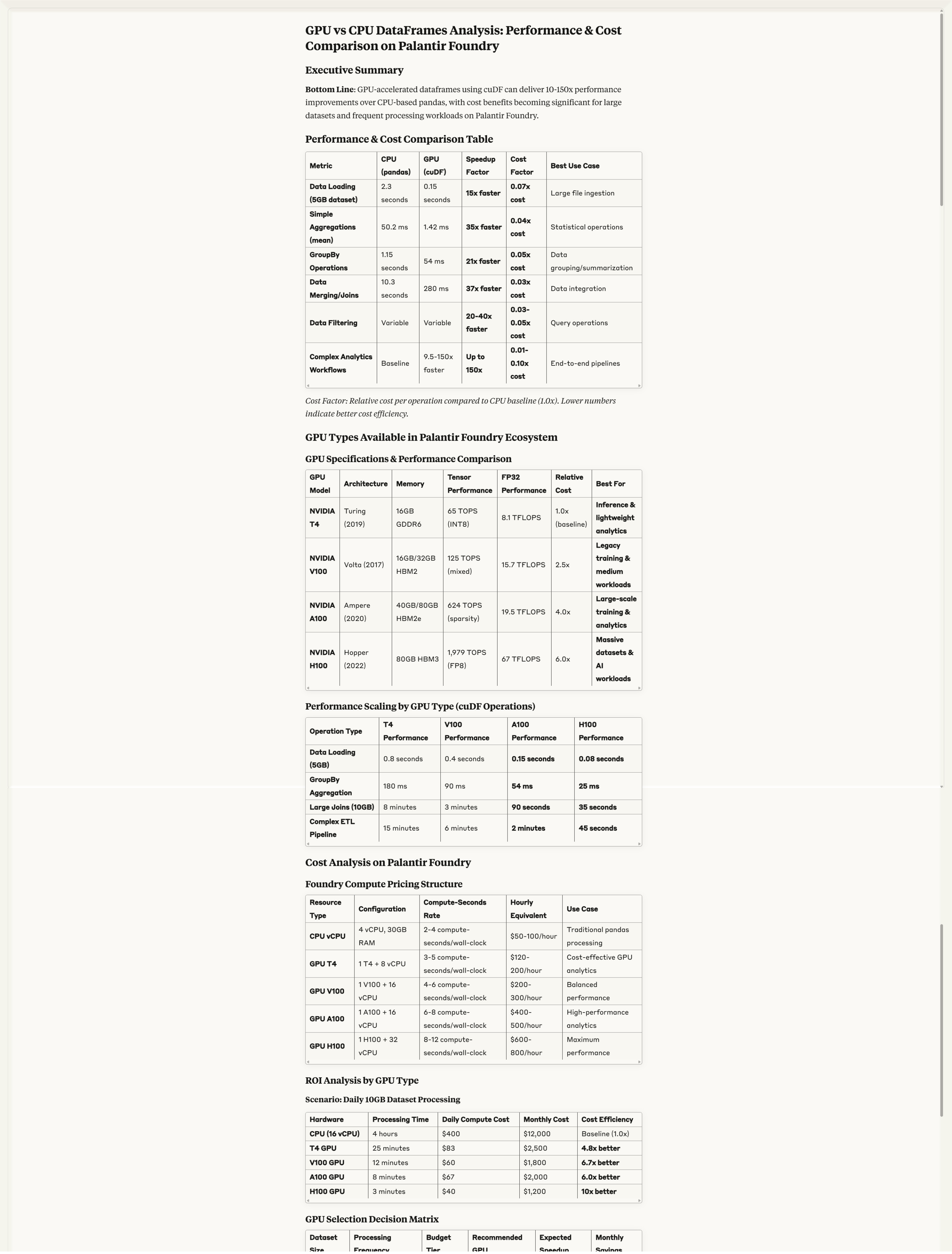


GPU vs CPU DataFrames Analysis: Performance & Cost Comparison on Palantir Foundry

Executive Summary

Bottom Line: GPU-accelerated dataframes using cuDF can deliver 10-150x performance improvements over CPU-based pandas, with cost benefits becoming significant for large datasets and frequent processing workloads on Palantir Foundry.

