AN ANALYTIC EXPLANATION FOR VERTICAL INTEGRATION BEHAVIOR IN THE MARKETPLACE

CALEB WILLIAMS - SPACEWORKS ENTERPRISES

Presented at the 2019 ICEAA Professional Development & Training Workshop - www.iceaaonline.com

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Introduction to SpaceWorks Enterprises

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QUANTITATIVE MODELING + MARKET EXPERTISE

SpaceWorks Commercial

STRATEGIC INSIGHTS

COST ESTIMATION &
ECONOMIC ANALYSIS

MARKET FORECASTING &
COMPETITIVE INTELLIGENCE

STRATEGIC ADVISORY &
CONSULTING SERVICES

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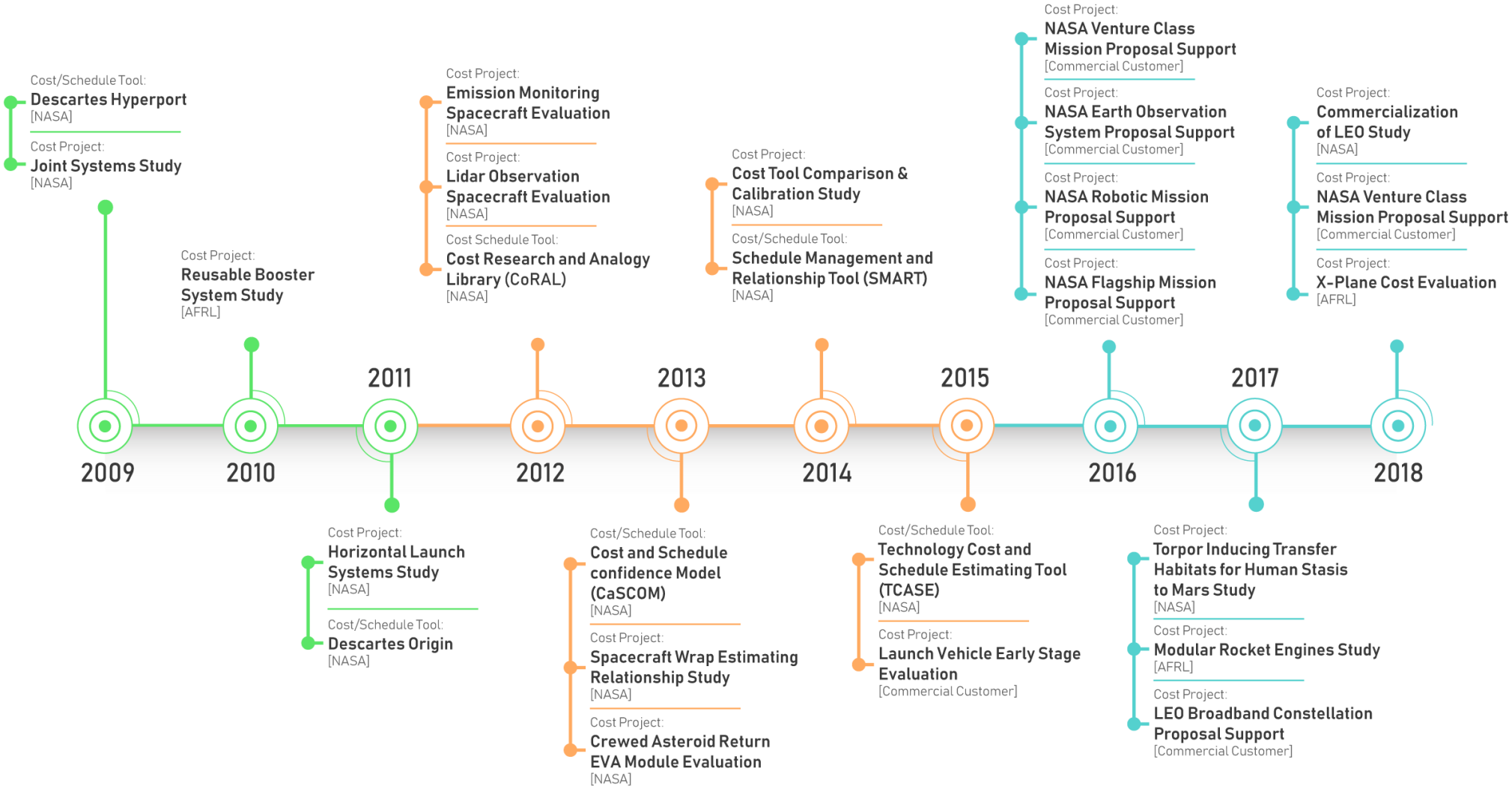
SpaceWorks Enterprises | History in the Cost Estimating Community



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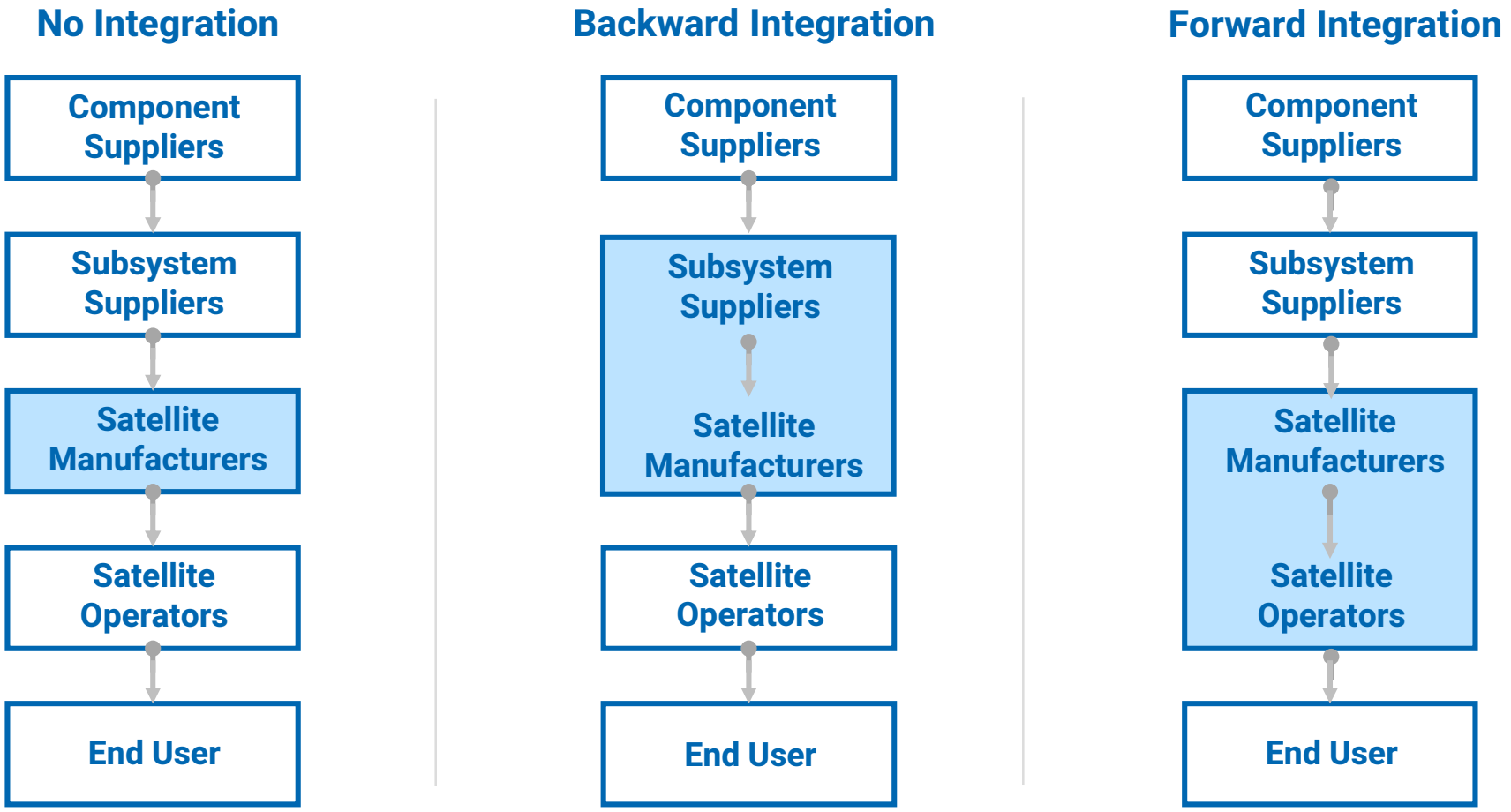
Overview of Vertical Integration

Overview | What is Vertical Integration?



