Assessing the Impact of Operational Constraints on the Near-Term UAS Traffic Management Supported Market

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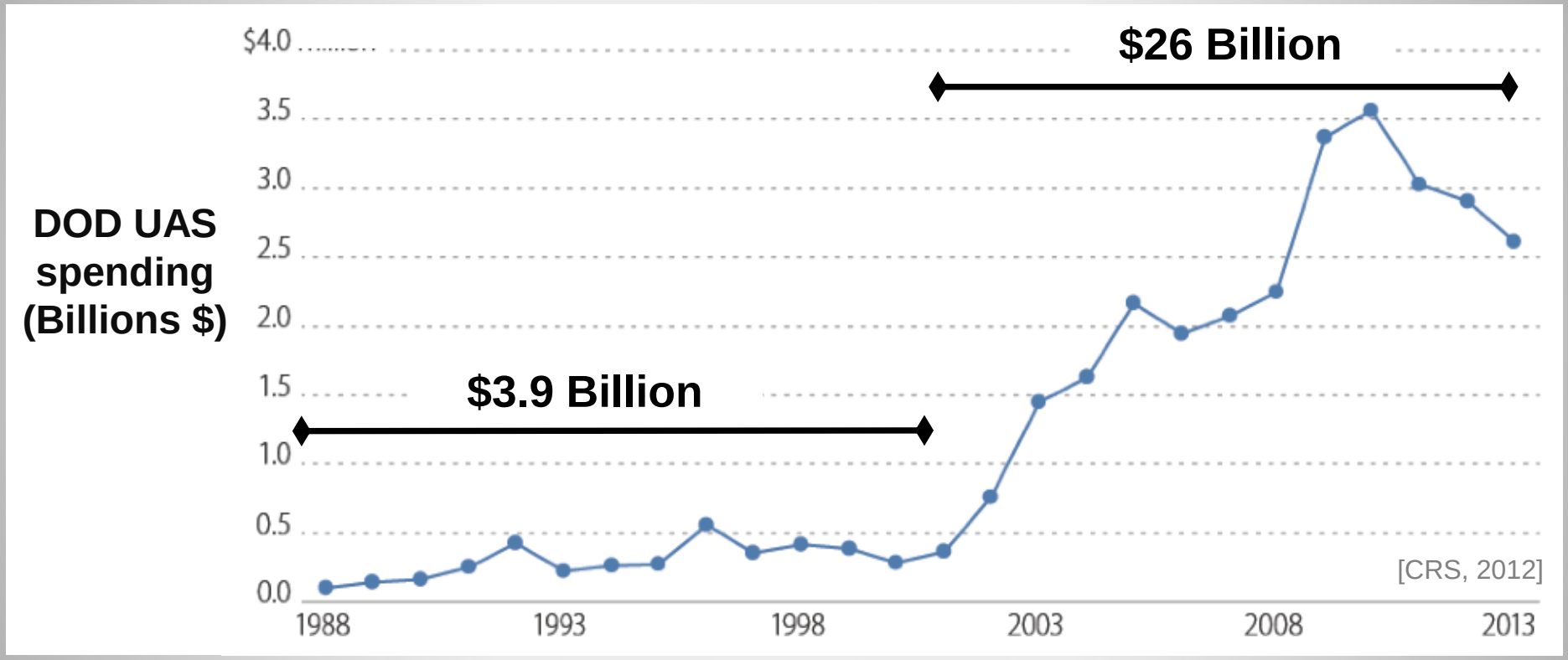
Agenda

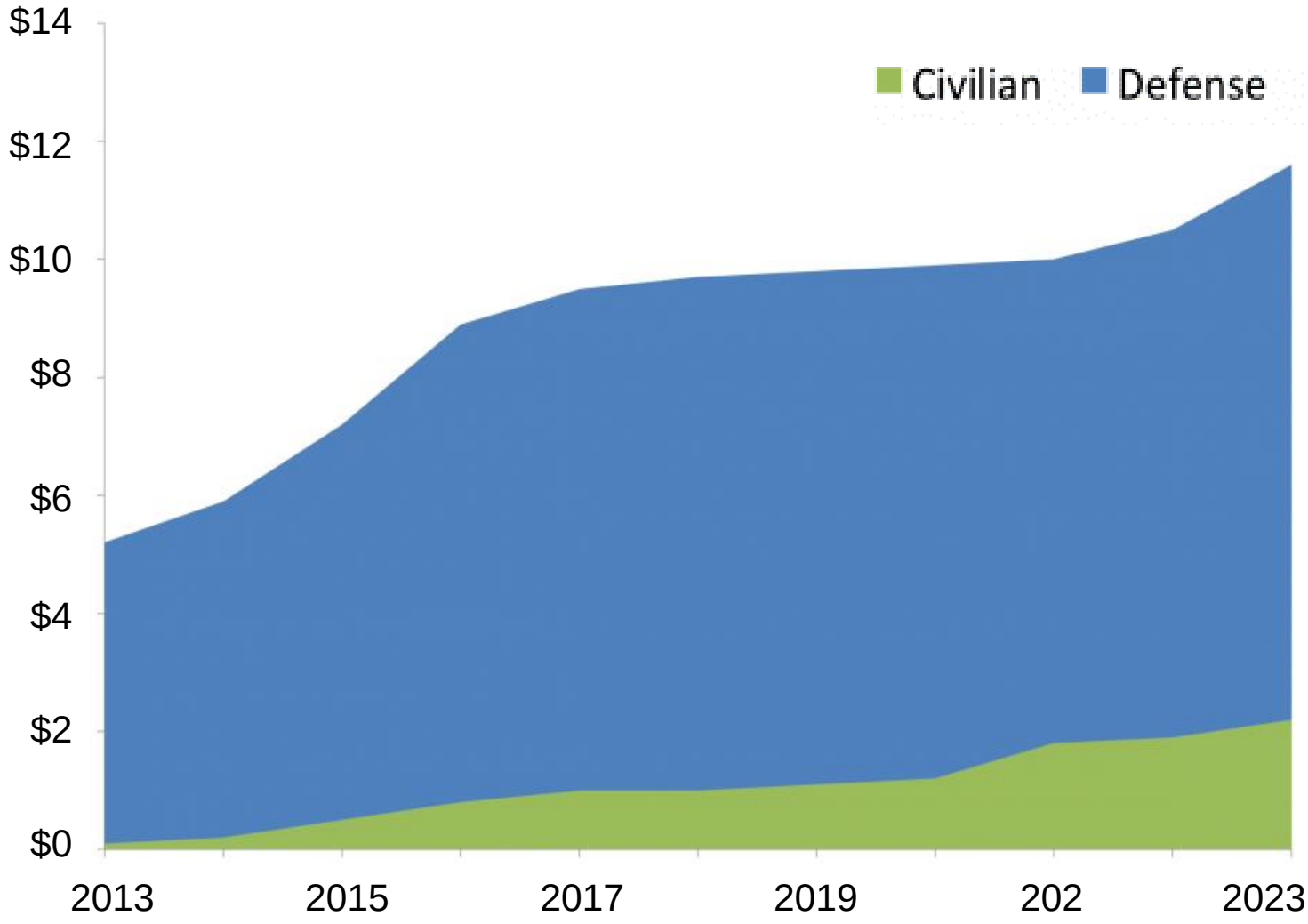
- Motivation
  - Commercial Unmanned Aircraft Systems (UAS)
  - NASA UAS Traffic Management (UTM)
- UAS Application Review
  - Identification of 135 UAS applications
  - Proposal of five comprehensive UAS mission categories
- Market Analysis Methodology
  - Power line sector example
- Market Analysis Forecast for 2020 Commercial UAS Sectors
  - Sensitivities to UTM operational constraints
- Conclusions

