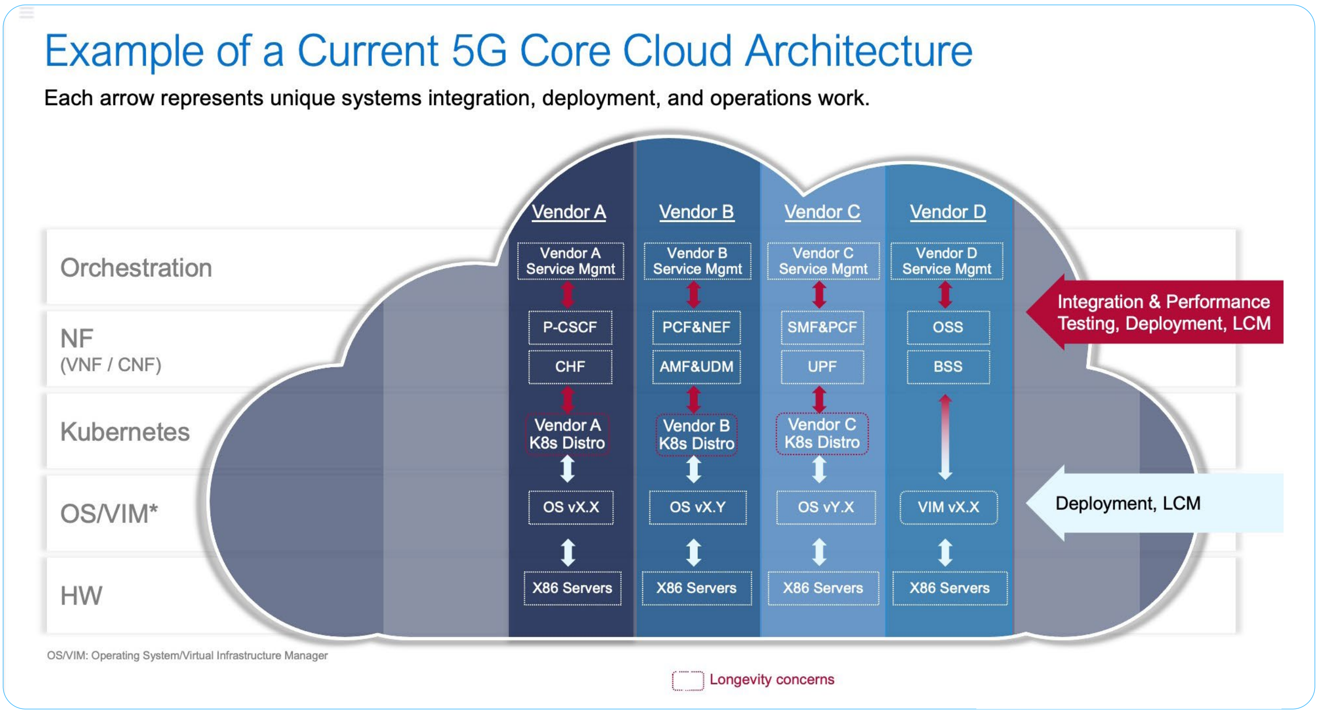

Figure 1. Example of Vertically Integrated Stacks

Solution: Horizontal Cloud-Native Architecture

A horizontal cloud-native architecture is a requirement for a flexible network solution and cloud service agility. Horizontal networks have multiple benefits:

- Better server utilization, which reduces CapEx and OpEx
- Reduced power consumption and CO² emissions
- Sharing of compute resources between many vendors' CNFs and applications
- An agile and scalable network architecture to support the rollout of new services
- Synergy between telecom and IT infrastructure

An example of a horizontal architecture is depicted in Figure 2. In this example the 5G core CNFs provided by different vendors run on top of a common Red Hat OpenShift platform based on Dell Telecom Infrastructure Blocks for Red Hat.