Vertical integration refers to a firm bringing additional elements of the industry value chain under common ownership

Overview | Rise of Vertical Integration in the Satellite Sector

	iridium	SATELLOGIC	spire
COMPONENT MANUFACTURER			●
SYSTEM INTEGRATOR		●	●
OPERATOR	●	●	●

Traditionally, satellite firms have solely operated spacecraft, but recently they are increasingly taking on manufacturer and integrator roles

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Summary of Past Research

Past Research | Corporate Motivations for Vertical Integration

- Initially presented at the 2018 NASA Cost & Schedule Symposium, this study investigated the **motivations behind the recent rise in vertical integration** in the satellite manufacturing sector

- As part of the study, satellite costs for both **traditional** and **vertically integrated manufacturing approaches** were calculated for constellations of various sizes

- By comparing the Avg-Per-Unit-Cost (APUC) of the two approaches, a **breakeven constellation size was identified** – that is, the number of satellites that must be produced before the vertically integrated approach becomes more cost effective

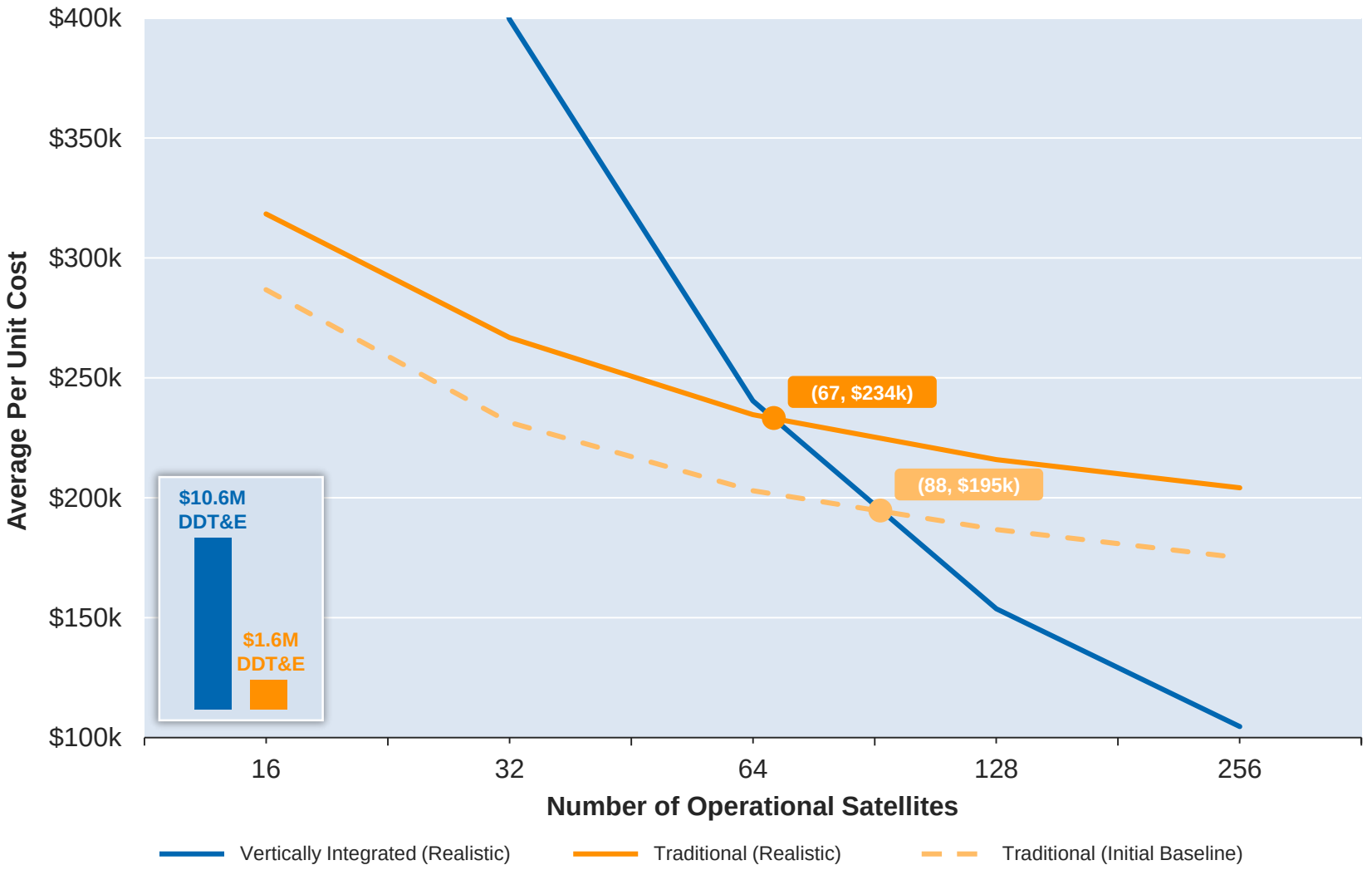
- Additional sensitivities comparing market conditions that may impact integration decisions were considered to **gain insight into corporate motivations for vertical integration**

Initial research was focused on the cost impact of vertical integration on hypothetical 3U and 300 kg small communication satellite constellations

Past Research | Why Do Satellite Firms Vertically Integrate?

Motivations for Vertical Integration in the Small Satellite Sector				
Enable Economies of Scale	Improve Quality Control	Increase Market Power	Eliminate Supplier Risk	Lower Transaction Costs