DOD UAS Investment



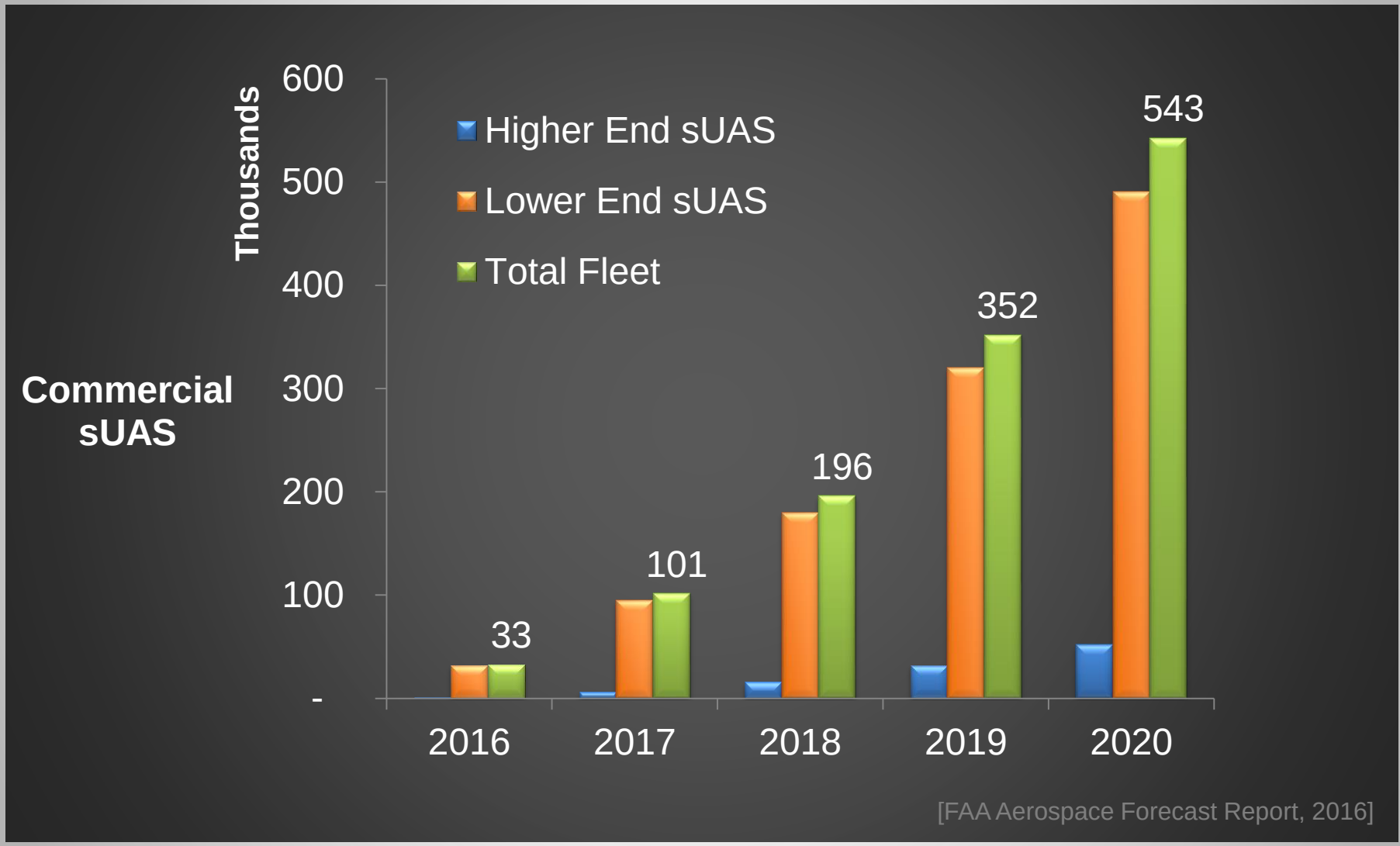
Global Commercial UAS Industry

Global UAS spending (Billions $)



[BI Intelligence, 2014]

US Commercial sUAS Industry



[FAA Aerospace Forecast Report, 2016]

NASA UTM

The NASA Unmanned Aircraft System Traffic Management (UTM) program is committed to ***safely enabling low-altitude airspace and UAS operations***

Research Question

Can a market analysis of the commercial UAS industry through 2020 provide insight into the economic impact of UAS traffic management operational constraints?

Commercial UAS Applications

[A]

[B]

[C]

[D]

Proposed commercial applications for UAS have ballooned over the past two years

[E]

[F]

[G]

[H]

Commercial UAS Applications

- 135 unique UAS applications were identified
- Performance and cost data were collected for nearly 400 UAS
- Five commercial UAS mission categories were identified to capture the diversity of ConOps in the 135 applications

UAS Mission Categories

1. Aerial Photography, Sensing & Surveillance
2. Communications
3. Transportation, Delivery & Interaction
4. Atmospheric & Earth Sciences
5. Audiovisual Presence

UAS Application Down-Selection

- The research considered only TCLs 1 and 2
- 16 representational commercial UAS sectors were defined to host the market analysis
- Each sector had the following traits:
  - Represented one or more application enabled by TCL 1 or 2
  - Substantial UAS market penetration possible by 2020
  - Anticipated to represent a significant market opportunity

UAS Application Down-Selection

Three sectors concerned UAS applications for farming

1. **Cropland Precision Agriculture**
2. **Pasture/Range Management**
3. **Aerial Application**

UAS Application Down-Selection

Five sectors involved the inspection of large infrastructure complexes

1. Cropland Precision Agriculture
2. Pasture/Range Management
3. Aerial Application
4. **Wind Turbine Inspection**
5. **Solar Farm Inspection**
6. **Dam Inspection**
7. **Heavy Industry Inspection**
8. **Communications Tower Inspection**

UAS Application Down-Selection

Five sectors concern the inspection of highly dispersed critical infrastructure

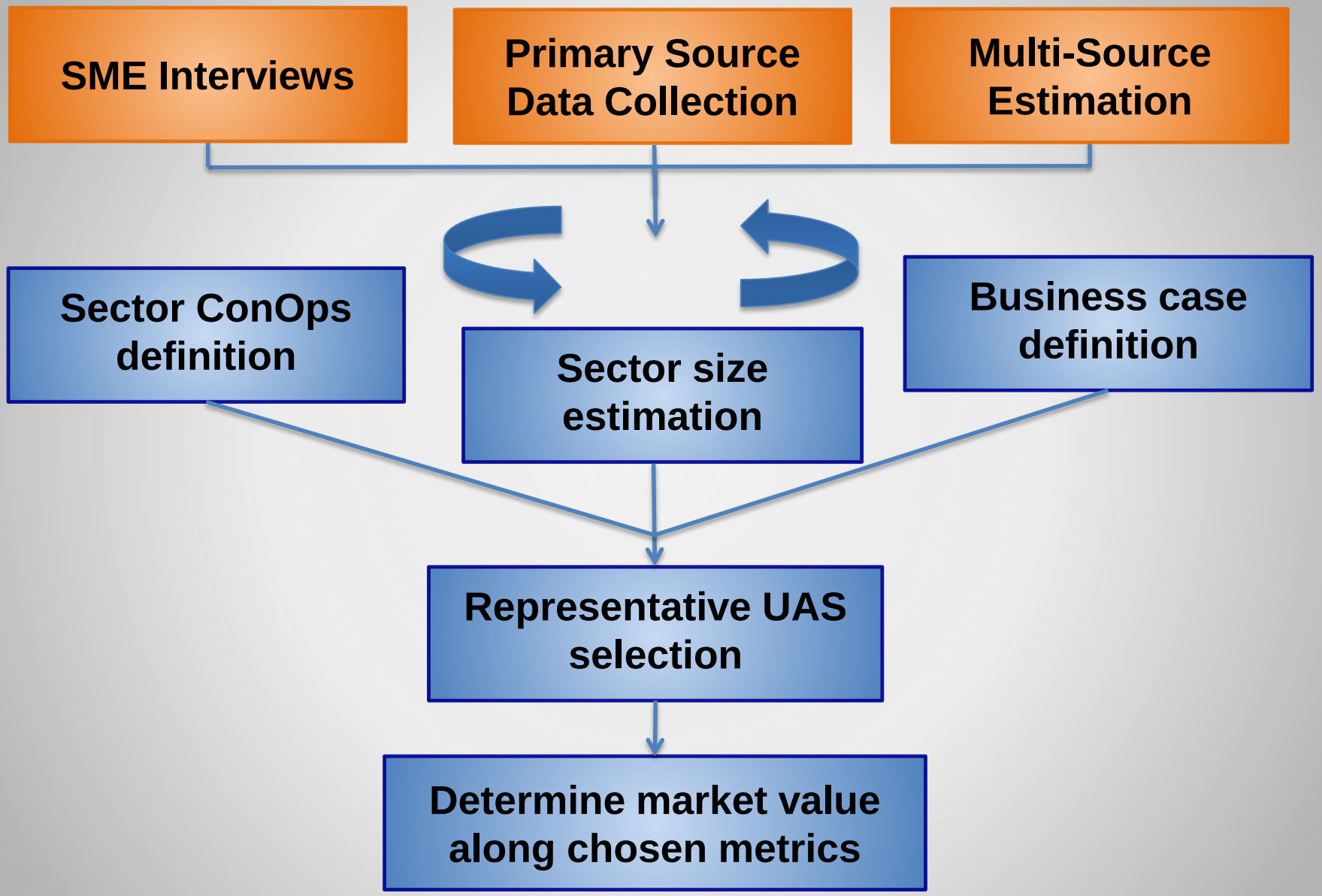
1. Cropland Precision Agriculture
2. Pasture/Range Management
3. Aerial Application
4. Wind Turbine Inspection
5. Solar Farm Inspection
6. Dam Inspection
7. Heavy Industry Inspection
8. Communications Tower Inspection
9. **Pipeline Inspection**
10. **Power Line**
11. **Railroad**
12. **Bridge Inspection**
13. **Trestle Inspection**

UAS Application Down-Selection

Three sectors concern the use of UAS for specialized purposes with changing needs

1. Cropland Precision Agriculture
2. Pasture/Range Management
3. Aerial Application
4. Wind Turbine Inspection
5. Solar Farm Inspection
6. Dam Inspection
7. Heavy Industry Inspection
8. Communications Tower Inspection
9. Pipeline Inspection
10. Power Line
11. Railroad
12. Bridge Inspection
13. Trestle Inspection
14. **Search and Rescue**
15. **Maritime Security & Surveillance**
16. **Construction**

Market Analysis Methodology



Market Analysis Methodology

Power line inspection example

First step: identify and characterize the various UAS application ConOps in the sector

1. **Power Line Patrol –** power line overflight
2. **Pylon Inspection –** pylon hovering
3. **Climber Assist –** rope lifting
4. **Construction –** wire stringing

Market Analysis Methodology

Power line inspection example

First step: identify and characterize the various UAS application ConOps in the sector

1. **Power Line Patrol –** power line overflight
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3. **Climber Assist –** rope lifting
4. **Construction –** wire stringing

Only power line and pylon inspection will be supported by TCLs 1 and 2

Market Analysis Methodology

Power line inspection example

Second step: characterize the sector size and market penetration potential

Sector Size Statistic	Value
2010 High Voltage Transmission Lines (miles)	288,418
% of Transmission Lines in Rural Areas	75%
Annual Inspection Rate of Transmission Lines	100%
Average Span between Transmission Line Pylon (ft)	750
Annual Detailed Inspection of Pylons	50%

Market Penetration	Base	Medium	High
UAS Transmission Line Inspection	20%	35%	50%
UAS Transmission Line Pylon Inspection	10%	25%	50%