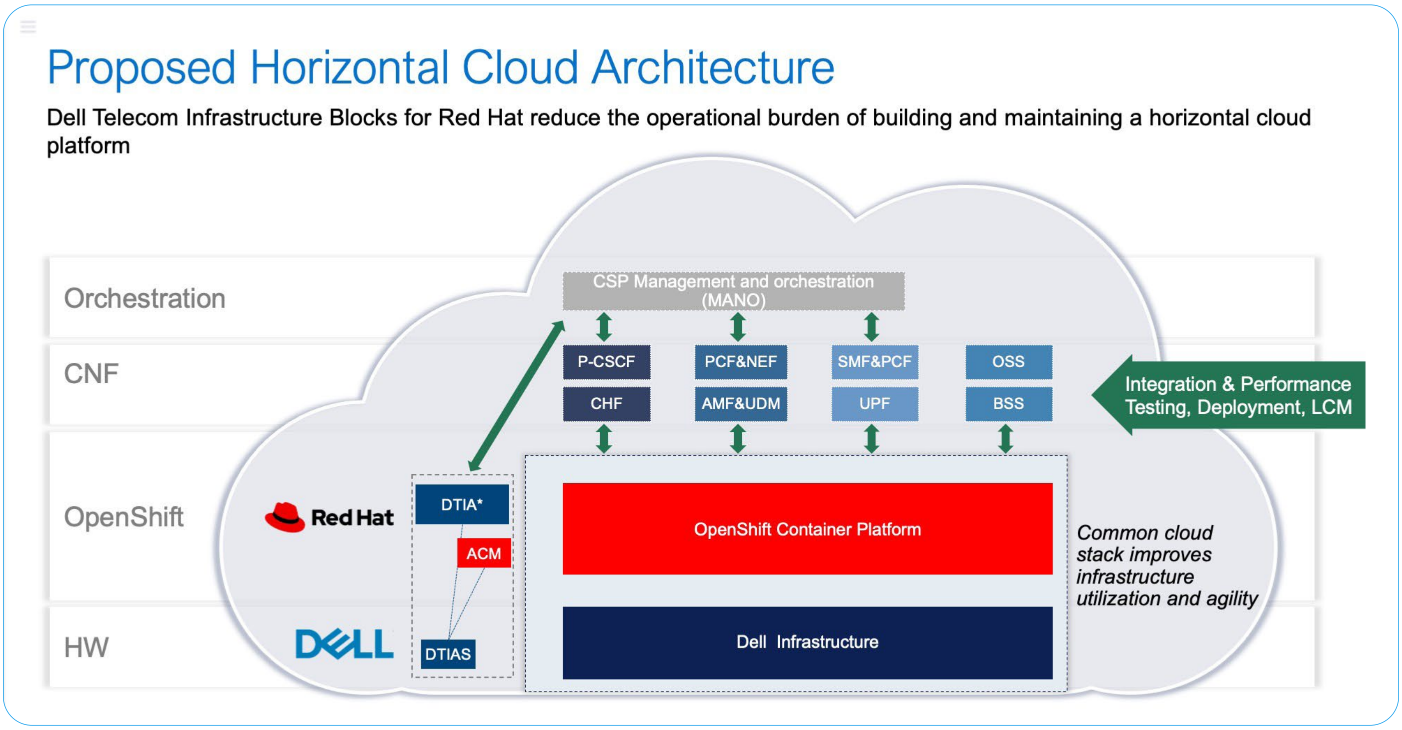

Figure 2. Horizontal Architecture with Dell Telco Infrastructure Blocks for Red Hat OpenShift

This paper focuses on the deployment of a horizontal cloud platform running from the 5G core out through the RAN using Dell Telecom Infrastructure Blocks for Red Hat. This solution includes Red Hat OpenShift (OCP) and Red Hat Advanced Cluster Management for Kubernetes (ACM) and provides the cloud layer and Dell servers combined with Dell Telecom Infrastructure Automation Suite.

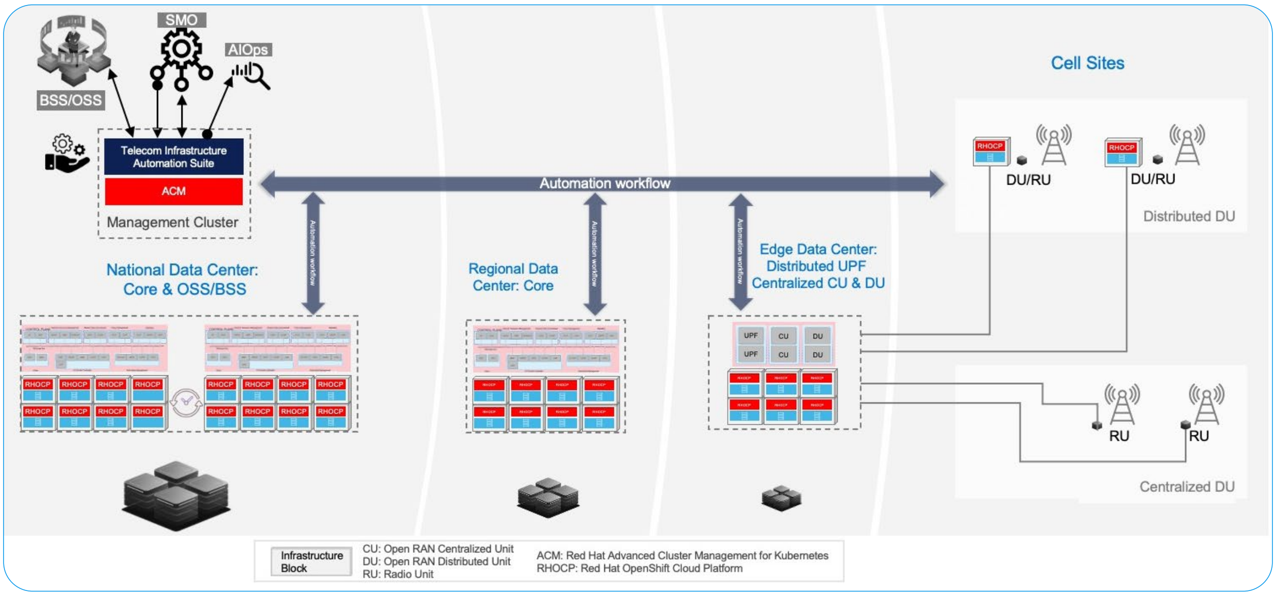

Figure 3. Horizontal Cloud Platform Extending from Core to RAN with Red Hat OpenShift

Cloud-native networks offer scalability, flexibility, and service agility and bring the benefits realized in cloud data centers to large-scale telecom networks. However, these benefits come at a cost:

- CSPs are used to deploying network solutions that are tested and integrated by large telecom vendors, and they depend on those vendors for network deployment and life-cycle management.
- Traditional network solutions are closed systems that do not provide the benefits of a telco cloud, but there is great experience that supports Day 0, Day 1, and Day 2 operations tasks. The transition to cloud-native networks will result in an operations paradigm shift, which could be challenging to navigate.
- Cloud-native architectures require operators to integrate and manage multiple, complex components: compute, storage, and networking hardware as well as the cloud-native software platform running on top of the hardware.
- CSPs need to deploy cloud infrastructure in highly distributed networks consisting of central data centers, regional data centers, edge data centers, and cell sites. In such networks there can be tens of thousands of edge locations that operate as mini cloud data centers.
- The management of a highly distributed cloud-native network is more challenging than managing clouds deployed in large, centralized data centers.
- These factors result in requirements for new skill sets for all components of the operations life cycle, which can be costly and labor intensive.