Past Research | 3U Market-realistic Case

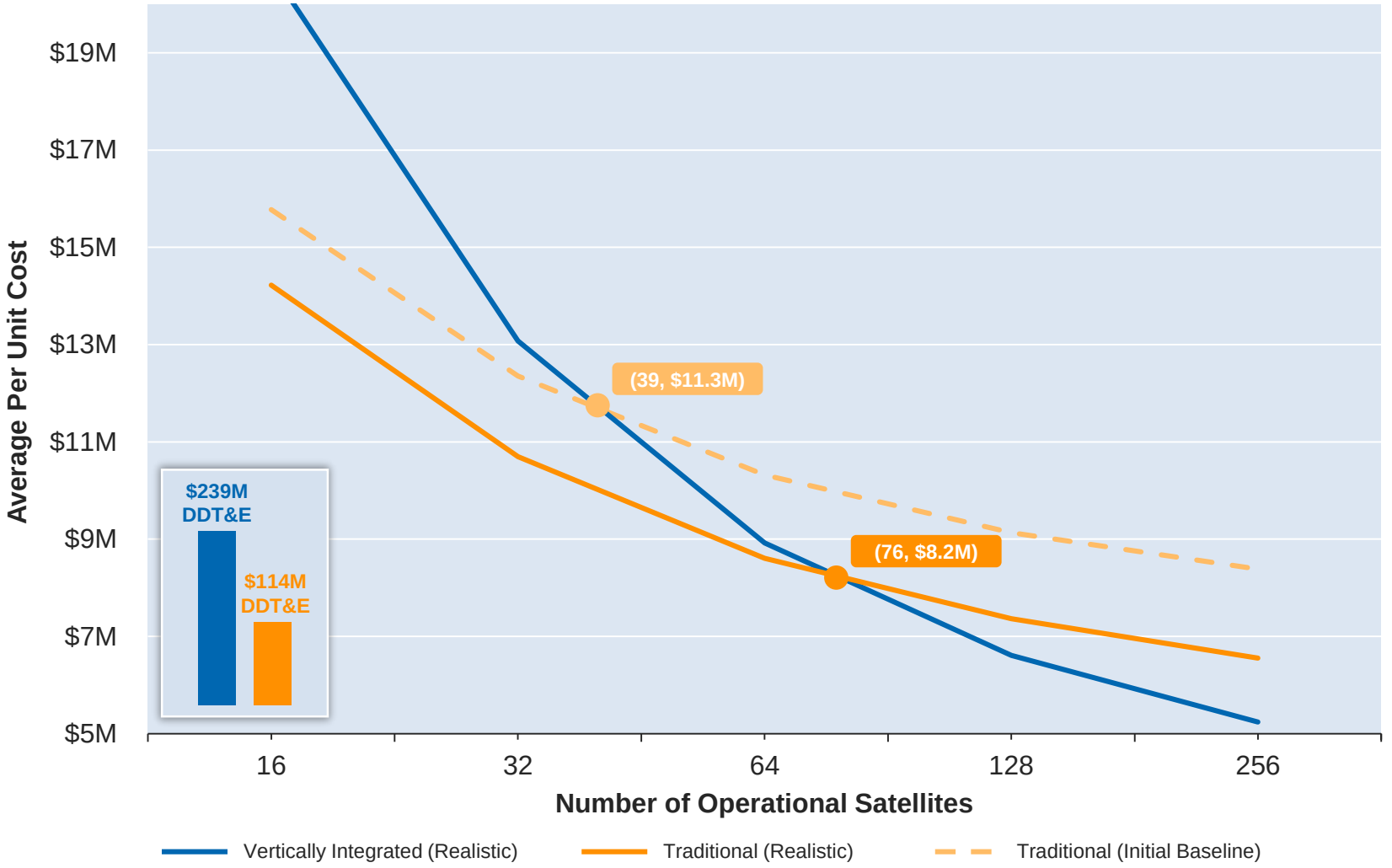


At **67 satellites**, a vertically integrated approach is more cost-effective than traditional manufacturing for Cube Satellites.

In contrast to the baseline, the market-realistic 3U model uses a **70% reliability rate**, significantly lowering the breakeven point.

The **high NRE costs associated** with the vertically integrated approach provide insight into why firms are not adopting this approach.

Past Research | 300 kg Market-realistic Case



At **76 satellites**, a vertically integrated approach becomes more attractive than traditional manufacturing approaches in the 300 kg segment.

The constellation size breakeven shifts outward when considering the current **market environment favoring buyers** in this segment.

Even in much larger constellation sizes, the benefits of vertical integration are **not as drastic in this segment** as in the 3U segment.

Past Research | Study Findings

- This research indicates that **enabling economies of scale** is the **strongest motivator for vertical integration** – a growing necessity given the size of constellation in development

- Beyond this, **increased market power** is the second most compelling motivation for vertical integration, **followed by improved quality control**

- Decreasing transaction costs was found **to not be compelling** reasons for vertical integration, as their **cost is easily absorbed in large-batch production runs**

- After considering relevant market factors, a **satellite constellation size breakeven point of 67 (3U)** and **76 (300 kg)** satellites was established

This research additionally demonstrated that commercial cost estimating tools can be used to generate insight into marketplace behavior

Study Methodology

Study Methodology | Origin of Current Research Effort

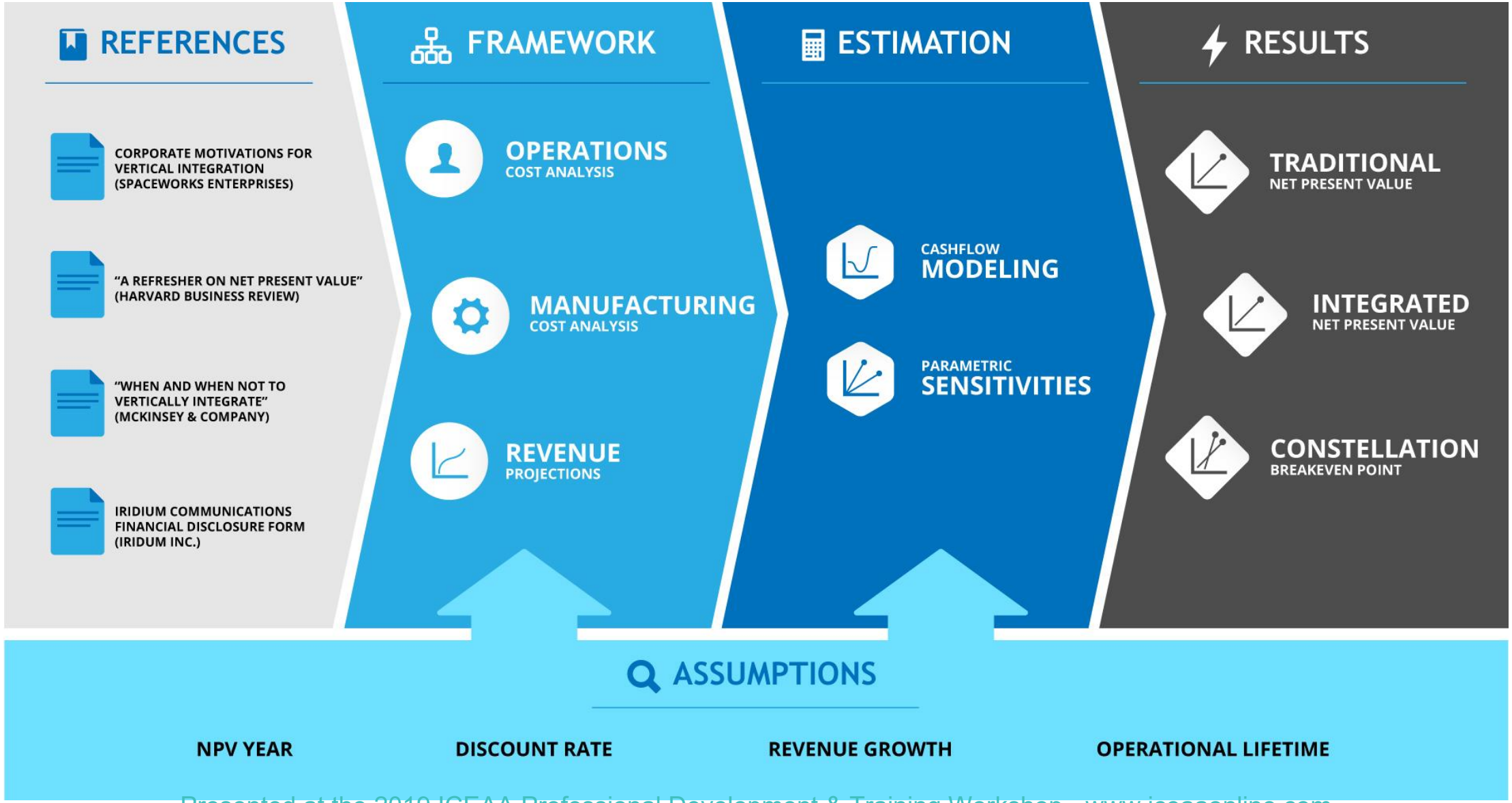
- A critically neglected component of the initial study is the **time value of capital**

- In all businesses, capital deployment decisions must be **weighed against opportunity cost**; most often in financial modeling shown by **discounting cashflows to calculate a Net Present Value**
  - That is, the value of the stream of cash flows, discounted against the average market return

