# WaitTime* Performance and Validation Report for Integration on Dell Technologies PowerEdge* R750

**Report**

***September 2022***

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# Revision History

| Date | Revision | Description |
|---|---|---|
| September 2022 | 1.0 | Initial release. |

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# 1.0 Overview

This document provides an overview and results for validation of multiple versions of WaitTime* software running on an enterprise server solution (Dell Technologies PowerEdge* R750) installed with a production version of WaitTime application software.

The focus of this report will be running the WaitTime algorithm on the CPU.

Testing was completed with and without video being recorded to local server disk drives. Sizing estimates will be provided for configurations with and without video storage in the *Conclusion* section of this document.

The objective of the validation process is to:

i. Validate and Size the system configuration for concurrent multi-stream video analytics.
ii. Validate that WaitTime algorithms' is evenly distributed across all compute units.
iii. Confirm that maximum video analytics channel density is achieved at 90-95% of maximum compute capacity
iv. Confirm that overall software/hardware solution is steady and operates without fail(s) for at least 24 hours.
v. Measure and log key system running parameters:
    - Overall system CPU load: average and standard deviation.
    - Video analytic inference performance in frames per second: Average and deviation

## 1.1 WaitTime Overview

WaitTime provides real-time data and historical analytics on crowd behavior.

WaitTime's patented artificial intelligence allows operations personal to monitor crowd movement and density in real-time, while providing guests with useful information they can use to navigate the venue they are in.

For more information, visit https://www.thewaittimes.com/ .

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# 2.0 System Configuration

**Table 1. System Configuration**

| Components | Version |
|---|---|
| **Hardware** | |
| Chassis | Dell Technologies PowerEdge R750 |
| CPU | 2x Intel® Xeon® Gold 6338N CPU @ 2.20GHz, 32 Core(s), 64 Logical Processor(s) |
| Memory | Installed Physical Memory (RAM) of 256 GB |
| Hard drives | 512GB Total Storage but not leveraged for Storage |
| HDDL card | None |
| Network card | Intel® Ethernet Network Adapter E810-DA4 QP 25GbE SFP28 OCP 3.0 |
| Others | N/A |
| **Software** | |
| BIOS | Dell Inc. 1.4.4 |
| iDRAC | 5.00.20.00 (Build 22) |
| Operating System | Windows Server 2019 |
| Application Software | WaitTime application – multiple versions |
| Others | Hyper Threading (Logical Processor in BIOS) |
| Others | Enabled dynamic CPU frequency |

## 2.1 Processor Details

| Name | Processor | Version | Current Speed | Core Count |
|---|---|---|---|---|
| CPU1 Status | Intel® Xeon® Gold 6338N CPU @ 2.20GHz | Model 106 Stepping 6 | 2.20Gz | 32 |
| CPU2 Status | Intel® Xeon® Gold 6338N CPU @ 2.20GHz | Model 106 Stepping 6 | 2.20GHz | 32 |

## 2.2 Dell iDRAC Processor Settings

| Dell iDRAC Processor Settings | |
|---|---|
| **Logical Processor** | Enabled |
| **CPU Interconnect Speed** | Maximum data rate |
| **Virtualization Technology** | Enabled |
| **Kernel DMA Protection** | Disabled |
| **Directory Mode** | Enabled |
| **Adjacent Cache Line Prefetch** | Enabled |
| **Hardware Prefetcher** | Enabled |
| **DCU Streamer Prefetcher** | Enabled |
| **DCU IP Prefetcher** | Enabled |
| **Sub NUMA Cluster** | Enabled |
| **MADT Core Enumeration** | Round Robin |
| **UPI Prefetch** | Enabled |
| **XPT Prefetch** | Enabled |
| **LLC Prefetch** | Enabled |
| **Dead Line LLC Alloc** | Enabled |
| **Directory AtoS** | Disabled |
| **Logical Processor Idling** | Disabled |
| **AVX P1** | Normal |
| **Intel SST-BF** | Disabled |
| **Intel SST-CP** | Disabled |
| **x2APIC Mode** | Enabled |
| **AVX ICCP Pre-Grant License** | Disabled |
| **AVX ICCP Pre-Grant Level** | 128 Heavy |
| **Number of Cores per Processor** | All |
| **Processor Core Speed** | 2.20 GHz |
| **Processor Bus Speed** | 11.2 GT/s |
| **Local Machine Check Exception** | Disabled |
| **Family-Model-Stepping** | 6-6A-6 |
| **Brand** | Intel® Xeon® Gold 6338N CPU @ 2.20GHz |
| **Level 2 Cache** | 32x1280 KB |
| **Level 3 Cache** | 48 MB |
| **Number of Cores** | 32 |
| **Maximum Memory Capacity** | 6 TB |
| **Microcode** | 0xD000311 |