It is clear to most CSPs that the transition to cloud-native networks is a necessary step to ensure future profitability and growth in an increasingly competitive industry. The question is how the transition to a cloud-native network can be done most effectively. The goals of this transition should be:

- Reduce risk
- Accelerate rollouts of cloud-native networks
- Decrease network operations expenses
- Arrive at an end state where cloud-native networks enable quick rollout of new profitable services

Dell Telecom Infrastructure Blocks Value Proposition

Dell Technologies recognizes the challenges of deploying horizontal cloud-native network infrastructure and has developed a solution to simplify life-cycle management of large cloud-native networks. This allows CSPs to migrate to a desired horizontal architecture more quickly and with less risk. Dell Telecom Infrastructure Blocks provide a fully engineered solution with Dell PowerEdge servers integrated with cloud software platforms. Infrastructure Blocks are targeted at specific use cases, including RAN, edge, and 5G core. A horizontal architecture based on Infrastructure Blocks with Infrastructure Automation Suite allows operators to discover and pool resources and reconfigure those resources to meet changing workload requirements to break down silos and improve resource utilization. Infrastructure Automation Suite discovery and automation accelerates the move to a horizontal architecture powered by Dell's new PowerEdge servers, directly reducing the number of servers required to run 5G core network functions, simultaneously improving server utilization, and increasing both CapEx and OpEx savings. We estimate that server utilization can be improved by 15% or more based on previous ACG research. Although we use the 15% improvement in our TCO analysis, this is a very conservative estimate, and in practice improvement in server utilization will be higher.

Telecom Infrastructure Blocks are preintegrated and tested, shipped to customers, and can be deployed quickly. Dell is building on its Telecom Multicloud Foundations framework, its supply chain operations, customer support and professional services offerings to develop a portfolio of use case focused, pre-engineered, preintegrated, prevalidated solutions. Dell provides a single point of support for life-cycle operations for both the servers and the cloud platform, eliminating finger pointing and reducing CSPs' vendor management complexity.

Benefits of Dell PowerEdge Servers in 5G Core and vRAN/ Open RAN Networks

Dell's new PowerEdge servers, powered by 4th Gen Intel Xeon Scalable processors, bring substantial performance improvements to both 5G core and vRAN networks. These servers effectively support virtualized distributed unit (vDU), centralized unit (vCU), 5G core user plane functions (UPF), and control plane functions, outperforming their predecessors. Notably, Intel testing has demonstrated up to a 2X improvement on vDU workloads and 1.88X improvements in 5G Core UPF functions when compared to 3rd Gen Intel Xeon Scalable processors[1].

[1] Intel Product Brief: Drive High Throughput and Low Latency with Next-Generation Network-Optimized Processors.

Moreover, the innovative designs incorporated in these servers simplify operations in telecom environments, leading to a reduction in service disruptions and t he number of on-site visits. Dell'sSmart Cooling design ensures increased power efficiency, even in harsh environmental conditions. The XR8000 server is a chassis and sled-based system that leverages existing telco cabinets and power infrastructure, significantly reducing network installation expenses.

Accelerating New PowerEdge Server Deployments with Telecom Infrastructure Blocks

One key benefit of Dell Telecom Infrastructure Blocks is the reduction in the time it takes to first deployment. This accelerated timeline enables CSPs to swiftly transition to next-generation servers and realize the TCO benefits identified in previous studies. ACG has written on both the TCO benefits of next-generation servers[2] and Infrastructure Blocks in vRAN networks. With Infrastructure Blocks, Dell validates these new telco-optimized servers with the latest enhancements to Red Hat OpenShift to deliver a fully validated, telco optimized cloud platform that leverages the latest software and hardware advancements.

Infrastructure Blocks play a crucial role in achieving this accelerated deployment by minimizing risks, accelerating network deployments and reducing life-cycle operations expenses. These benefits encompass the entire deployment process, including Day 0 (planning and design), Day 1 (deploy), and Day 2 (operate) operations. Specifically, Day 0 and Day 1 benefits accelerate network deployments by reducing the time required for Day 0 and Day 1 tasks.

Day 0 Benefits: Infrastructure Blocks provide solutions for vRAN, O-RAN, and 5G core using Red Hat OpenShift software. Infrastructure Blocks are pre-engineered, preintegrated, and prevalidated systems using field proven design guidelines to meet the requirements of the specific use case. Design requirements for cell sites often vary based on location and anticipated capacity requirements. Dell Infrastructure Blocks provides CSPs with preintegrated servers, hardware, and Red Hat software, accelerating deployment of Dell’s newest generation of servers while delivering an engineered system designed to create a performance tuned CaaS platform. The TCO model demonstrates that accelerated deployment of new technology results in significant TCO benefits.

[2] https://infohub.delltechnologies.com/section-assets/acg-dell-tco-benefits-of-dell%E2%80%99s-next-gen-telco-servers-2023-2

Day 1 Benefits: Factory integration of all hardware and software eliminates the need to configure hardware and software onsite or in a configuration center. Dell Services can also ship custom configurations to meet the operator's unique requirements through a Dell Second-Touch facility. Network deployment is accelerated through the integration between Dell Telecom Infrastructure Automation Suite and Red Hat OpenShift. This integration automates deployment and life-cycle management of the cloud platform from bare metal through the cloud software layer, bringing the cloud platform to a workload ready state. This simplifies configuration and deployment of the cloud platform across an entire network of distributed data centers, which improves the speed of deployment and reduces configuration errors. This is especially important in large, complex networks with hundreds of edge data centers and tens of thousands of servers.