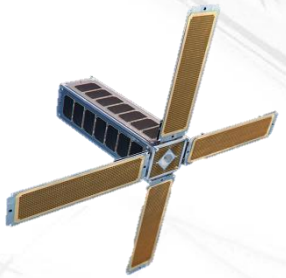
- The evaluation of vertical integration decisions in the context of NPV, rather than cost, is particularly important to this research, as **vertically integrated firms require significantly more upfront capital** than their traditional counterparts
  - This high NRE costs adversely impacts NPV calculations, penalizing vertically integrated approaches

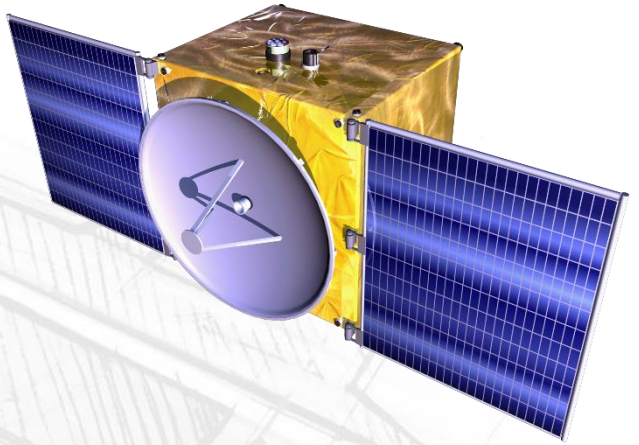
The current research effort is intended to evaluate the role that the time value of capital plays in a firm's decision to vertically integrate

Study Methodology | Business Case Modeling



Study Methodology | Baseline Assumptions



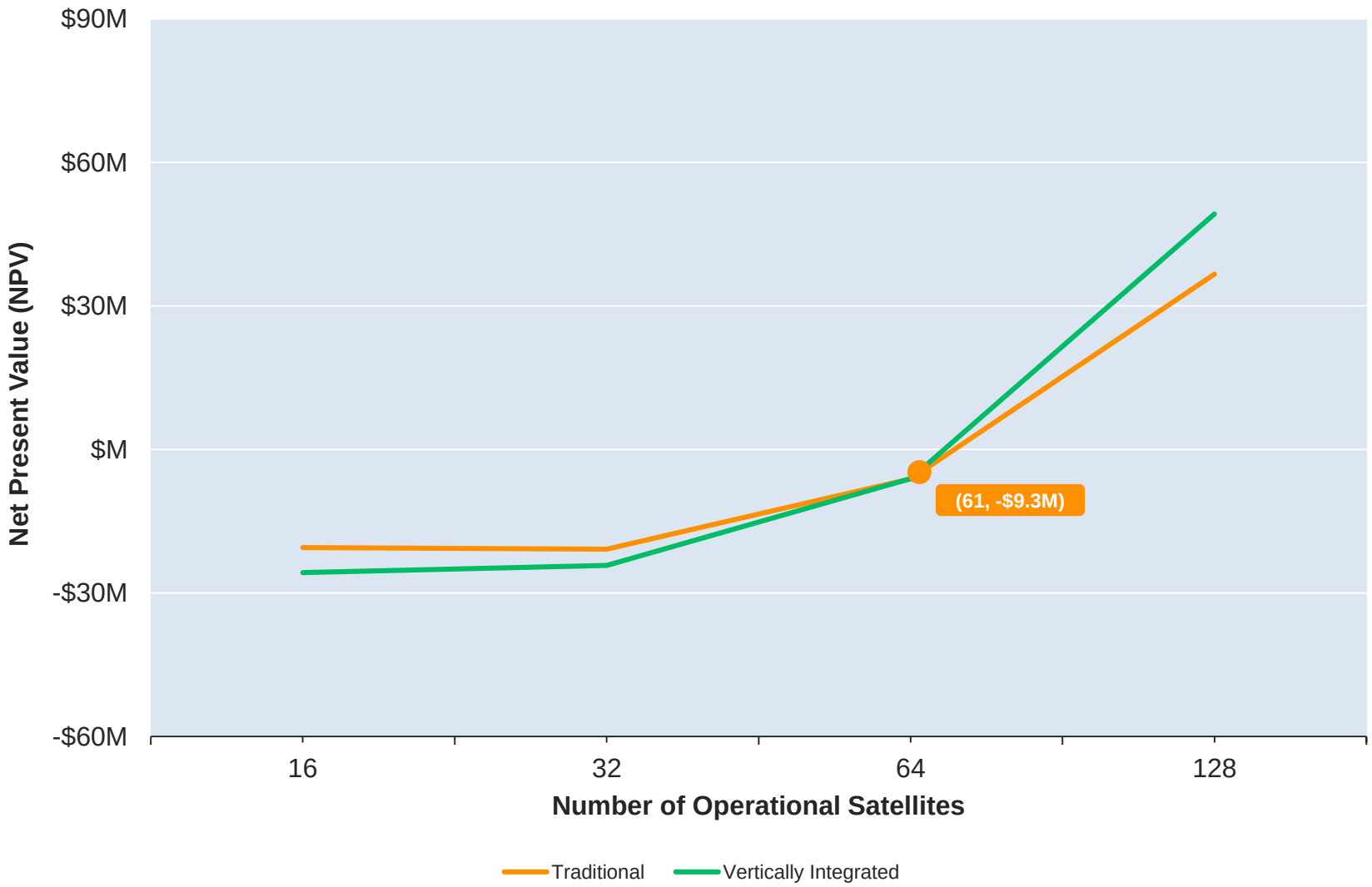


All Cases Assumption	3U Cube Satellite	300 kg Satellite
Development Standard	Commercial	Commercial
Hardware Heritage	Varying (COTS[1] – Make)	Varying (COTS[1] – Make)
Prior Production Units	Various (1 – 1000)	Various (1 – 1000)
Market Power	50/50	75/25
Reliability	70%	97%
Discount Rate	7%	7%
NPV Year	Year 10	Year 10
Max Satellites Per Year	100	64

[1] COTS = Commercial off the Shelf

3U Constellation Results

3U Constellation Results | Baseline Case (7% Discount Rate)