Market Analysis Methodology

Power line inspection example

Third step: establish the business case for the proposed sector:

- For power lines, current industry costs were determined through the published financials
- UAS service costs were estimated from SME information, available published rates, or a cost based approach

Visual Patrol Business Case Data	Value
UAS Fee per Hour (2015 $)	$500
UAS Vehicle Price (2015 $)	$50,000
Current Visual Patrol Cost (per mile)	$109.69
Inspection Time Reduction	20%
Production Downtime Reduction	10%

Market Analysis Methodology

Power line inspection example

Third step: establish the business case for the proposed sector:

- For power lines, current industry costs were determined through the published financials
- UAS service costs were estimated from SME information, available published rates, or a cost based approach

Pylon Inspection Business Case Data	Value
UAS Fee per Hour (2015 $)	$150
UAS Vehicle Price (2015 $)	$20,000
Current Pylon Inspection Cost (per pylon)	$72.71

Market Analysis Methodology

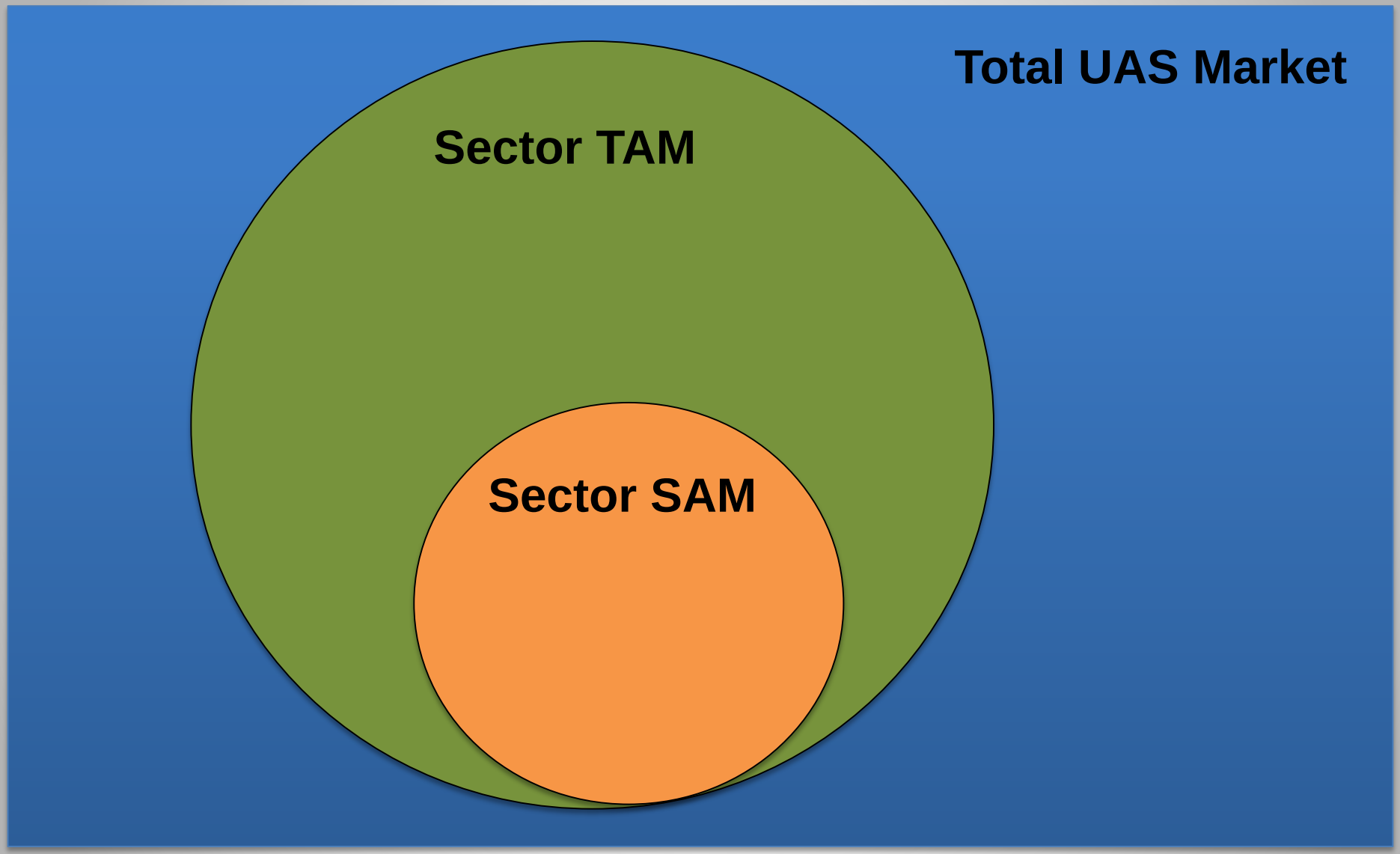
Unlike previous UAS market analyses, a variety of market parameters were utilized to provide a holistic picture of the potential impact of UAS on the sector

The first two metrics concern the market opportunity available to a UAS service provider (internal or external to a client)

1. **Total Addressable Market (TAM)** – Revenue opportunity for a UAS service provider if 100% market penetration were achieved

2. **Serviceable Addressable Market (SAM)** – Revenue opportunity for a UAS service provider considering limitations such as market penetration, service scalability, and non-UAS competition

Market Analysis Methodology



Market Analysis Methodology

3. **UAS Application Industry Size** – Number of UAS service providers needed to meet the market service demands

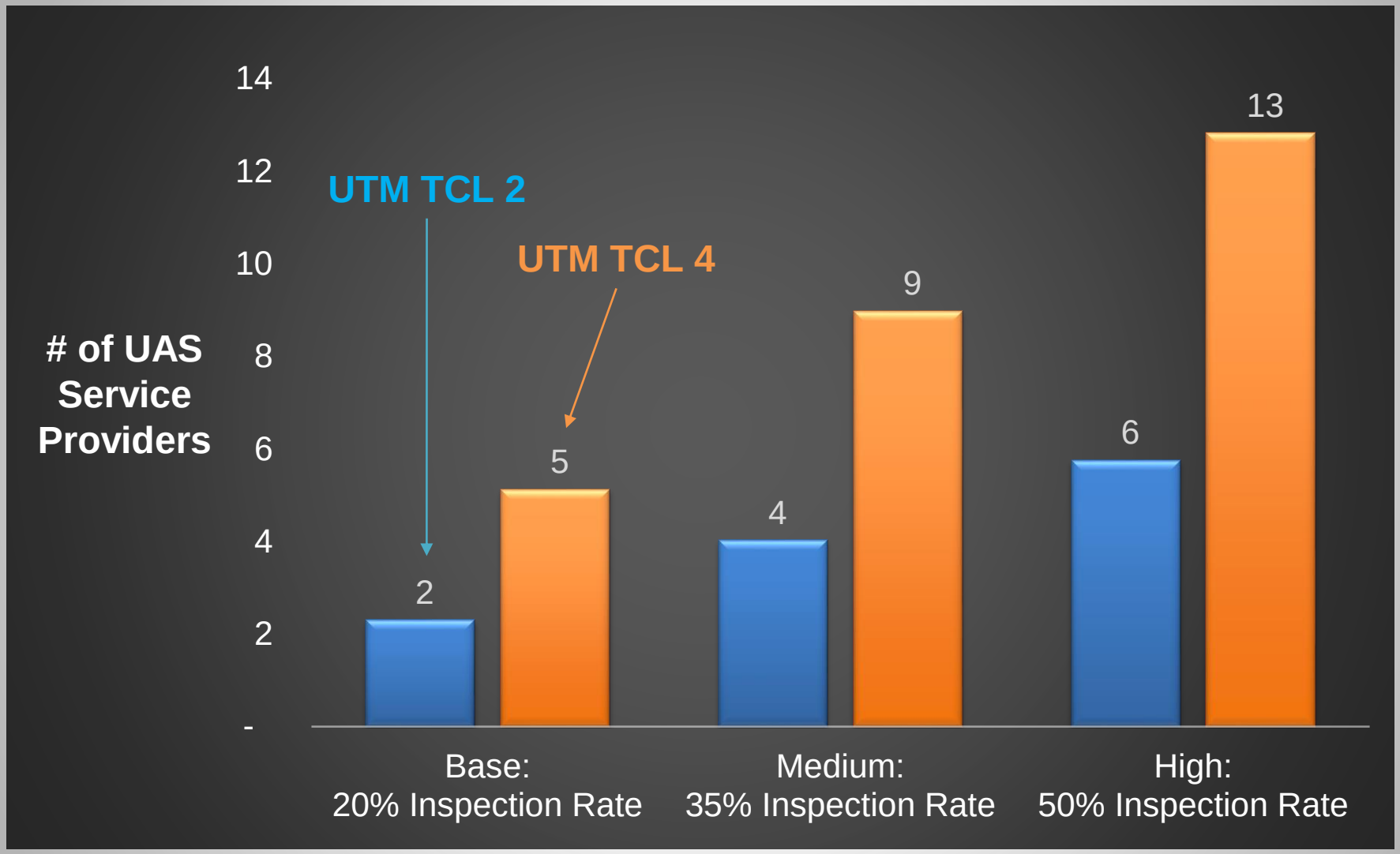
4. **UAS Capital Investment** – Manufacturer sales of UAS equipment necessary to meet the demands of the UAS service provider

5. **Operations Savings Potential** – financial savings switching to UAS services from conventional services