A breakdown of Day 0 and Day 1 tasks, which accelerate deployment of next-generation servers, is provided in Table 1 and Table 2. These are the tasks that must be completed to deploy next-generation servers in production networks.

ACG Research has performed hundreds of hours of interviews with Tier 1 and Tier 2 CSPs across all major global markets to understand and model the time they spend on tasks associated with design, deployment, and management of their network. The savings are estimates based on the information from these operators.

ACG Research has developed a TCO model for Dell Technologies that enables the company to work with its customers to analyze the impact of Telecom Infrastructure Blocks in their networks. In this model, the parameters listed in the table can be adjusted to align with the CSP's operating environment.

Day 0 Tasks	Description	Infrastructure Blocks Benefits	Total Labor Hours	Time to Complete Task without IB	Time to Complete Task with IB	Savings
Day 0 Reference Arch Design	High-level design of the cloud infrastructure architecture.	Hardware and software architecture is already predefined in Infrastructure	480 hrs. w/o IB 240 hrs. with IB	1 month	0.5 month	50%

		Blocks so architects only need to focus on use case and environmental details.				
Day 0 Benchmarking	Initial design work requires benchmarking with alternative approaches.	An integrated Dell/Wind River solution provides engineers and architects with data required for benchmarking, which simplifies this process.	240 hrs. w/o IB 120 hrs. with IB	0.5 month	0.2 month	50%
Day 0 POC	Proof of concept requires that systems be tested and integrated in a lab before deployment.	Dell's pre-integration and pretesting greatly simplifies the POC.	960 hrs. w/o IB 192 hrs. with IB	1.5 months	0.7 months	80%
Day 0 Detailed Design	Detailed design specifies detailed configurations for each regional and edge data center based on the use case requirements.	Pre-engineered, preintegrated, and prevalidated Infrastructure Blocks simplify detailed design because engineers only need to focus on the specifics of their network and data centers but not on cloud and hardware design and configuration.	1920 hrs. w/o IB 384 hrs. with IB	1 month	0.5 month	80%

Table 1. Key Areas of Day 0 and Day 1 Labor Savings Due to the Dell Telecom Infrastructure Blocks

Day 1 Tasks	Description	Infrastructure Blocks Benefits	Labor Hours per Server	Time to Complete Task without IB	Time to Complete Task with IB	IB Savings
Day 1 Procurement	Procurement teams are responsible for purchasing and delivering all hardware and software.	A single point of contact with Dell simplifies procurement of cloud software integrated with hardware.	0.5 hrs. w/o IB 0.25 hrs. with IB	1 month	0.5 month	50%
Day 1 Hardware Installation	Installation, wiring, and testing of hardware on site.	Infrastructure Blocks provide turnkey solutions that simplify hardware installation.	4 hrs. w/o IB 2 hrs. with IB	2 months	1.5 months	50%
Day 1 Cloud Platform Installation	Installation and configuration of cloud software on hardware infrastructure.	Pre-engineered, preintegrated, and prevalidated Infrastructure Blocks simplify cloud software installation, which can be complex and time consuming without Infrastructure Blocks.	6 hrs. w/o IB 1.2 hrs. with IB	3 months	1 month	80%
Day 1 Network Testing	End-to-end testing of the network cloud platform	Infrastructure Blocks are pretested before they are shipped, which	4 hrs. w/o IB 0.8 hrs.	2 months	1 month	80%

	and hardware configurations after installation. Documentation of the hardware and cloud platform configuration.	dramatically reduces on-site testing.	with IB			
Day 1 Documentation	Documentation of the hardware and cloud platform configuration. Documentation of the hardware and cloud platform configuration.	Standard Infrastructure Blocks and Customer Information Questionnaires allow CSPs to simplify documentation using boiler plate text for much of the configurations.	240 hrs. w/o IB 120 hrs. with IB (Note above are fixed hours not variable by server)	0.5 month	0.2 month	50%

Table 2. Key Areas of Day 0 and Day 1 Labor Savings Due to the Dell Telecom Infrastructure Blocks

Infrastructure Blocks accelerate the time to network deployment. Using our labor estimates and assumptions on the number of FTEs we developed the following Gantt charts showing next-generation server deployment times with and without Infrastructure Blocks. These Gantt charts are presented in Figure 4 and Figure 5. We estimate that Infrastructure Blocks will provide at minimum a six-month acceleration of the rollout of Dell PowerEdge servers with 4th Gen Intel Scalable Xeon processors.