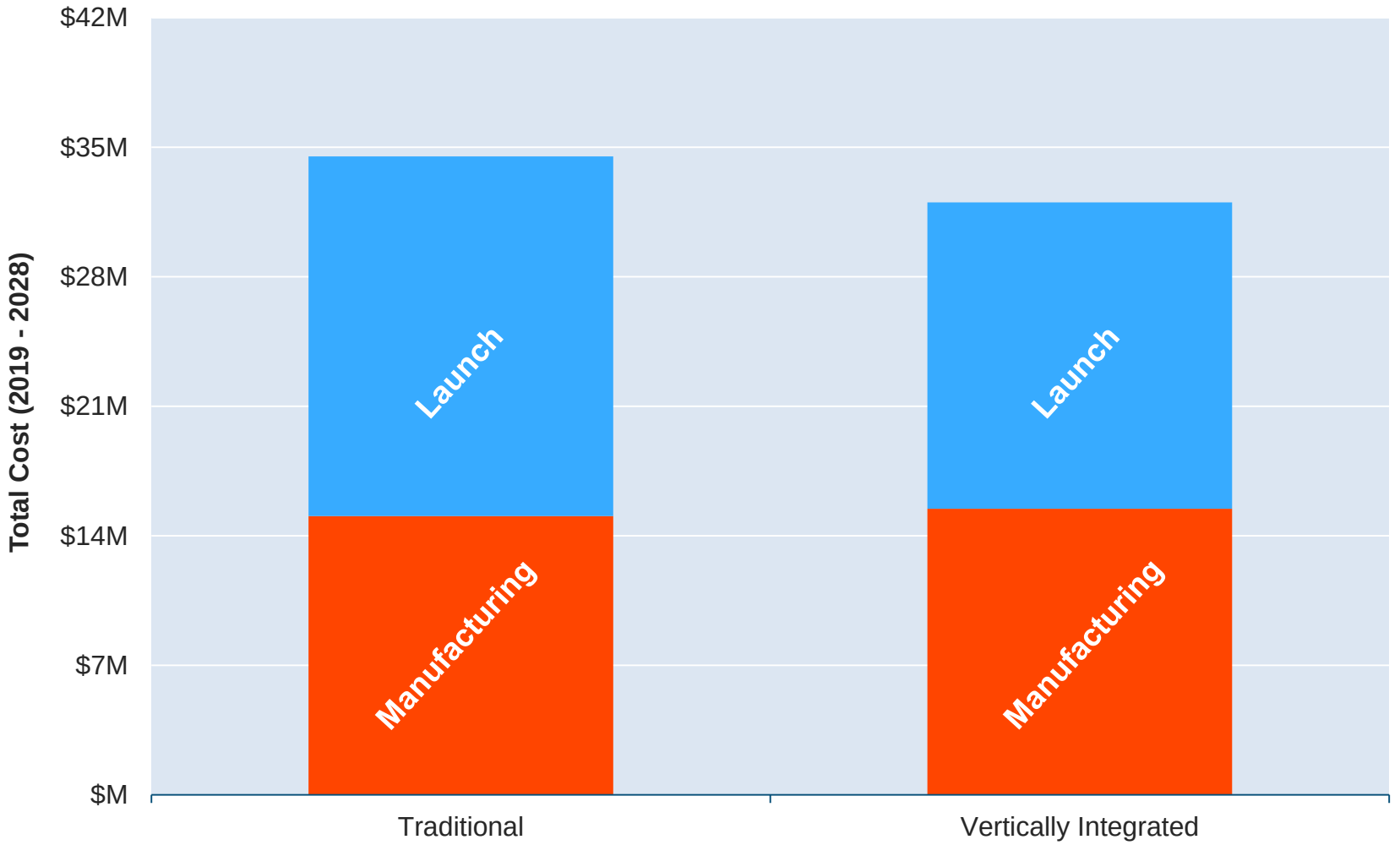


The breakeven for the 3U constellation when evaluating NPV actually shifted inwards, from **67 to 61 satellites**.

An inward shift **defies traditional logic**, as high upfront expenditures in the vertically integrated approach should reduce the NPV.

The resolution for this paradox comes by considering the **impact of launch costs**.

3U Constellation Results | Breakeven Case Mfg. & Launch Costs



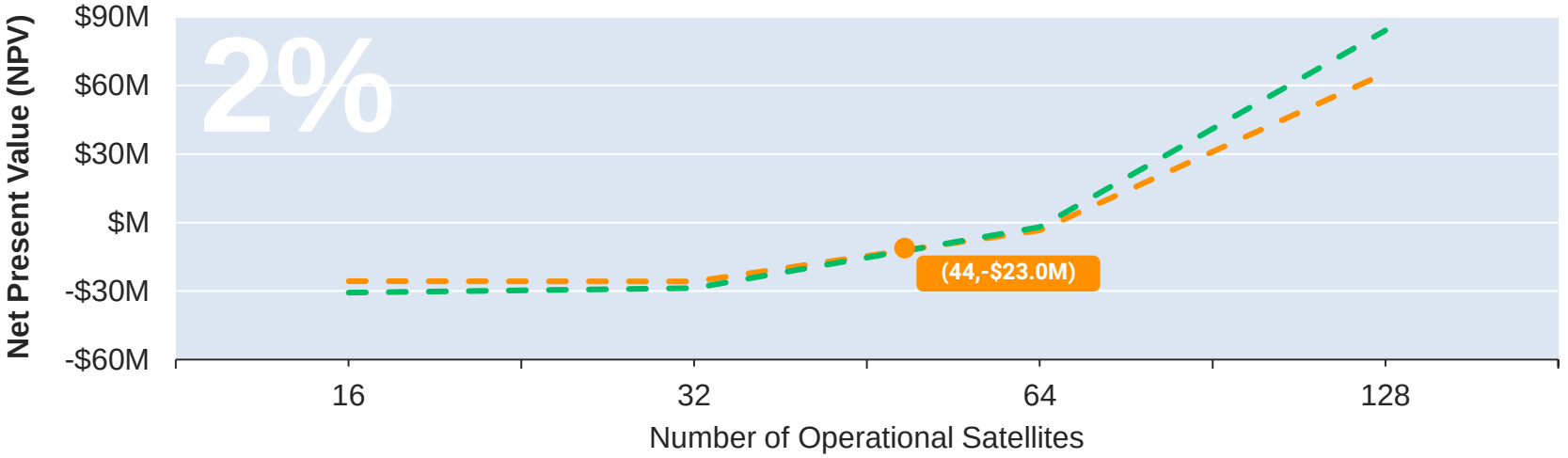
Curiously, launch costs, are **higher in the breakeven case for the** traditional manufacturing approach.

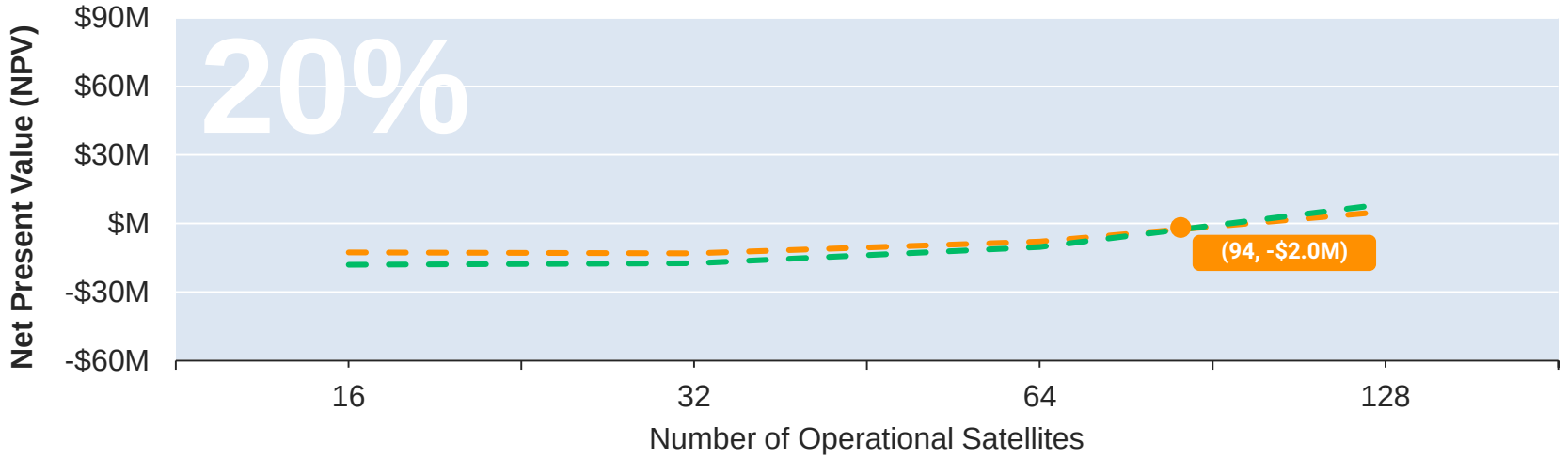
The reason for this is that low reliability rates in the traditional approach **require additional satellites to be launched**.

Although **launch costs occur in later periods**, they are high enough to overcome the NPV penalty occurred by the vertically integrated approach.