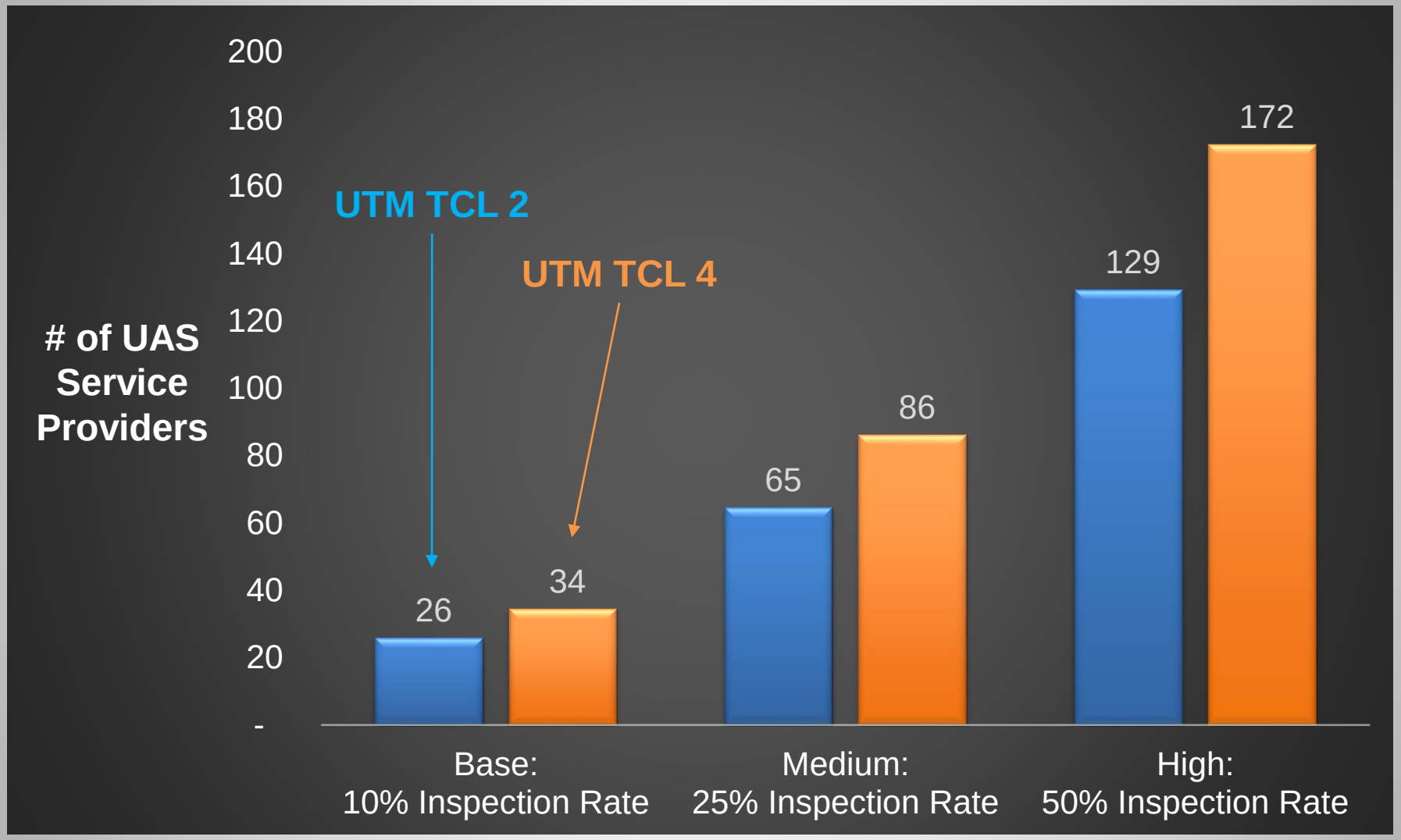
6. **Revenue Recovery Potential** – Value of “production recovery” or “failure avoidance” due to switch to UAS

7. **Safety Improvement Potential** – Value of safety improvements resulting from UAS operation

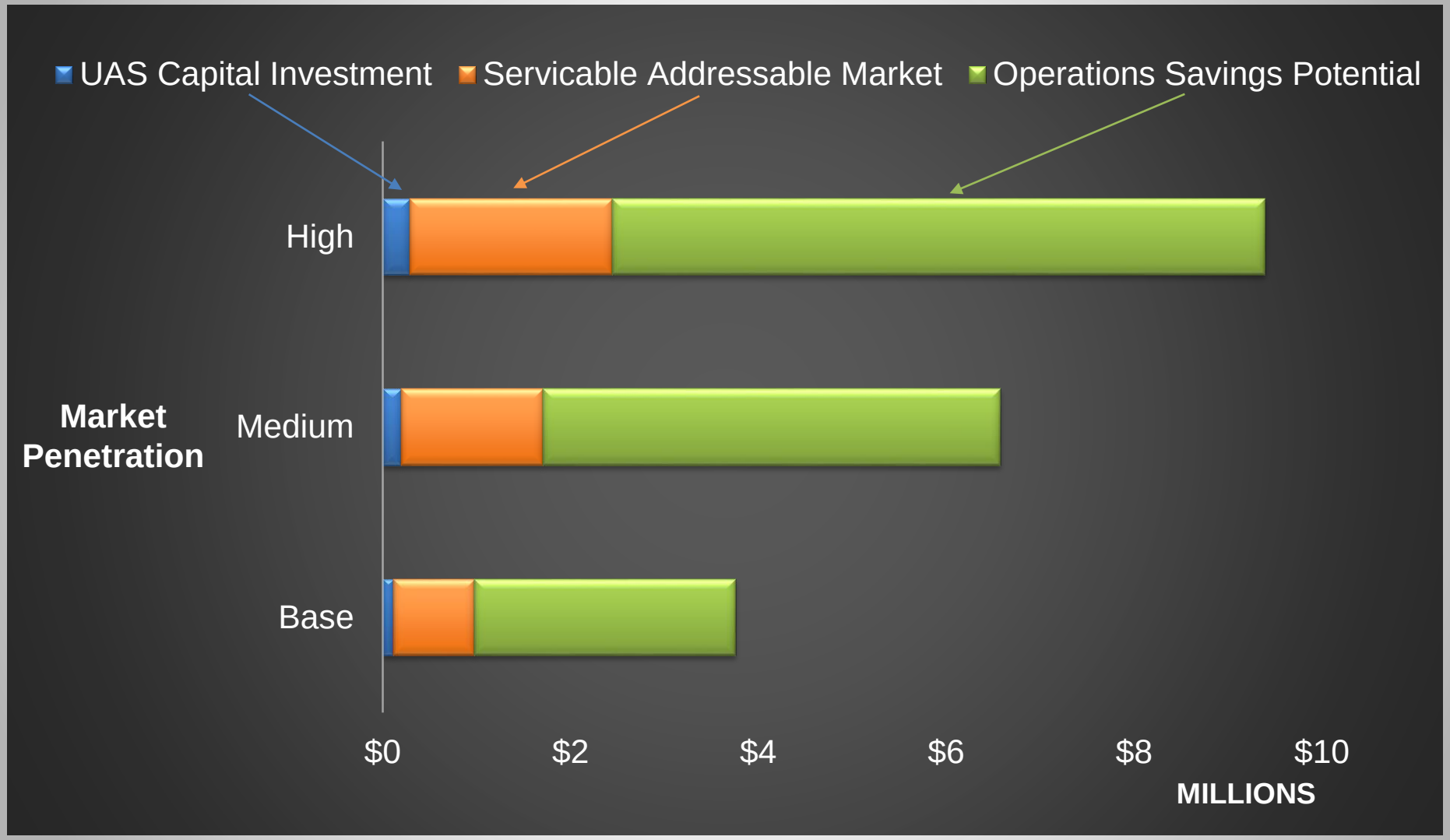
Power Line Visual Inspection Sector Size