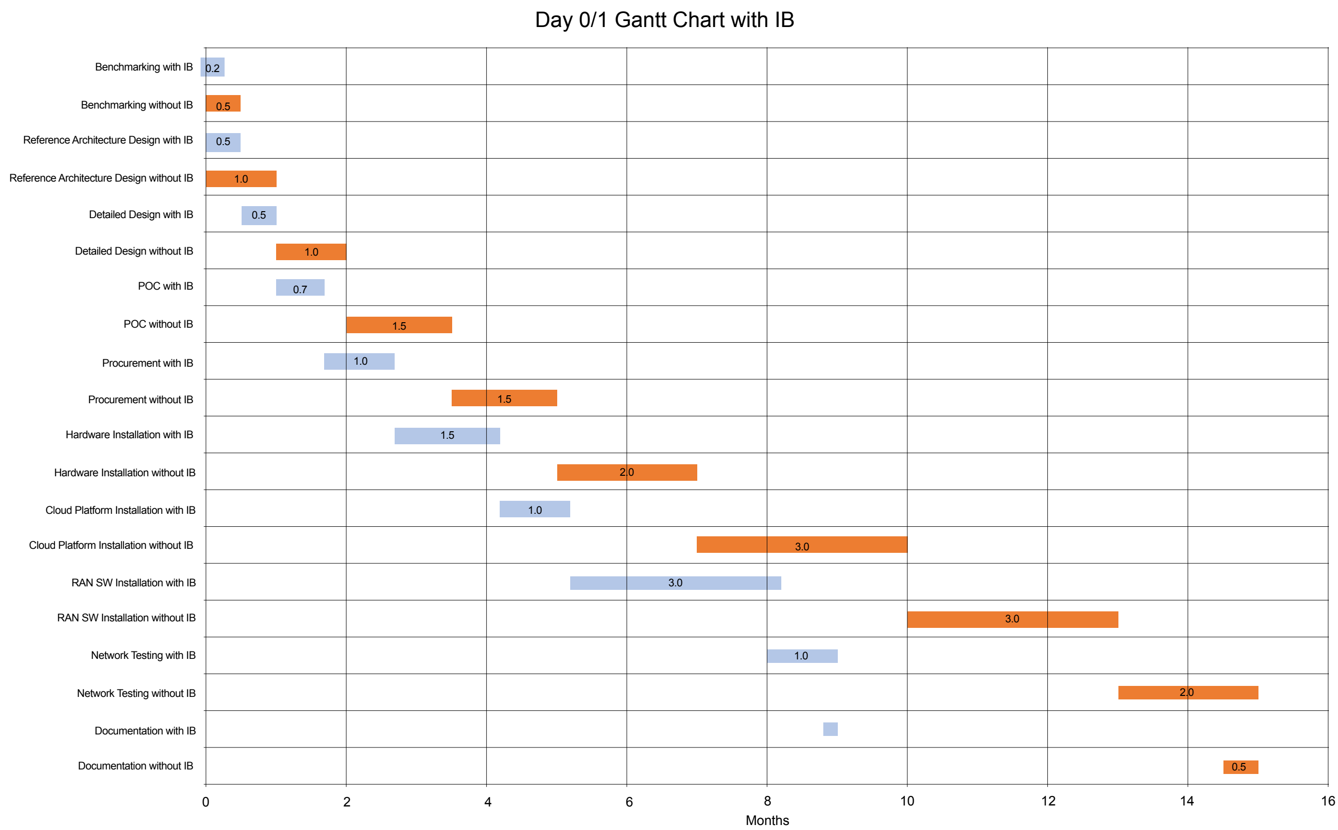

Figure 4. Gantt Chart Specifying the Timeline to Deploy Servers with and without Infrastructure Blocks

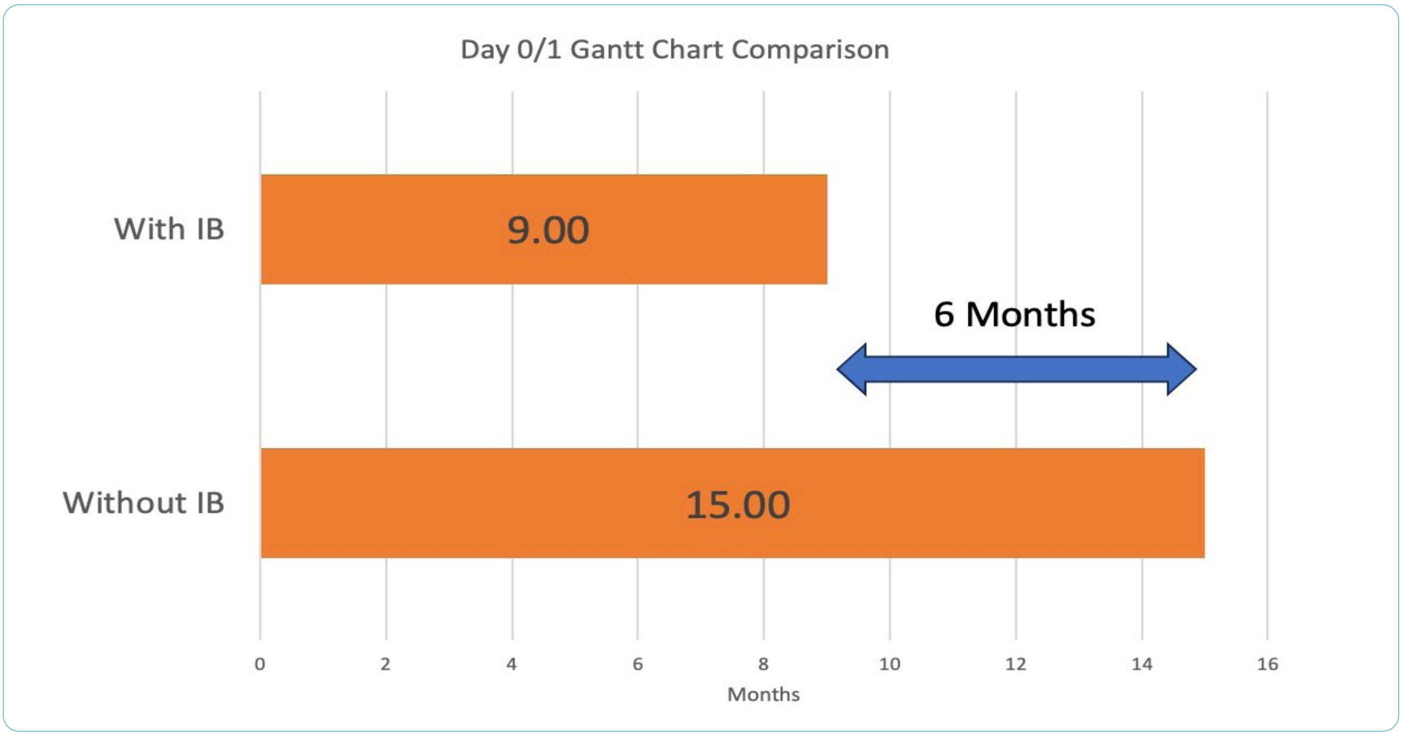

Figure 5. Gantt Chart Comparison of Deploying Servers with and without Infrastructure Blocks Shows a Six-Month Time Reduction