| | |
|---|---|
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| **Maximum Memory Capacity** | 6 TB |
| **Microcode** | 0xD000311 |

| Settings | Current Value |
|---|---|
| **System Profile** | Performance Per Watt (DAPC) |
| **CPU Power Management** | System DBPM (DAPC) |
| **Memory Frequency** | Maximum Performance |
| **Turbo Boost** | Enabled |
| **C1E** | Enabled |
| **C States** | Enabled |
| **Memory Patrol Scrub** | Standard |
| **Memory Refresh Rate** | 1x |
| **Uncore Frequency** | Dynamic |
| **Energy Efficient Policy** | Balanced Performance |
| **Monitor/Mwait** | Enabled |
| **Workload Profile** | Not configured |
| **CPU Interconnect Bus Link Power Management** | Enabled |
| **PCI ASPM L1 Link Power Management** | Enabled |
| **OS ACPI Cx** | OS Cx C2 |
| **GPSS Timer** | 500 us |
| **CPU C1 Auto Demotion** | Disabled |
| **CPU C1 Auto UnDemotion** | Disabled |
| **Workload Configuration** | Balance |
| **Dynamic L1** | Disabled |
| **Package C States** | Enabled |
| **Package C State Latency Negotiation** | Disabled |
| **Power and System Criteria for Package C State** | Disabled |

**NOTES:**

1. iDRAC = Integrated Dell Remote Access Controller.