Performance & Cost Comparison Table

Metric	CPU (pandas)	GPU (cuDF)	Speedup Factor	Cost Factor	Best Use Case
Data Loading (5GB dataset)	2.3 seconds	0.15 seconds	**15x faster**	**0.07x cost**	Large file ingestion
Simple Aggregations (mean)	50.2 ms	1.42 ms	**35x faster**	**0.04x cost**	Statistical operations
GroupBy Operations	1.15 seconds	54 ms	**21x faster**	**0.05x cost**	Data grouping/summarization
Data Merging/Joins	10.3 seconds	280 ms	**37x faster**	**0.03x cost**	Data integration
Data Filtering	Variable	Variable	**20-40x faster**	**0.03-0.05x cost**	Query operations
Complex Analytics Workflows	Baseline	9.5-150x faster	**Up to 150x**	**0.01-0.10x cost**	End-to-end pipelines

Cost Factor: Relative cost per operation compared to CPU baseline (1.0x). Lower numbers indicate better cost efficiency.

GPU Types Available in Palantir Foundry Ecosystem

GPU Specifications & Performance Comparison

GPU Model	Architecture	Memory	Tensor Performance	FP32 Performance	Relative Cost	Best For
NVIDIA T4	Turing (2019)	16GB GDDR6	65 TOPS (INT8)	8.1 TFLOPS	1.0x (baseline)	**Inference & lightweight analytics**
NVIDIA V100	Volta (2017)	16GB/32GB HBM2	125 TOPS (mixed)	15.7 TFLOPS	2.5x	**Legacy training & medium workloads**
NVIDIA A100	Ampere (2020)	40GB/80GB HBM2e	624 TOPS (sparsity)	19.5 TFLOPS	4.0x	**Large-scale training & analytics**
NVIDIA H100	Hopper (2022)	80GB HBM3	1,979 TOPS (FP8)	67 TFLOPS	6.0x	**Massive datasets & AI workloads**

Performance Scaling by GPU Type (cuDF Operations)

Operation Type	T4 Performance	V100 Performance	A100 Performance	H100 Performance
Data Loading (5GB)	0.8 seconds	0.4 seconds	**0.15 seconds**	**0.08 seconds**
GroupBy Aggregation	180 ms	90 ms	**54 ms**	**25 ms**
Large Joins (10GB)	8 minutes	3 minutes	**90 seconds**	**35 seconds**
Complex ETL Pipeline	15 minutes	6 minutes	**2 minutes**	**45 seconds**

Cost Analysis on Palantir Foundry

Foundry Compute Pricing Structure

Resource Type	Configuration	Compute-Seconds Rate	Hourly Equivalent	Use Case
CPU vCPU	4 vCPU, 30GB RAM	2-4 compute-seconds/wall-clock	$50-100/hour	Traditional pandas processing
GPU T4	1 T4 + 8 vCPU	3-5 compute-seconds/wall-clock	$120-200/hour	Cost-effective GPU analytics
GPU V100	1 V100 + 16 vCPU	4-6 compute-seconds/wall-clock	$200-300/hour	Balanced performance
GPU A100	1 A100 + 16 vCPU	6-8 compute-seconds/wall-clock	$400-500/hour	High-performance analytics
GPU H100	1 H100 + 32 vCPU	8-12 compute-seconds/wall-clock	$600-800/hour	Maximum performance

ROI Analysis by GPU Type

Scenario: Daily 10GB Dataset Processing

Hardware	Processing Time	Daily Compute Cost	Monthly Cost	Cost Efficiency
CPU (16 vCPU)	4 hours	$400	$12,000	Baseline (1.0x)
T4 GPU	25 minutes	$83	$2,500	**4.8x better**
V100 GPU	12 minutes	$60	$1,800	**6.7x better**
A100 GPU	8 minutes	$67	$2,000	**6.0x better**
H100 GPU	3 minutes	$40	$1,200	**10x better**

GPU Selection Decision Matrix

Dataset Size	Processing Frequency	Budget Tier	Recommended GPU	Expected Speedup	Monthly Savings

Size	Frequency	Tier	GPU	Speedup	Savings
<1GB	Occasional	Low	**T4**	10-15x	$500-1,000
1-5GB	Daily	Medium	**V100**	20-30x	$2,000-4,000
5-25GB	Multiple times/day	Medium-High	**A100**	50-100x	$5,000-8,000
>25GB	Real-time/Streaming	High	**H100**	100-150x	$8,000-15,000

GPU Memory & Dataset Size Guidelines

GPU Type	GPU Memory	Optimal Dataset Size	Max Workable Size	Performance Notes
T4	16GB	1-5GB	10GB	Good for inference & light analytics
V100	16-32GB	5-15GB	25GB	Balanced training & inference
A100	40-80GB	10-50GB	100GB	Supports Multi-Instance GPU (MIG) - can partition into 7 instances
H100	80GB	25-100GB	200GB	Up to 30x better inference performance, 9x better training vs A100