The adoption of Infrastructure Blocks expedites the realization of TCO benefits identified in previous studies. By reducing deployment time, CSPs can swiftly transition to next-generation technologies such as the XR8000 servers. The streamlined deployment process facilitated by Infrastructure Blocks allows CSPs to enjoy the cost savings and operational efficiencies sooner.

After servers are deployed and operational Infrastructure Blocks also reduces the Day 2 labor expenses. These Day 2 expense reductions contribute to long-term TCO savings. The Day 2 expenses are presented in Table 3.

Task	Description	Infrastructure Blocks Benefits	Labor Hours per Server	Savings
Day 2 Engineering & Planning	On-going engineering and planning of the cloud platform to support the network.	Infrastructure Blocks simplify engineering because they are standard units designed for specific network use cases.	0.5 hrs. w/o IB 0.25 hrs. with IB	50%
Day 2 Procurement	On-going procurement of hardware and cloud software.	A single point of contact with Dell simplifies procurement of cloud software integrated with hardware.	0.1 hrs. w/o IB 0.05 hours with IB	50%
Day 2 Test & Certification	All major hardware and software releases need to go through test and certification before being deployed in the network.	Infrastructure Blocks are pretested, which dramatically reduces the time required for software test and certification. Optional integrations with the CSP's CI/CD pipeline processes and offloading of test processes to Dell OTEL further streamline Day 2 test and certification processes.	10,800 hrs. w/o IB 2160 hrs. with IB (Note above are fixed hours not variable by server)	80%

Day 2 Hardware Upgrades	On-going upgrades of hardware.	Infrastructure Blocks are engineered systems with roadmaps that define hardware and software enhancements that will be delivered as turnkey solutions to simplify planning and implementation of hardware upgrades.	0.5 hours without IB 0.25 hours with IB	50%
Day 2 Software Upgrades	On-going upgrades of software.	Infrastructure Blocks provide turnkey solutions, which simply software upgrades.	1 hrs. w/o IB 0.2 hrs. with IB	80%
Day 2 CI-CD Pipeline Integration	On-going continuous integration and deployment of software.	Dell Services can integrate Dell's lab with a customer's CI-CD pipeline to streamline integration processes.	960 hrs. w/o IB 192 hrs. with IB (Note above are fixed hours not variable by server)	80%
Day 2 Fault Management	On-going troubleshooting and remediation of problems.	Dell's extensive design and integration testing minimizes design and interoperability issues to reduce faults and performance management issues for the cloud stack. Infrastructure Automation Suite automates the detection and remediation of hardware configuration drift to further reduce fault and performance issues.	4 hrs. w/o IB 1.4 hrs. with IB	65%

		Dell's single point of contact simplifies support processes when fault and performance management issues occur. When problems occur, zero-touch provisioning from bare metal to CNF deployment accelerates problem remediation.		
Day 2 Performance Management	On-going system performance management and tuning.	Infrastructure Blocks are pre-engineered for high performance. Design guidance simplifies the deployment of the cloud stack at scale. BMO reduces issues due to configuration drift. Dell's single point of contact simplifies performance management.	2 hrs. w/o IB 0.7 hrs. with IB	65%
Day 2 Configuration Management	On-going provisioning and system configuration.	Factory integrated Infrastructure Blocks simplify configuration and provisioning. Automated deployment and upgrades that align with an operator's approved configurations and the ability of Infrastructure Automation Suite to automate the detection and remediation of configuration drift and ensure a consistent, approved configuration across the CSP's landscape.	1 hrs. w/o IB 0.5 hrs. with IB	50%

Table 3. The Day 2 Expenses

Total Cost of Ownership Model Assumptions

The total cost of ownership model represents a combined 5G core and vRAN network that is typical of a Tier 1 European CSP or a large region in North America. We model a network with 40 million subscribers and 28,800 cell sites. The vRAN network can support both a centralized and distributed DU architecture. In a distributed architecture the DU is located at the cell site; in a centralized architecture the DU is located in an edge data center. The radios in the cell sites connect with the centralized DU using a fronthaul network. In all cases the CUs and the UPFs are located in edge data centers, and the packet core control plane is located in a central regional data center. The number of centralized and distributed DU sites is presented in Table 4. The cell sites grow from the initial value to the final value over five years.

Cell Site Type	Number of Cell Sites
Distributed DU	24,000
Centralized DU	4,800

Table 4. Numbers of Central and Distributed DU Cell Sites

We assume that there are multiple radio carriers distributed in multiple sectors at each cell site. We also model massive MIMO 100MHs 64X64 carriers as well as more common 20MHz 4X4 carriers. The number of sectors for each radio carrier is presented in Table 5.

Radio Carrier	Distributed DU	Centralized DU
100MHz 64X64	6 Sectors	6 Sectors
20MHz 4X4	9 Sectors	9 Sectors

Table 5. Radio Carriers for Each Type of Cell Site

In this TCO model we model Dell servers using 3rd Gen Intel Xeon Scalable processors and 4th Gen Intel Xeon Scalable processors. The servers modeled in this paper are specified in Table 6.