# 3.0 WaitTime System Configuration

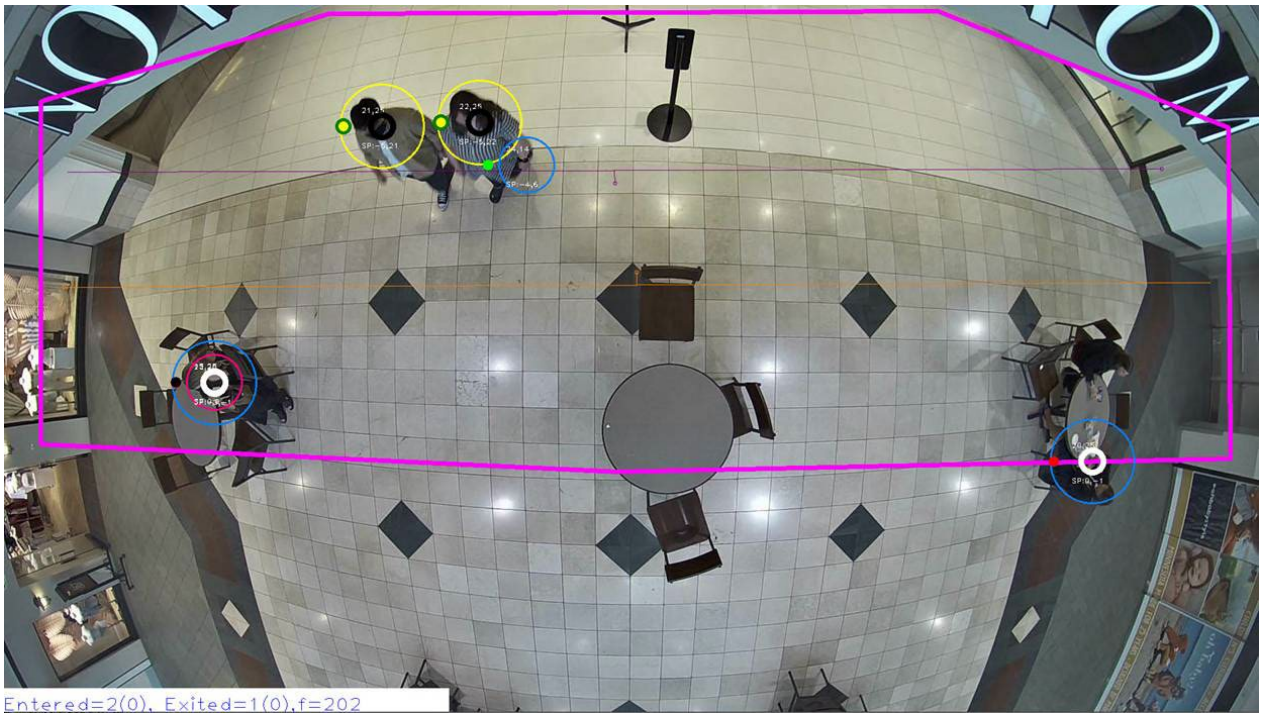
## 3.1 Video Stream Configuration

| Component | Settings | Comments |
|---|---|---|
| Video Analytic Input video stream parameters | 1920x1080@24fps (1080p) | High-resolution video stream |
| Number of input video streams for analytics (virtual cameras) | 1-120 based on video resolution and FPS | Each virtual camera stream has high-resolution and low-resolution videos |
| Video analytic inference framerate per video channel | Variable based on the load | Each AI service is set to process the max amount |
| Number of active video analytics streams at maximum testing | 120 max<br>(refer to *Performance Test Results* for details) | Maximum Number of Streams where video analytics were applied |

## 3.2 Video Analytics Algorithm Description and Parameters

| Item | Vehicles Detection and Tracking – Intel® Xeon® Gold CPU |
|---|---|
| Description | OpenCV |
| Version | Opencv_videoio_ffmpeg451_64.dll, Opencv_videoio_ffmpeg452_64.dll |
| Date | 09/2022 |

**Figure 1. Enter/Exit (Occupancy Tracking) Algorithm**




The *Enter/Exit (Occupancy Tracking)* algorithm was used for testing as it the most server resource-intensive algorithm compared to other WaitTime algorithms, namely *Stanchion, Queue*, and *Massing*.

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# 4.0 Profiling

## 4.1 Validation Steps

1. Deploy and Configure Dell Technologies* PowerEdge* R750 Server.
2. Install Windows 2019 Operating System and Analytics Platform with Testing Criteria.
    a. Set up maximum virtual video streams with specified video sources for high-resolution streams.
    b. Set up WaitTime video analytics to process the virtual video streams.
3. Utilize batch files to run analytics on video files.
4. Analyze results and report.

## 4.2 Checklist for Results Validation

i. WaitTime is utilizing the maximum amount of CPU without compromising the system accuracy.

ii. Processing frame rate is matching the expectations.

iii. CPU usage and Memory consumption values are consistent during the test.

iv. Increase analytics workload until frame loss occurs.

v. Test with recording enabled/disabled[1].

[1] See *Section 5.0 Performance Test Results* for results with and without recording.

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# 5.0 Performance Test Results

To measure system scalability, we sequentially increased the number of streams being processed in parallel while keeping records about hardware utilization and processing time for each stream.

Multiple versions of WTFA were tested:

- Section 5.1 **WTFA version 2.1.3900**
- Section 5.2 **WTFA version 2.3.597**

## 5.1 WTFA version 2.1.3900

### 5.1.1 1080p@24FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (overall) | Memory (per stream) |
|---|---|---|---|
| 10 | 1.5% to 1.6% | 17% | 490MB to 500MB |
| 20 | 1.7% to 2.8% | 41% | 490MB to 500MB |
| 25 | 1.8% to 2.9% | 61% | 480MB to 510MB |
| 28 | 2.0% to 3.2% | 77% | 480MB to 510MB |
| 30[1] | 2.5% to 3.4% | 96% | 480MB to 500MB (most streams at 500MB) |

**NOTES:**

1. Increasing streams further will cause loss of frames.

### 5.1.2 1080P@24FPS with Recordings

| Streams | CPU Utilization (per stream) | CPU Utilization (overall) | Memory (per stream) |
|---|---|---|---|
| 22 | 2.5% to 3.5% | 75% | 500MB to 530MB<br>Verified that 100% of frames were recorded |

### 5.1.3 1080P@15FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (Overall) | Memory (per stream) |
|---|---|---|---|
| 10 | 1.0% to 1.1% | 11% | 420MB to 450MB |
| 20 | 1.0% to 1.1% | 21% | 420MB to 450MB |
| 30 | 1.0% to 1.1% | 34% | 420MB to 450MB |
| 40 | 1.1% to 1.6% | 53% | 420MB to 450MB |
| 50[1] | 1.7% to 2.0% | 94% | 420MB to 450MB |

**NOTES:**
1. Increasing streams further will cause loss of frames.

### 5.1.4 1080P@15FPS with Recording

| Streams | CPU Utilization (per stream) | CPU Utilization (Overall) | Memory (per stream) |
|---|---|---|---|
| 35 | 1.6% to 1.8% | 67% | 440MB to 460MB |
| 38 | 2.1% to 2.7% | 93% | 440MB to 460MB<br>**Observation**:<br>Sub Numa Cluster = 2-Way Clustering<br>Verified that 100% of frames were recorded |