The impact of improved quality control is understated when accounting only manufacturing costs – the compounding effect of launch must also be considered

3U Constellation Results | Discount Rate Sensitivities





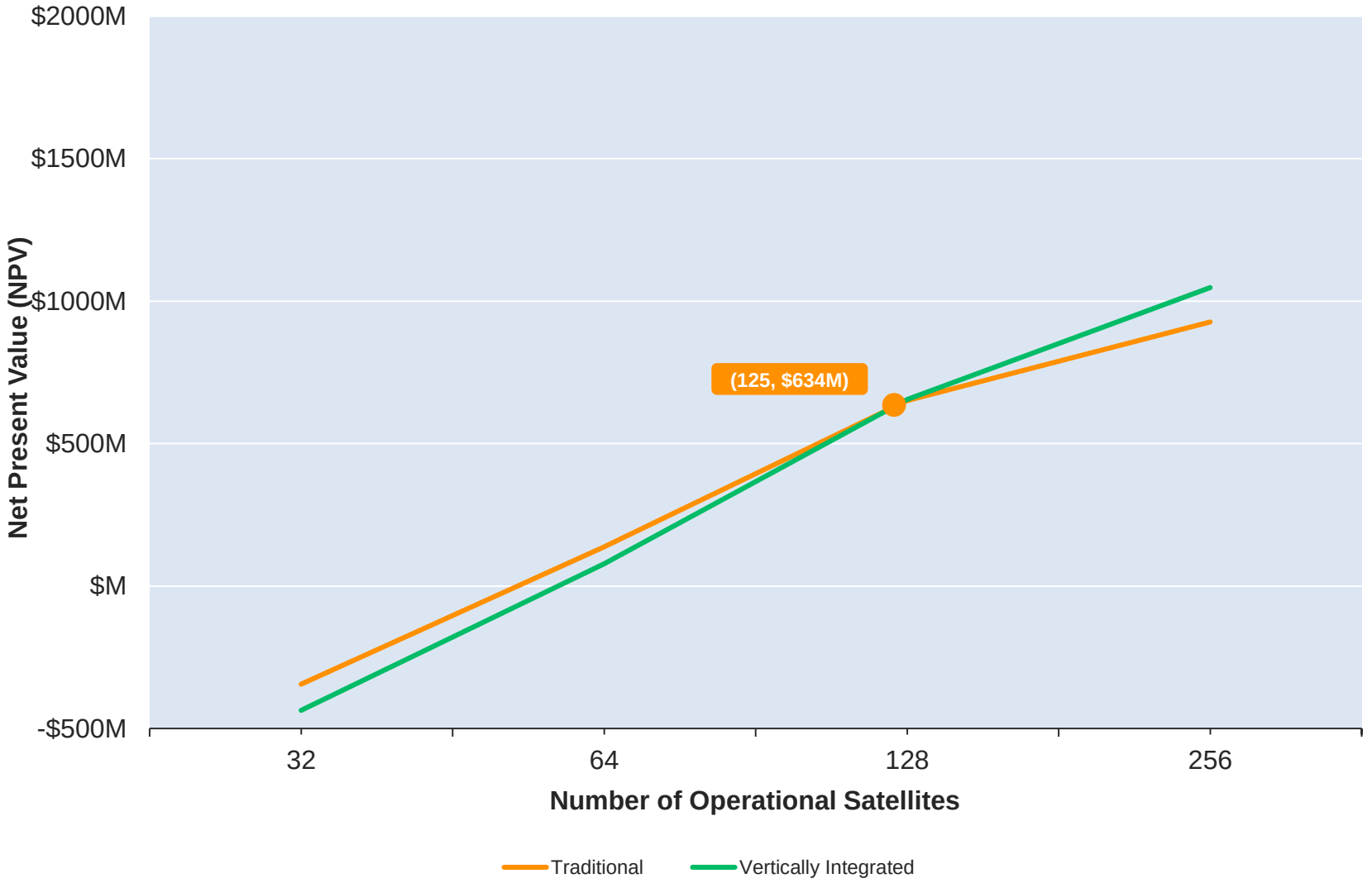
If able to borrow at "risk free" lending rates (2%), vertical integration becomes **more attractive at smaller constellation sizes**.

Conversely, **when capital is expensive** (e.g., a high discount rate), vertical integration becomes less attractive.

Although **not particularly surprising**, these trends shed light on how different borrowing environments impact vertical integration decisions.

300 kg Constellation Results

300kg Constellation Results | Baseline Case (7% Discount Rate)



Integration of NPV calculation has a **dramatic impact** on the 300 kg constellation, shifting the breakeven point by over 50%.

Significant **upfront capital expenditures** associated with satellites of this size are a major contributor to this shift.

Due to higher, and more clustered, reliability rates in this segment, **launch costs do not have a significant effect**, as seen in the 3U segment

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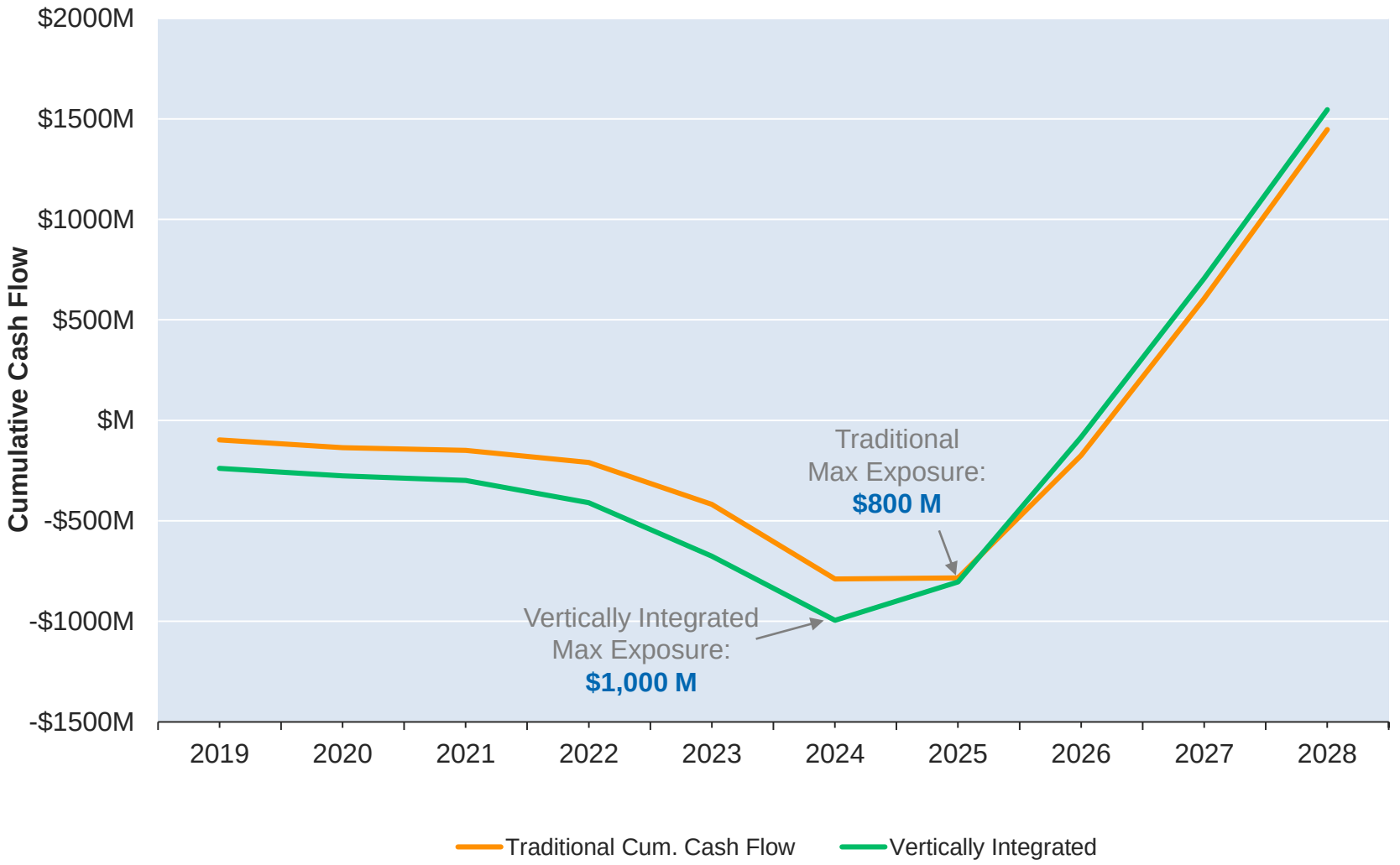
300kg Constellation Results | Breakeven Case Cashflow Comparison