Network Function	3rd Gen Intel Server	4th Gen Intel Server
Cell Site DU	XR11	XR8620 1 Sled
Centralized DU	XR11	XR8620 2 Sleds
CU	R750	R660
UPF	R750	R660
5G Core Control Plane	R750	R660
Management Controllers	R750	R760

Table 6. Servers Used in the TCO Model for Each Network Function

In our TCO model we use the ACG Business Analytics Engine (BAE)[3] to compare two scenarios:

- With Dell Telecom Infrastructure Blocks
- Without Dell Telecom Infrastructure Blocks

A key difference between the two scenarios is that we assume that Dell Telecom Infrastructure Blocks accelerate the deployment of next-generation servers. This is due to the ability of Infrastructure Blocks to accelerate the total time to complete Day 0 and Day 1 tasks from 15 months to 9 months, as illustrated in in Figure 5. The assumptions we use for the two scenarios are:

- With Infrastructure Blocks: 15G servers are deployed for the first 9 months and then 16G servers are deployed for the following 51 months
- Without Infrastructure Blocks: 15G servers are deployed for the first 15 months and then 16G servers are deployed for the following 45 months

The model inputs consist of network architecture, unit expense, and OpEx assumptions. The vRAN model calculates the number of RAN servers based on the growth of cell sites and the radio carriers. This demand drives the number of servers in CU and DU pools. The model calculates servers using the following approach:

- Each type of cell site has a combination of radio carriers (specified in Table 5)
- Radio carriers drive the configuration of vDU and vCU components where each vDU and each vCU has a specific number of processor core requirements based on the type and number of carriers at each cell site

[3] https://www.acgbae.com/

- As cell sites grow, vDU and vCU components also grow, and the growth in processor core requirements drives the growth of servers

Cell sites with distributed DUs need fewer XR8000 servers than XR11 servers due to the DU performance improvements in the 4th Gen Intel Xeon Scalable processors. Based on the radio carrier requirements at each cell site we have calculated the number of servers required in each distributed DU cell site as specified in Table 7. For centralized DU deployments the DU servers are pooled in edge data centers and pooling further reduces the number of servers required.

	Number of Servers
XR11	2 Servers
XR8620, 1 Sled	1 Server

Table 7. Number of Servers Required in Each Distributed DU Cell Site for Each Generation of Technology

The 5G core model uses subscribers and network traffic to drive the number of 5G core control plane and UPF servers. We assume that the number of subscribers grows from zero to 40 million, and each subscriber has average busy period data rate of 800 Kbps. For the 5G core we also assume that the migration to the new generation of PowerEdge servers is faster with Infrastructure Blocks. We use the server deployment assumptions specified in Figure 4. Additionally, in the 5G core Red Hat OpenShift provides a common framework for multivendor infrastructure. This is a horizontal cloud platform that delivers efficiency in server utilization as compared to traditional vertical cloud platforms that are provided by individual telecom vendors.

Combined RAN and 5G Core Infrastructure Blocks TCO Savings

Using our TCO model and the detailed network assumptions for a combined vRAN and 5G core network, we compared two scenarios: with Infrastructure Blocks and without Infrastructure Blocks. We modeled network growth over five years. Our TCO model showed a five-year cumulative TCO savings of 12% and an ROI of 301%. The results for the cumulative period are presented in Table 8.

	Without IBs	With IBs	Savings	ROI
Five-Year Cumulative TCO	$1,176.32 Million	$1,032.35 Million	$143.97 Million 12% Savings	301%
Five-Year Cumulative OpEx	$ 597.2 Million	$488.52 Million	$108.68 Million 18% Savings	
Five-Year Cumulative CapEx	$597.2 Million	$543.83 Million	$35.29 Million 6% Savings	

Table 8. Comparison Combine 5G RAN and Core Infrastructure Blocks Savings

A breakdown of the five-year cumulative CapEx and OpEx comparison of the two scenarios is provided in Figure 6. These charts show that the largest drivers of TCO savings are server acquisition costs, cloud software support, fault management, cloud platform installation, and hardware support and maintenance. One reason for these savings is that fewer XR8000 servers are required than XR11 servers in the network because of the overall performance improvements provided by the 4th Gen Intel Xeon Scalable processors with vRAN Boost technology. Moving to the XR8000 more quickly accelerates these TCO advantages. The other key reason for the savings is that Dell provides a preintegrated, tested, and validated solution with a single point of contact for support, which provides significant labor savings for Day 0 through Day 2 operations.