### 5.1.5 1080P@10FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (Overall) | Memory (per stream) |
|---|---|---|---|
| 10 | 0.6% to 0.8% | 8% | 420MB to 440MB |
| 20 | 0.6% to 0.8% | 14% | 420MB to 450MB |
| 30 | 0.6% to 0.8% | 20% | 420MB to 450MB |
| 40 | 0.6% to 0.8% | 28% | 420MB to 450MB |
| 50 | 0.6% to 0.8% | 33% | 420MB to 450MB |
| 60 | 0.7% to 1.1% | 52% | 420MB to 450MB |
| 70[1] | 0.8% to 1.2% | 74% | 420MB to 450MB |

**NOTES:**
1. Increasing will cause streams to start losing frames.

### 5.1.6 1080P@10FPS with Recording

| Streams | CPU Utilization (per stream) | CPU Utilization (Overall) | Memory (per stream) |
|---|---|---|---|
| 55 | 1.0% to 1.6% | 74% | 440MB to 460MB |
| 60 | 1.3% to 1.8% | 96% | 440MB to 460MB<br>**Observation**:<br>Sub Numa Cluster = 2-Way Clustering<br>Verified that 100% of frames recorded |

### 5.1.7 720P@20FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (Overall) | Memory (per stream) |
|---|---|---|---|
| 60 | 0.4% to 0.6%<br>**Observation**:<br>Reduced performance when increased to 70 streams, possible bandwidth issue | 57% | 200MB to 220MB<br>**Observation**:<br>Sub Numa Cluster = 2-Way Clustering |

### 5.1.8 720P@15FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (Overall) | Memory (per stream) |
|---|---|---|---|
| 90 | 0.5% to 0.9% | 60% | 190MB to 200MB<br>**Observation**:<br>Sub Numa Cluster = 2-Way Clustering |

### 5.1.9 720P@10FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (Overall) | Memory (per stream) |
|---|---|---|---|
| 120 | 0.7% to 1.1% | 55% | 190MB to 200MB<br>**Observation**:<br>Sub Numa Cluster = 2-Way Clustering |

## 5.2 WTFA version 2.3.597

### 5.2.1 1080p@24FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (overall) | Memory (per stream) |
|---|---|---|---|
| 10 | 1.6% to 1.8% | 18% | 490MB to 510MB |
| 20 | 1.6% to 2.8% | 46% | 490MB to 500MB |
| 25[1] | 1.7% to 3.2% | 71% | 480MB to 510MB |

**NOTES:**
1. Increasing will cause streams to start losing frames.

### 5.2.2 1080p@15FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (overall) | Memory (per stream) |
|---|---|---|---|
| 10 | 1.0% to 1.1% | 11% | 420MB to 450MB |
| 20 | 1.0% to 1.1% | 23% | 420MB to 450MB |
| 30 | 1.2% to 1.5% | 41% | 420MB to 450MB |
| 40 | 1.4% to 2.1% | 70% | 420MB to 450MB |
| 43[1] | 1.4% to 2.8% | 91% | 420MB to 450MB |

**NOTES:**
1. Increasing will cause streams to start losing frames.

### 5.2.3 1080p@10FPS

| Streams | CPU Utilization (per stream) | CPU Utilization (overall) | Memory (per stream) |
|---|---|---|---|
| 10 | 0.6% to 0.8% | 8% | 420MB to 440MB |
| 20 | 0.6% to 0.8% | 14% | 420MB to 450MB |
| 30 | 0.6% to 0.8% | 22% | 420MB to 450MB |
| 40 | 0.6% to 0.8% | 30% | 420MB to 450MB |
| 50 | 0.6% to 0.8% | 42 | 420MB to 450MB |
| 60 | 0.7% to 1.1% | 63 | 420MB to 450MB |
| 65[1] | 1.0% to 1.5% | 82% | 420MB to 450MB |

**NOTES:**
1. Increasing will cause streams to start losing frames.

# 6.0 Conclusion

Based on the analysis in this report, we can define the specifications required per stream/camera to be deployed using the Dell Technologies PowerEdge R750 with the dual socket Intel® Xeon® Gold 6338N CPU.

Testing confirms that Xeon SP 3rd Generation has allowed a 60% increase in overall performance.

We have also determined proper minimum sizing guidelines for multiple versions of WaitTime using video streams parameters consistent with production requirements.

Please consult with your WaitTime and Dell technical sales representative for final sizing recommendations.

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