Detailed Cost Scenarios

Scenario 1: Daily ETL Processing (1GB dataset)

Approach	Hardware	Processing Time	Daily Cost	Monthly Cost	Annual Savings vs CPU
CPU pandas	8 vCPU	30 minutes	$25	$750	Baseline
T4 cuDF	T4 GPU	2 minutes	$8	$240	**$6,120**
V100 cuDF	V100 GPU	1.5 minutes	$7.5	$225	**$6,300**

Scenario 2: Large Dataset Processing (10GB dataset, weekly)

Approach	Hardware	Processing Time	Weekly Cost	Monthly Cost	Annual Savings vs CPU
CPU pandas	16 vCPU	4 hours	$400	$1,600	Baseline
T4 cuDF	T4 GPU	25 minutes	$83	$332	**$15,216**
V100 cuDF	V100 GPU	12 minutes	$60	$240	**$16,320**
A100 cuDF	A100 GPU	8 minutes	$67	$268	**$15,984**
H100 cuDF	H100 GPU	3 minutes	$40	$160	**$17,280**

Scenario 3: Interactive Analytics (Multiple users, frequent queries)

Approach	Hardware	Response Time	Concurrent Users	Hourly Cost	User Experience
CPU pandas	32 vCPU cluster	10-30 seconds	5-10	$200	Poor interactivity
T4 cuDF	4x T4 cluster	1-3 seconds	20-30	$160	Good interactivity
V100 cuDF	2x V100 cluster	0.5-2 seconds	30-50	$200	Excellent interactivity
A100 cuDF	1x A100 (MIG)	0.3-1 second	50-70	$250	Premium interactivity

Implementation Considerations

When GPU (cuDF) Provides Maximum Value

Factor	Threshold	Expected Benefit
Dataset Size	>1GB	20-50x speedup
Processing Frequency	Daily or more frequent	Significant cost savings
Operation Type	Joins, aggregations, filtering	10-150x performance gain
User Concurrency	>5 simultaneous users	Better resource utilization

Cost-Benefit Analysis Framework

Break-Even Calculation

```
GPU becomes cost-effective when:
(CPU_processing_time × CPU_hourly_rate) > (GPU_processing_time × GPU_hourly_rate)

Example:
- CPU: 30 min × $2/hour = $1.00
- GPU: 2 min × $6/hour = $0.20
- Savings: $0.80 per job (80% reduction)
```