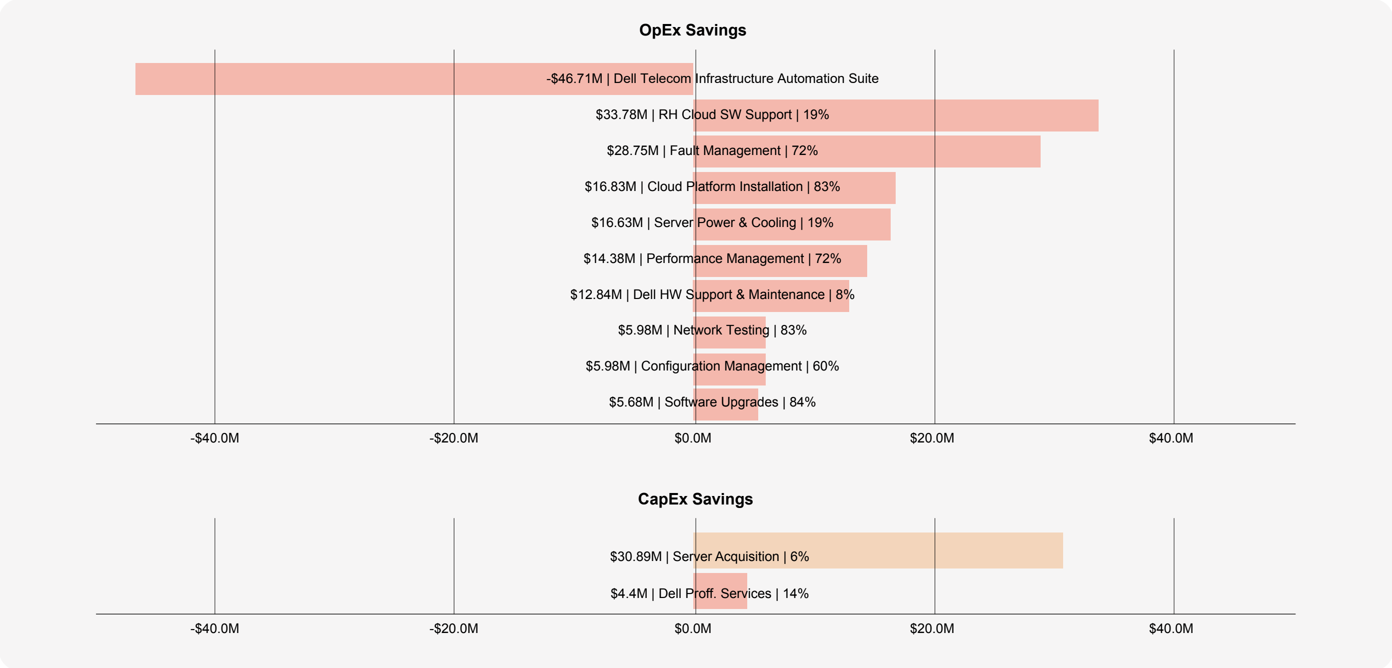

Figure 6. Comparison of Cumulative Five-Year TCO for 5G Combined RAN and Core with and without Infrastructure Blocks

Power and cooling expenses and reduction in CO² emissions are another key area of savings. Power and cooling is reduced over the five years because of the reduction in the number of servers under management as well as the overall power efficiency of the newer server technology.

Sustainability has become increasingly important to CSPs worldwide. Last year, the GSMA made the first assessment of how the mobile industry is progressing toward net zero by 2050. A detailed report from GSMA highlights how many mobile operators (50) have committed to reducing their carbon footprint [4]. In the results we assume average North American power expenses. The results are presented in Table 9. The CO² emissions savings translates to driving 21,855 cars for one year or 19,109 homes electricity use for one year [5].

	Savings
Total Power & Cooling Savings (USA)	$16,720,000
Total Kwatt Hour Savings	138,583,333 Kilowatt Hours
Total CO2 Emissions Savings	98,212 Metric Tons

Table 9. Five-Year Cumulative Power and Cooling Savings and CO2 Emissions Savings

5G RAN TCO Savings

The largest component of the combined network is the RAN. This is because one or more servers is required in all the distributed DU cell sites and many servers are also required in the centralized DU edge data centers. The number of DU and CU servers greatly exceeds the number of packet core servers. The results of the analysis for the 5G RAN are presented in Table 10.

	Without IBs	With IBs	Savings	ROI
Five-Year Cumulative TCO	$1.148.08 Million	$1,017.47 Million	$130.61 Million 11% Savings	286%
Five-Year Cumulative OpEx	$584.41 Million	$480.7 Million	$103.71 Million 18% Savings	
Five-Year Cumulative CapEx	$563.67 Million	$536.77 Million	$26.9 Million 5% Savings	

Table 10. Comparison of Cumulative Five-Year TCO for 5G RAN with and without Infrastructure Blocks

[4] https://www.gsma.com/betterfuture/wp-content/uploads/2022/05/Moble-Net-Zero-State-of-the-Industry-on-Climate-Action-2022.pdf

[5] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

5G CORE TCO Savings

Although the number of servers and dollar savings is much smaller for the 5G core, the percentage savings are much higher. This is a result of moving from a vertical to horizontal RAN architecture, which provides better optimization of servers. All the 5G core UPF and control plane servers are aggregated in data centers. The faster migration to a next-gen server has a high benefit in clusters of servers aggregated in data centers. The results of the 5G core TCO are presented in Table 11.

	Without IBs	With IBs	Savings	ROI
Five-Year Cumulative TCO	$31.51 Million	$15.64 Million	$15.87 Million 50% Savings	772%
Five-Year Cumulative OpEx	$ 16.06 Million	$8.59 Million	$7.47 Million 47% Savings	
Five-Year Cumulative CapEx	$15.45 Million	$7.05 Million	$8.4 Million 54% Savings	

Table 11. Comparison of Cumulative Five-Year TCO for 5G Core with and without Infrastructure Blocks

Conclusion

The analysis concludes that adopting Dell Telecom Infrastructure Blocks for Red Hat significantly accelerates the deployment of new 5G technology, resulting in substantial savings in both capital expenditure and operational expenditure. Over five years, the combined 5G RAN and core network TCO savings is estimated at 12%, with an impressive ROI of 301%. These savings are attributed to the reduced need for servers due to performance improvements and the integration and validation services provided by Dell, which streamline operations from deployment to ongoing management. The transition to Dell's Infrastructure Blocks not only yields economic benefits but also contributes to sustainability efforts, with sizeable reductions in power and cooling needs and consequent CO^2 emissions savings. The paper emphasizes the strategic value of Dell's Infrastructure Blocks in fostering a swift and efficient transition to advanced cloud-native network infrastructures, ultimately enhancing CSPs' competitiveness in the 5G era.

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