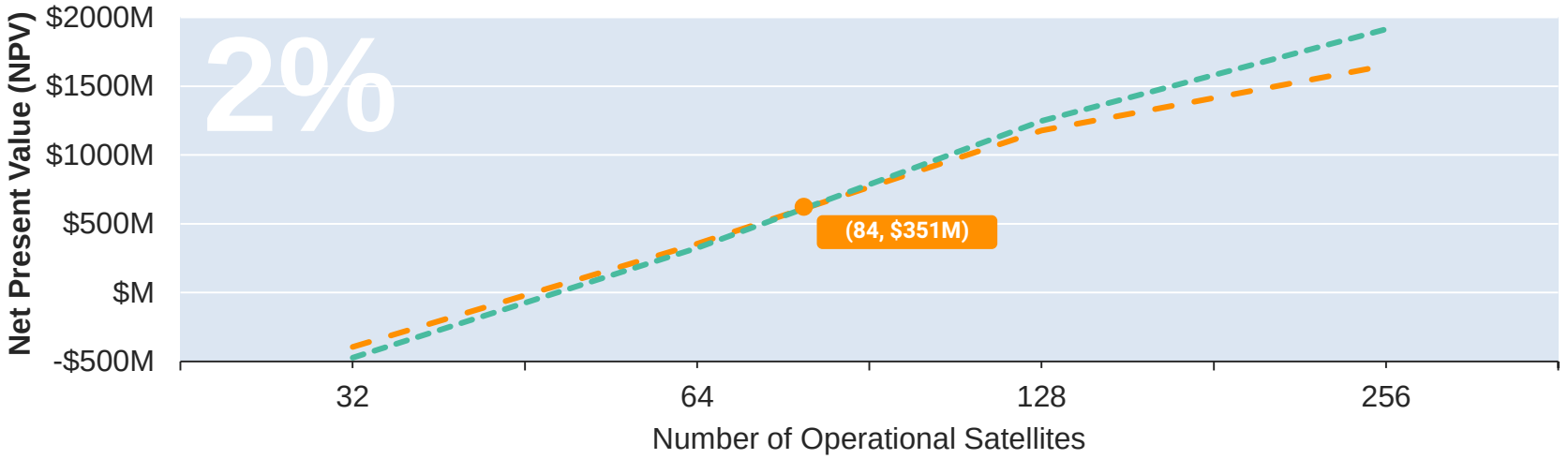


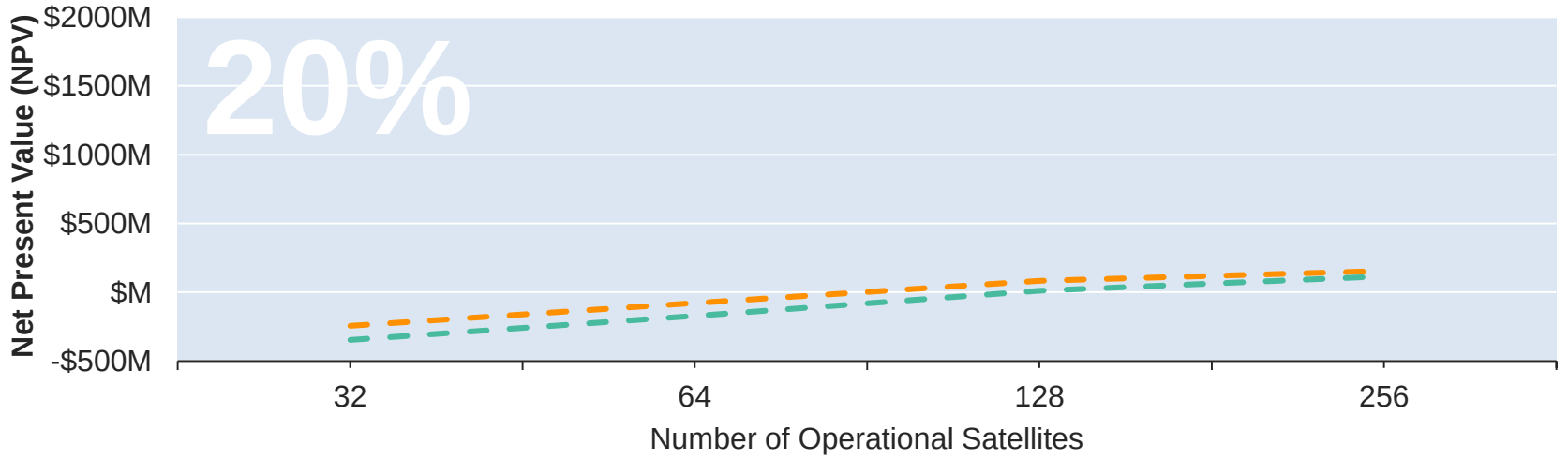
Upfront capital expenditures in this segment are **nearly 10x** what is seen in the 3U segment.

Maximum exposure in this segment occurs in 2024, **2 years after it occurs for the 3U segment**.

This **longer payback cycle shifts the overall constellation breakeven point outwards** by a substantial amount.

300kg Constellation Results | Discount Rate Sensitivities





Additional upfront capital expenditures in this segment make it **highly sensitive to discount rate**.

Just a **5% decrease in discount rate** results in a **corresponding 33% shift** in the constellation breakeven point

When considering a 20% discount rate, the **vertically integrated approach is unable to catch-up** within the window considered.

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In expensive capital borrowing environments, a vertically integrated approach may never be attractive for large satellites, no matter the constellation size

Insights & Analysis

Insights & Analysis | Role of NPV in Evaluating Vertical Integration

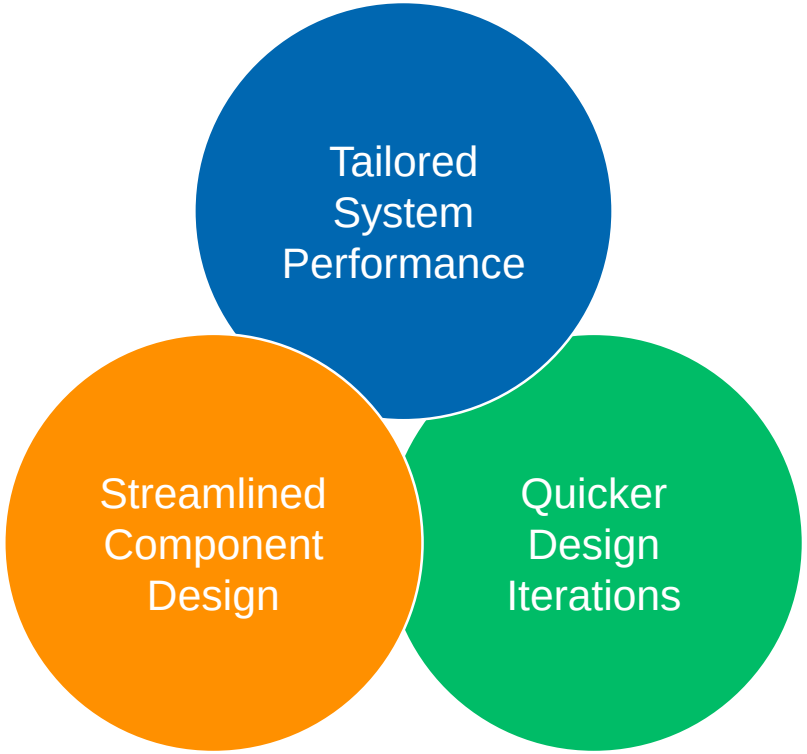
- NPV calculations provide **additional context around the decisions of firms to vertically integrate** in the satellite manufacturing sector
- More specifically, it helps explain why **certain firms are choosing not to vertically integrate** – particularly those firms **reliant on short-term exit strategies**
- The results of this study illustrate that the high upfront capital requirements of a vertically integrated approach **must be considered when evaluating decisions to integrate**
- Discount rate sensitivities further demonstrate that depending on the **capital borrowing environment**, firm decisions **may be substantially altered**