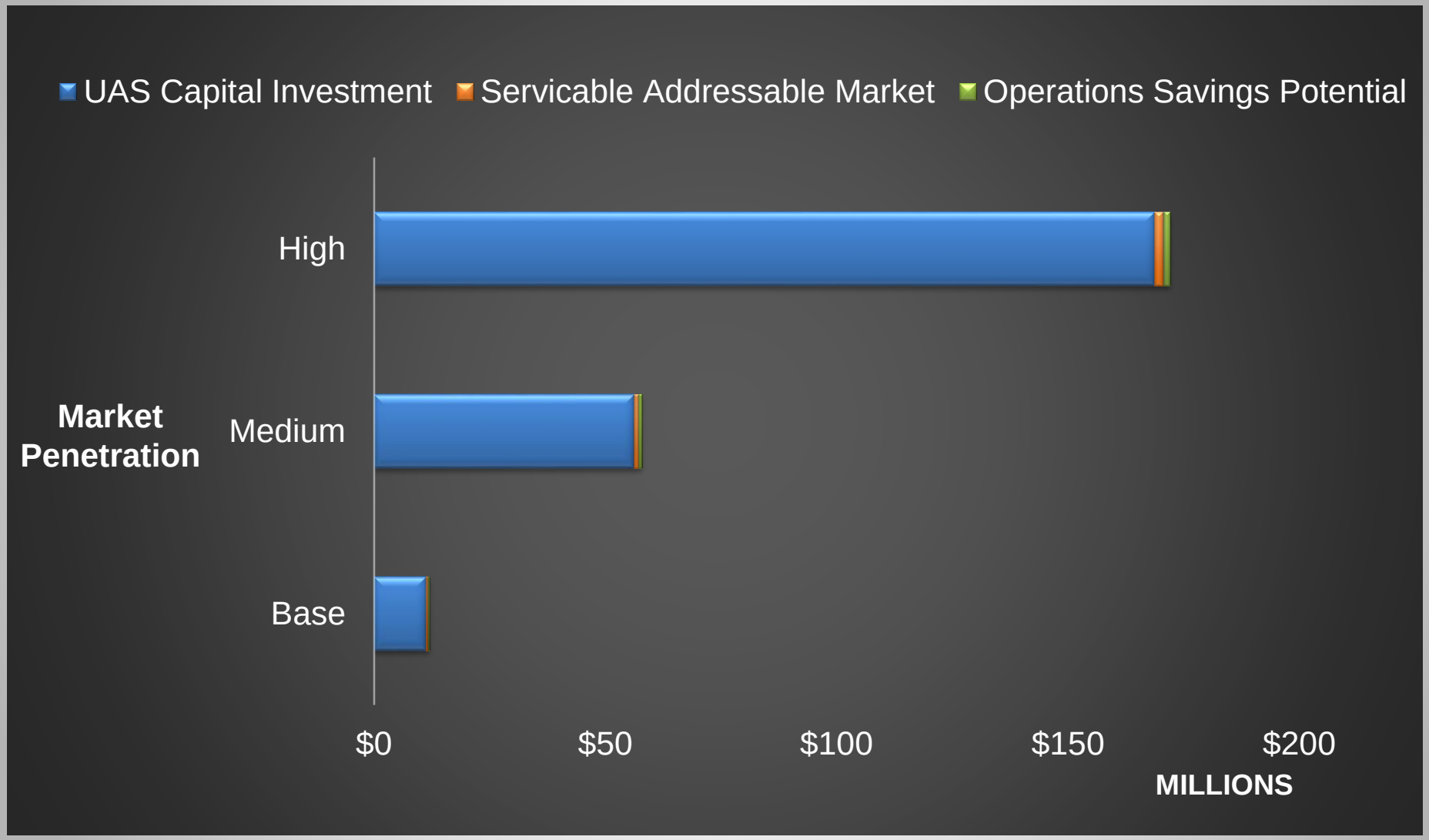
Power Line Pylon Inspection Sector Size



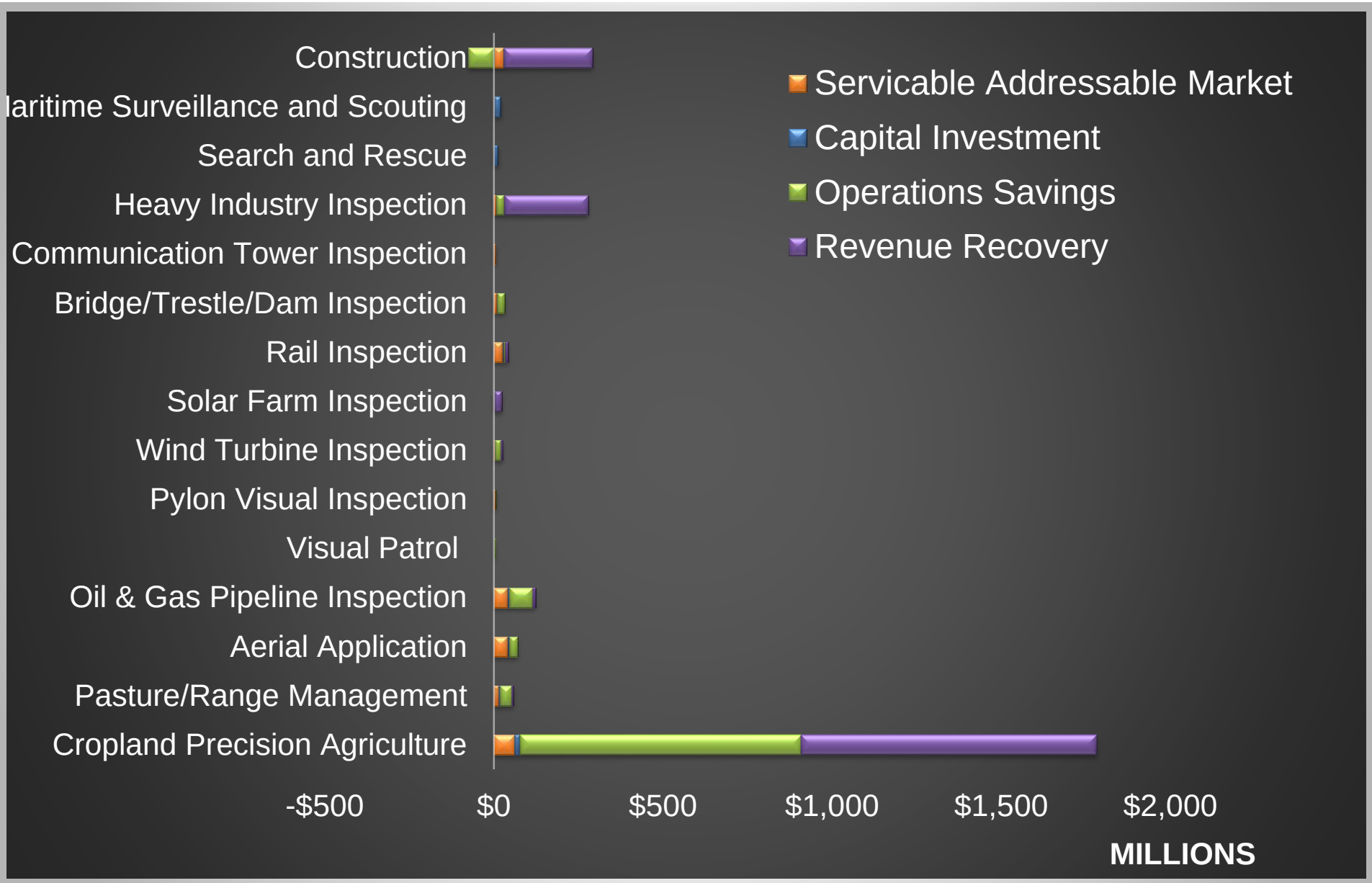
Power Line TCL 2 Visual Patrol Market Analysis