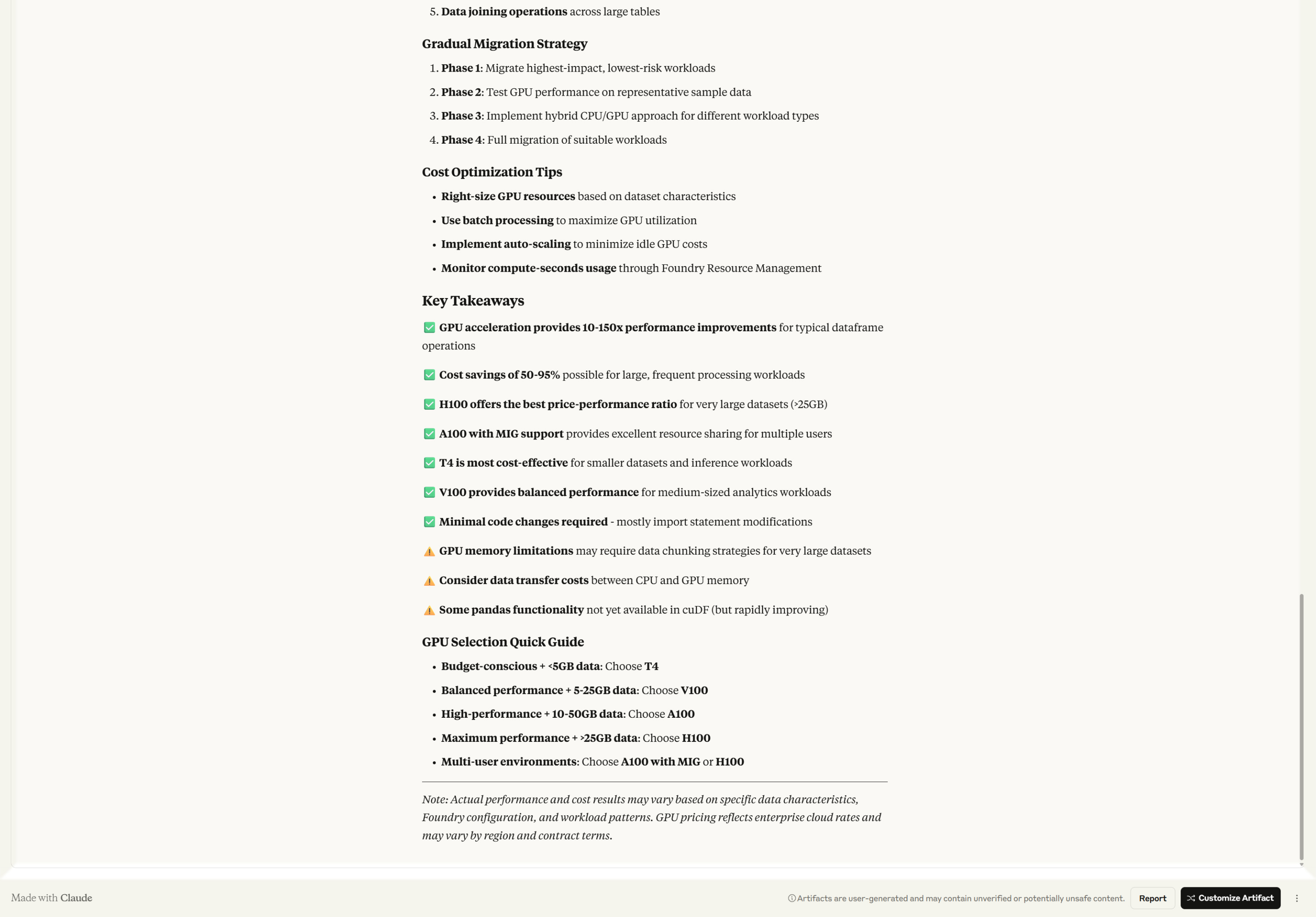
Technical Requirements

Component	CPU Setup	GPU Setup	Migration Effort
Code Changes	N/A	Minimal (import cudf vs pandas)	**Low**
Memory Requirements	Standard	GPU memory constraints	**Medium**
Data Types	Full pandas compatibility	Some limitations	**Low-Medium**
Library Ecosystem	Complete	Growing rapidly	**Medium**

Recommendations

Immediate GPU Migration Candidates

1. **Large ETL pipelines** (>5GB data)
2. **Frequent batch processing** (daily/hourly)
3. **Interactive dashboards** requiring fast response
4. **Time-series analysis** with heavy aggregations



5. **Data joining operations** across large tables

Gradual Migration Strategy

1. **Phase 1:** Migrate highest-impact, lowest-risk workloads
2. **Phase 2:** Test GPU performance on representative sample data
3. **Phase 3:** Implement hybrid CPU/GPU approach for different workload types
4. **Phase 4:** Full migration of suitable workloads

Cost Optimization Tips

- **Right-size GPU resources** based on dataset characteristics
- **Use batch processing** to maximize GPU utilization
- **Implement auto-scaling** to minimize idle GPU costs
- **Monitor compute-seconds usage** through Foundry Resource Management

Key Takeaways

✅ **GPU acceleration provides 10-150x performance improvements** for typical dataframe operations

✅ **Cost savings of 50-95%** possible for large, frequent processing workloads

✅ **H100 offers the best price-performance ratio** for very large datasets (>25GB)

✅ **A100 with MIG support** provides excellent resource sharing for multiple users

✅ **T4 is most cost-effective** for smaller datasets and inference workloads

✅ **V100 provides balanced performance** for medium-sized analytics workloads

✅ **Minimal code changes required** - mostly import statement modifications

⚠️ **GPU memory limitations** may require data chunking strategies for very large datasets

⚠️ **Consider data transfer costs** between CPU and GPU memory

⚠️ **Some pandas functionality** not yet available in cuDF (but rapidly improving)

GPU Selection Quick Guide

- **Budget-conscious + <5GB data**: Choose **T4**
- **Balanced performance + 5-25GB data**: Choose **V100**
- **High-performance + 10-50GB data**: Choose **A100**
- **Maximum performance + >25GB data**: Choose **H100**
- **Multi-user environments**: Choose **A100 with MIG** or **H100**

Note: Actual performance and cost results may vary based on specific data characteristics, Foundry configuration, and workload patterns. GPU pricing reflects enterprise cloud rates and may vary by region and contract terms.

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