Consideration of NPV (as opposed to only manufacturing cost) shifts the satellite constellation breakeven by as much as 30 – 50%

Insights & Analysis | Impact of Improving Quality Control

- Perhaps the most interesting finding of this study is the **dramatic impact that reliability rates** have on vertical integration decisions
- The benefits of improved quality control are well understood, however, initial research **understated their impact** on constellation costs
- Because failures occur after the satellite is in orbit, launch **effectively doubles the cost** of each failed satellite
- As seen in the 3U case, the additional launch costs associated with **low reliability present in traditional manufacturing approaches** had such a dramatic impact that it actually shifted the breakeven inwards

Vertically Integrated Quality Control Benefits



Source: SpaceWorks Insights

Improved quality control, not increased market power, is likely the strongest driver of vertical integration behavior seen in the marketplace

Insights & Analysis | Capital Borrowing Environment

- Results from the trade study examining sensitivities to discount rates yielded intriguing insights regarding the **impact of the capital borrowing environment** on vertical integration decisions

Capital Type	Approx. Discount Rate
Risk Free Debt	1 – 3%
Publicly Traded Debt	3 – 8%
Publicly Traded Equity	8 – 15%
Private Equity	15 – 20%
Venture Capital Equity	20%+

- For **investors who highly value capital** (such as venture capitalists), **traditional manufacturing approaches may be preferable**, depending on the constellation size
  - This is illustrated particularly well in the 20% discount rate sensitivities (especially the 300 kg case)

- While vertical integration may be **more cost effective in the long-run** (depending on constellation size), the **long payback period may be unattractive** to different types of investors

When capital is cheap, vertical integration is more attractive, while when capital is expensive, traditional approaches are more attractive

Takeaways

Takeaways | Conclusions

- The findings of this study help to **provide greater context** around the **decisions of satellite manufacturers to vertically integrate**
- Specifically, insights generated by this research around **reliability rates** and **launch costs** contribute to a better understanding of why vertical integration is popular for smaller satellite sizes
- Additionally, examination of the constellation size breakeven sensitivity to discount rates illustrate the **impact that the borrowing environment** has on a firm's **evaluation of vertical integration**
- When considering NPV, rather than just manufacturing costs, the updated constellation size breakeven point is **61 satellites** (previously 67) for the **3U constellation** and **125** (previously 76) for the **300 kg constellation**

This study offers an analytic explanation for the increase in vertical integration behavior seen in the marketplace

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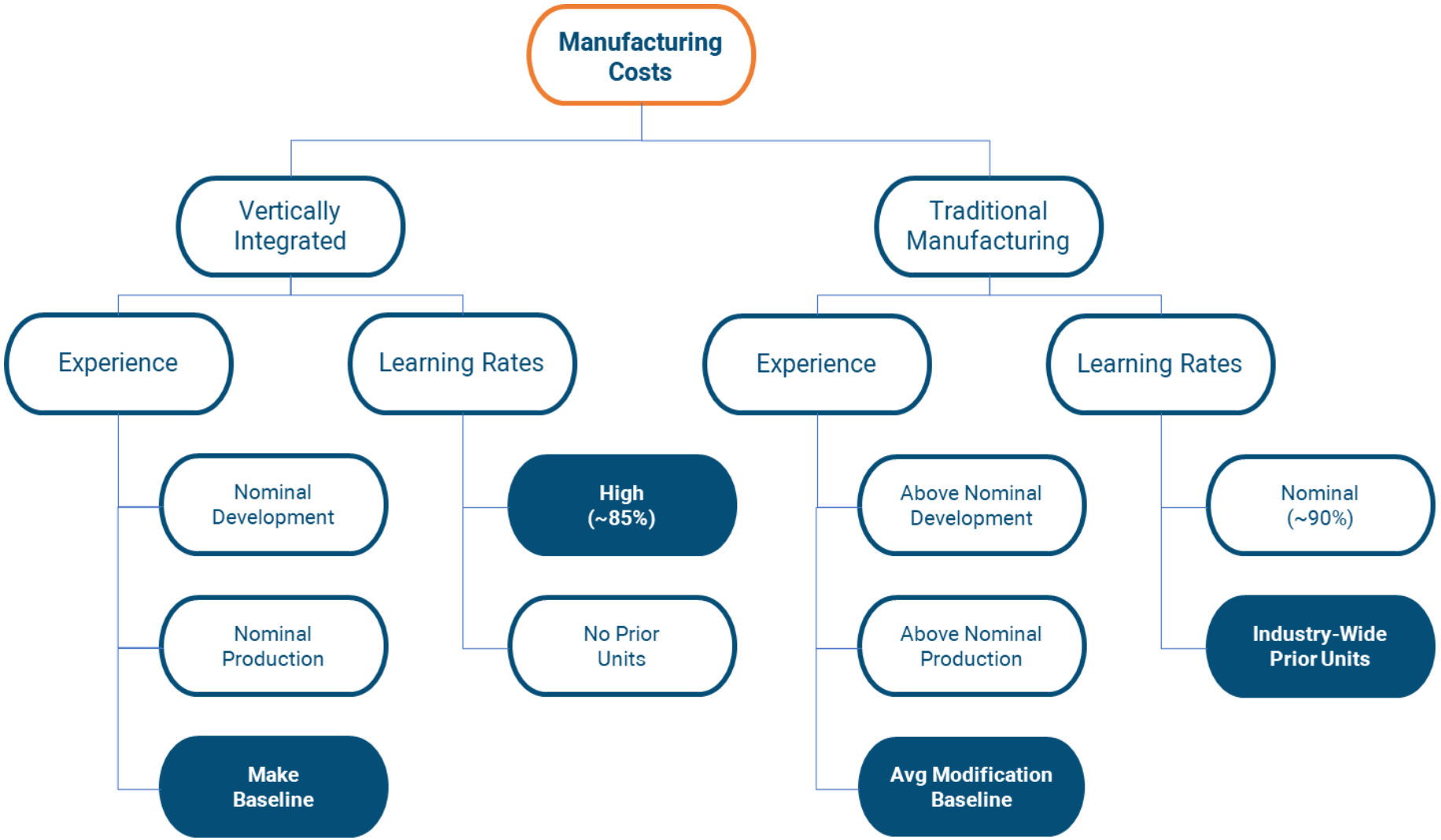
Takeaways | Extensibility to Other Research



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See accompanying paper for general framework to be applied to modeling traditional vs. vertically integrated approaches using industry standard costing tools

Takeaways | Final Thoughts

- Taking a step back from the satellite manufacturing context of this presentation, this study has **broader implications for the field of cost estimation and analysis**
- This research demonstrates how industry-standard cost modeling tools can be used in combination with business case analysis to **understand firm behavior in the marketplace**
- As logical actors, firms are driven by financial motivations, and **proper modeling of the true economic environment can shed light on their behavior**
- While market characteristics may require **new methods and additional layers of abstract** (such as those used for capturing the impact of market power and quality control), accounting for them yields a **more accurate understanding of costs incurred by commercial firms**

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