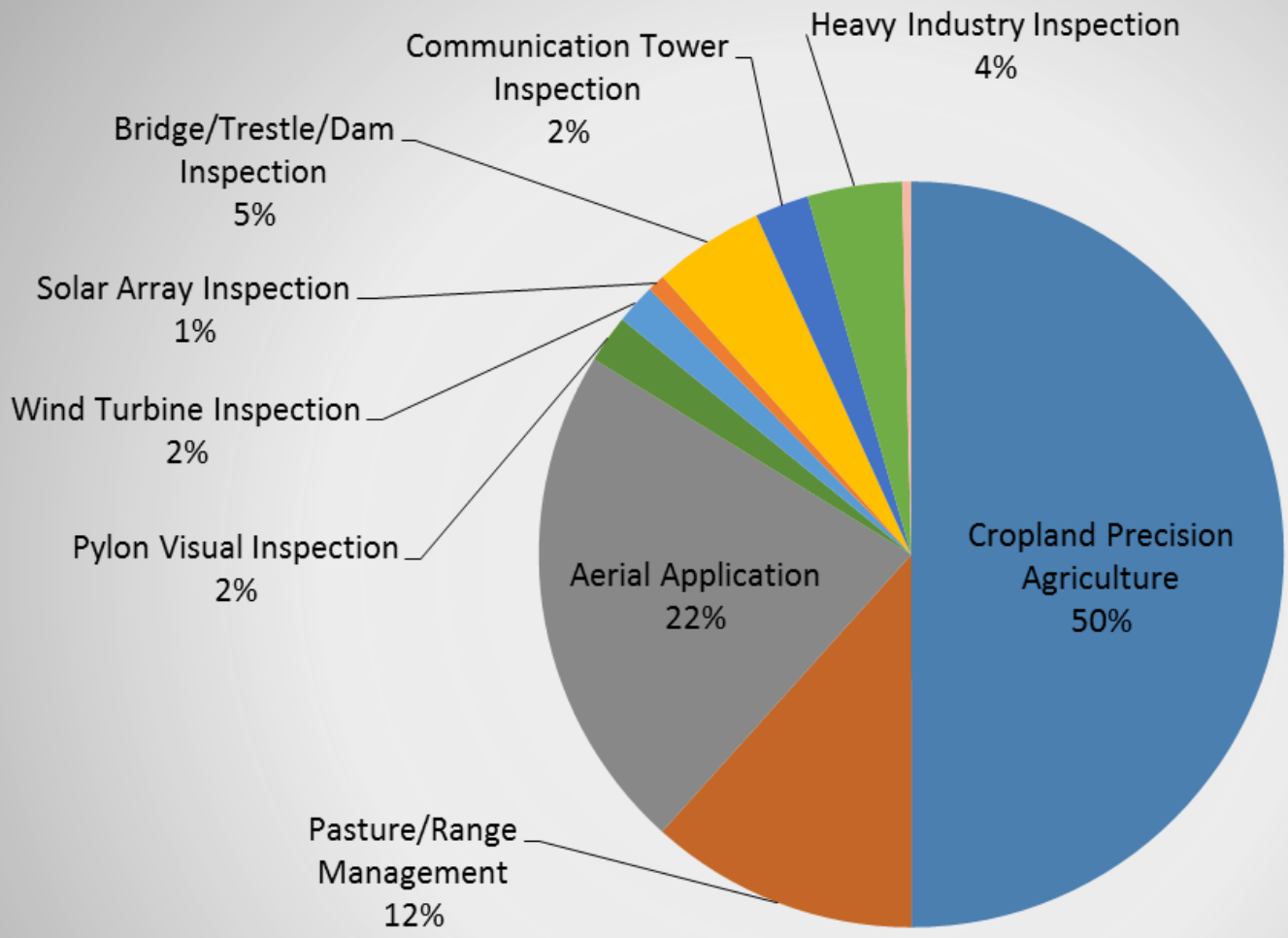
Search and Rescue TCL 2 Market Analysis



Sector Snapshots for UTM TCLs 1 & 2



UTM TCL 1 Sector SAM Snapshot

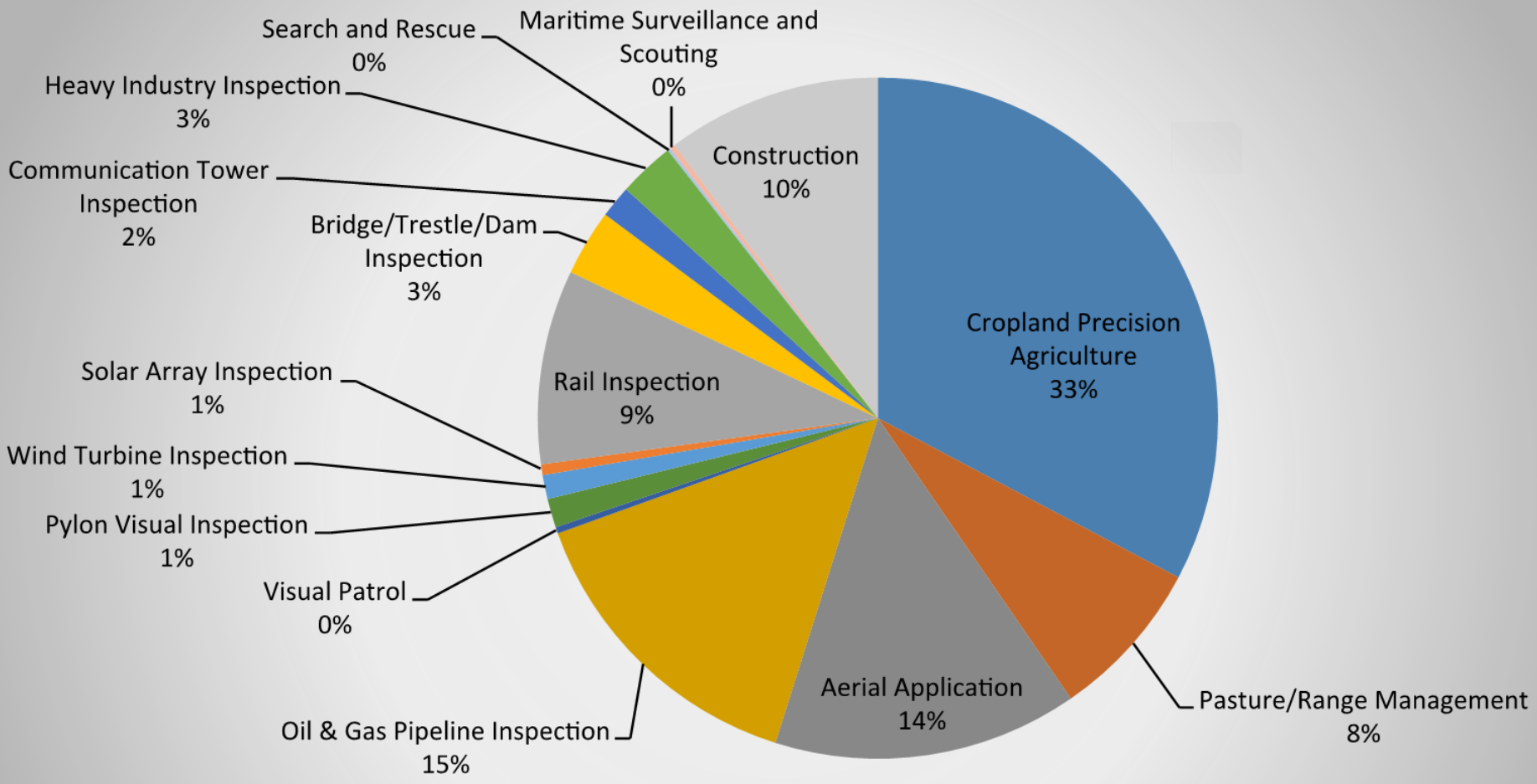


Assumptions

- base level market penetration
- independent service provider model

Total SAM: $215,000,000

UTM TCL 2 Sector SAM Snapshot



Assumptions

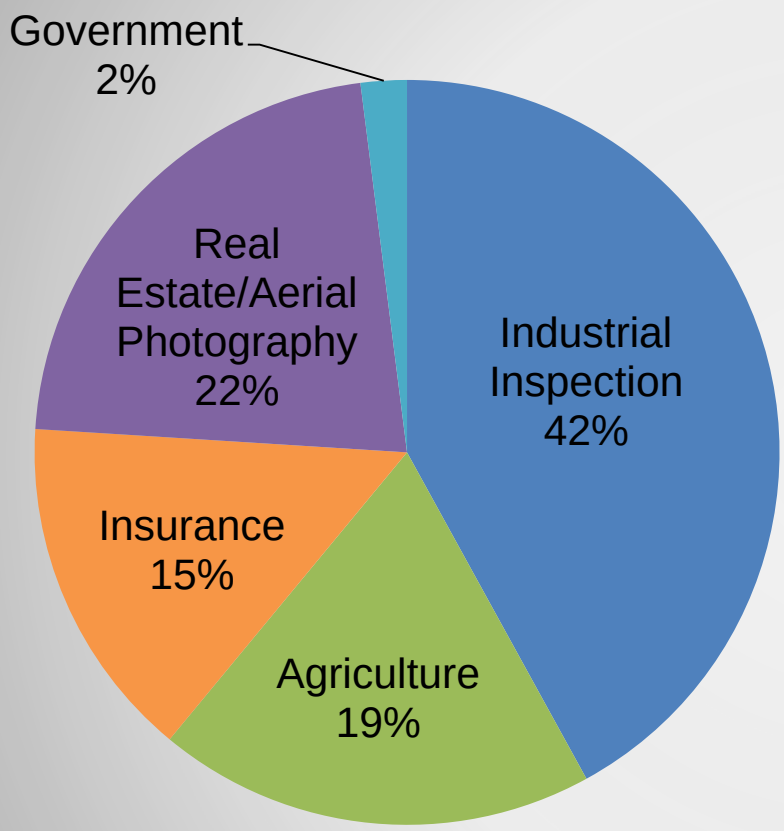
- base level market penetration
- independent service provider model

Total SAM: $284,000,000

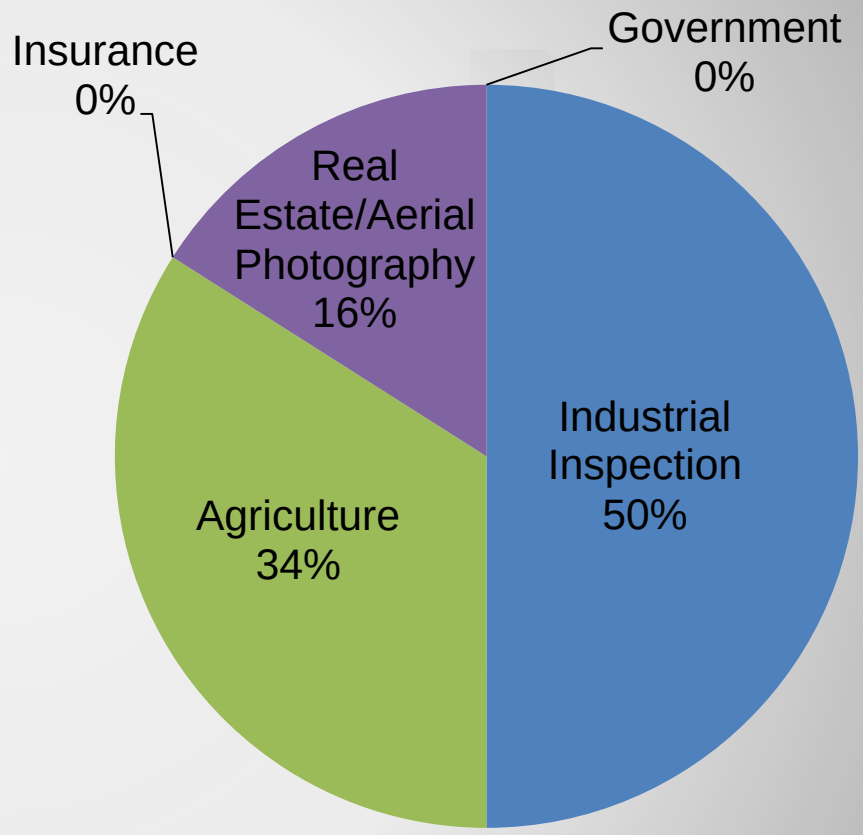
Comparison to FAA Aerospace Forecast

Top 5 sUAS sectors

FAA 2016 Aerospace Forecast



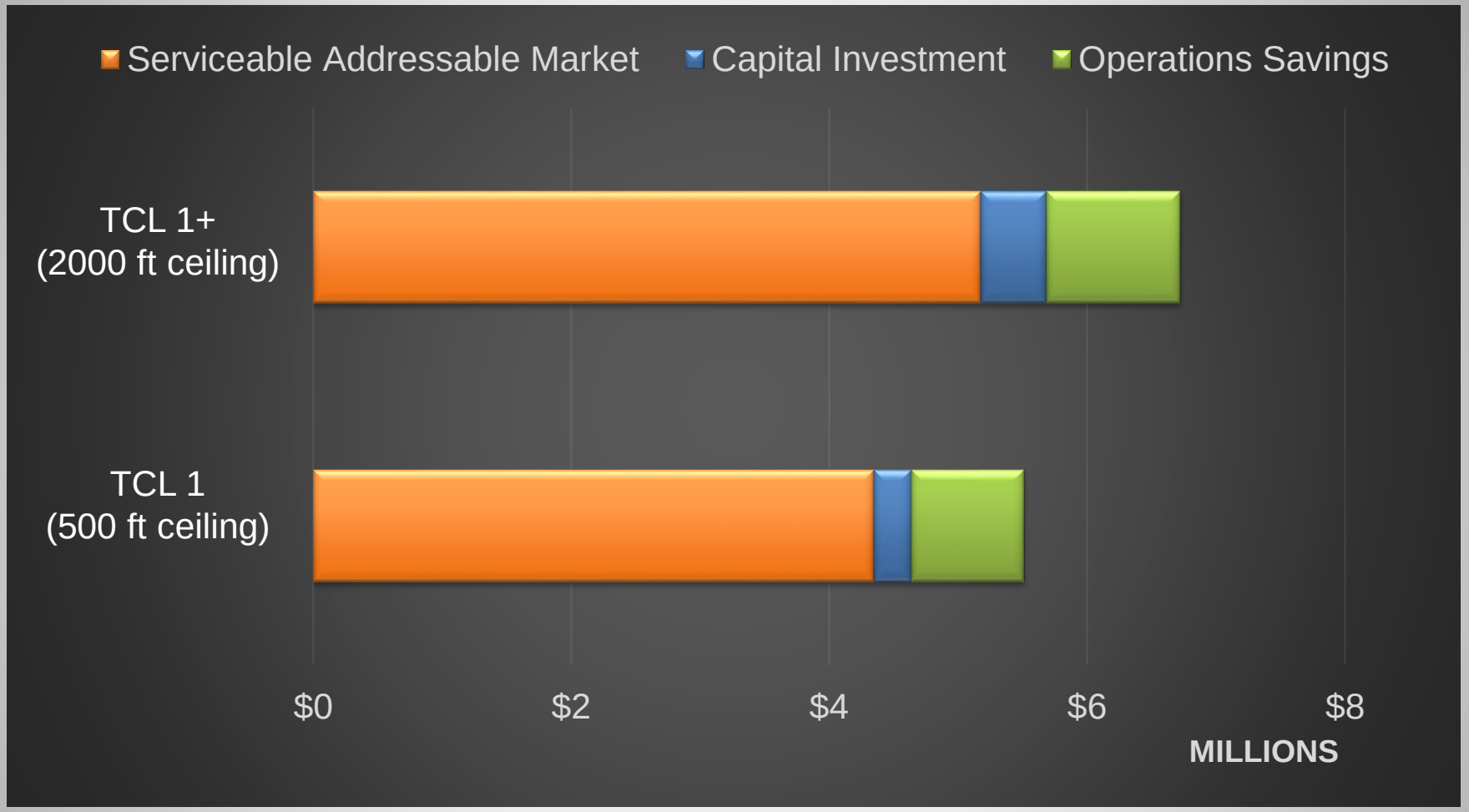
TCL 2 Study Findings



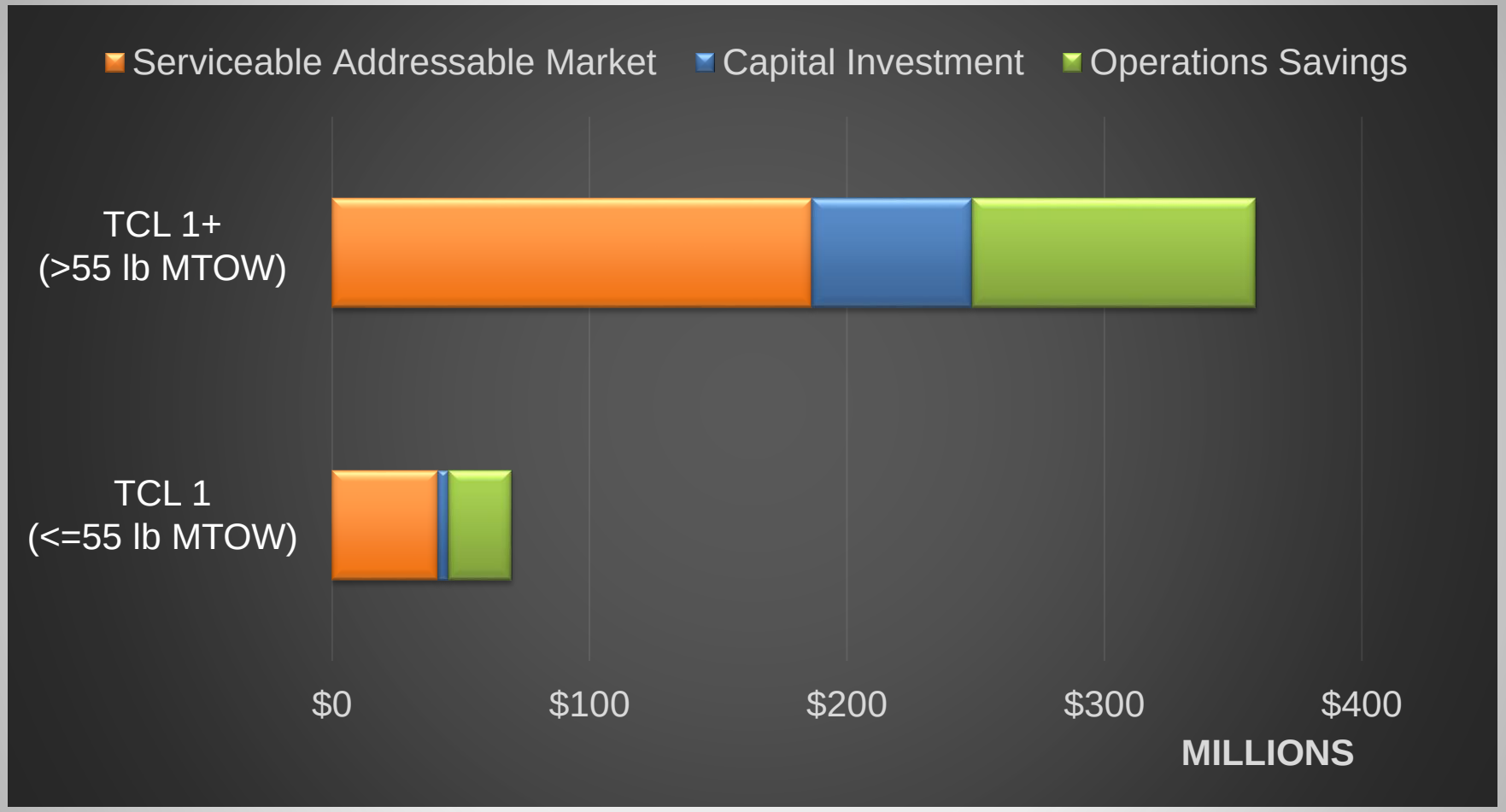
Assumptions

- base level market penetration
- mixed service provider model

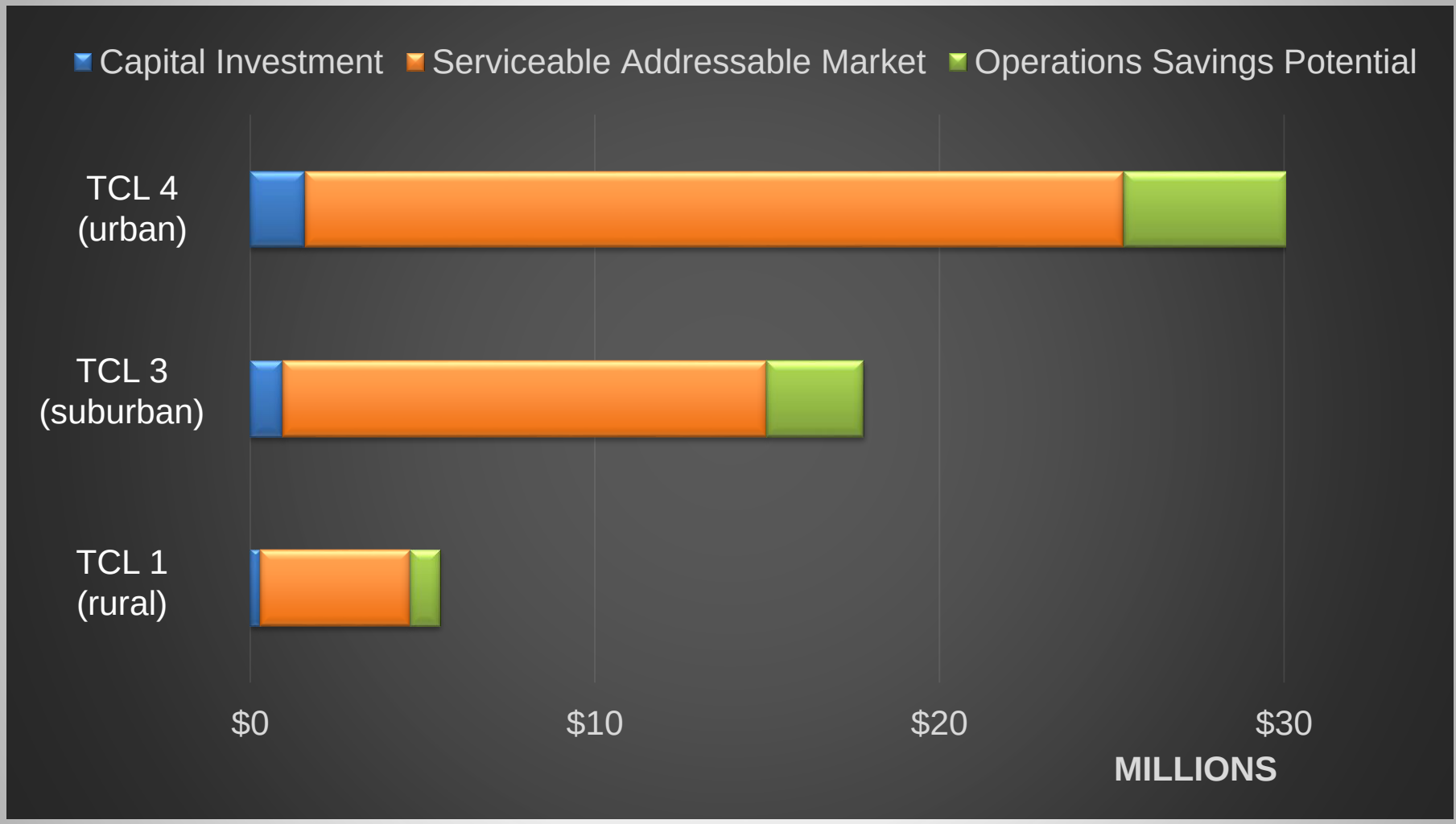
Communications Tower Inspection Operating Altitude Constraint Sensitivity



Aerial Application Maximum Takeoff Weight Operating Constraint Sensitivity



Communications Tower Inspection Population Density Overflight Sensitivity



Conclusion

Can a market analysis of the commercial UAS industry through 2020 provide insight into the economic impacts of UAS traffic management operational constraints?

- 16 leading market sectors were defined that are *enabled* by UTM Technology Capability Level (TCL) 1 or 2
- Agricultural UAS sectors represent the largest early adopter markets
- Sensitivity studies found population overflight and line of sight constraints to have a significant impact on numerous sectors
- Maximum ceiling and takeoff weight constraints significantly impacted a few specific sectors

Thank you

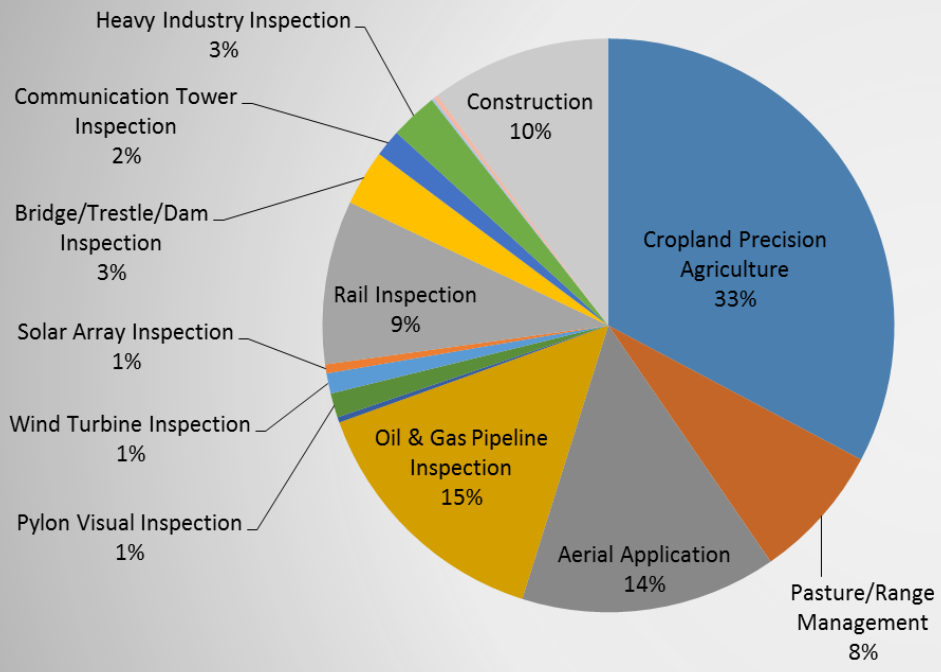
QUESTIONS?

References

Provider Model Sensitivity

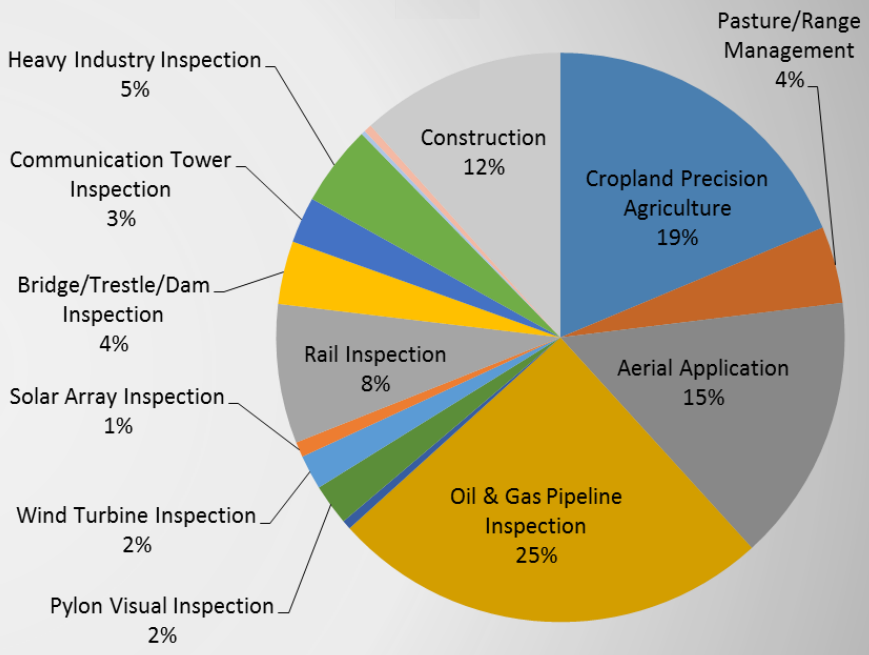
Independent Service Provider Model

Total SAM: $284,000,000



Mixed Service Provider Model

Total SAM: $169,000,000



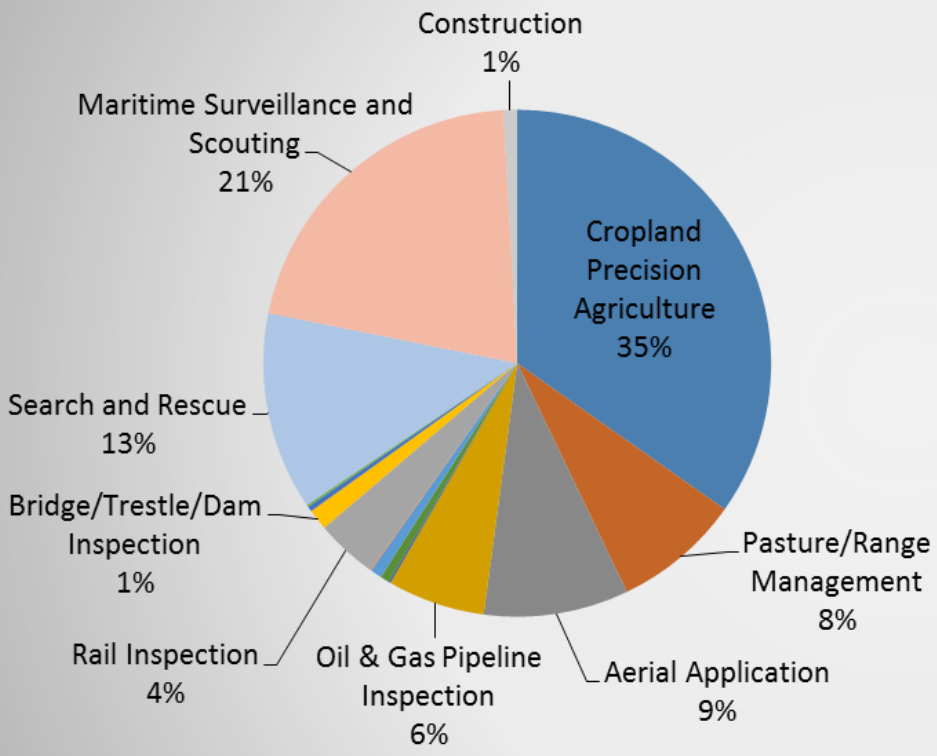
Assumptions

- UTM TCL 2 supported sectors
- base level market penetration

Provider Model Sensitivity

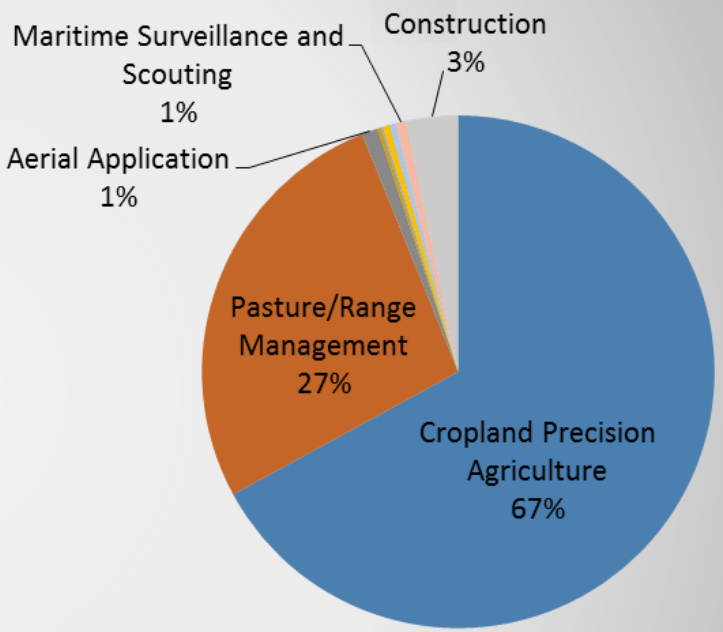
Independent Service Provider Model

Total Capital Investment: $89,000,000



Mixed Service Provider Model

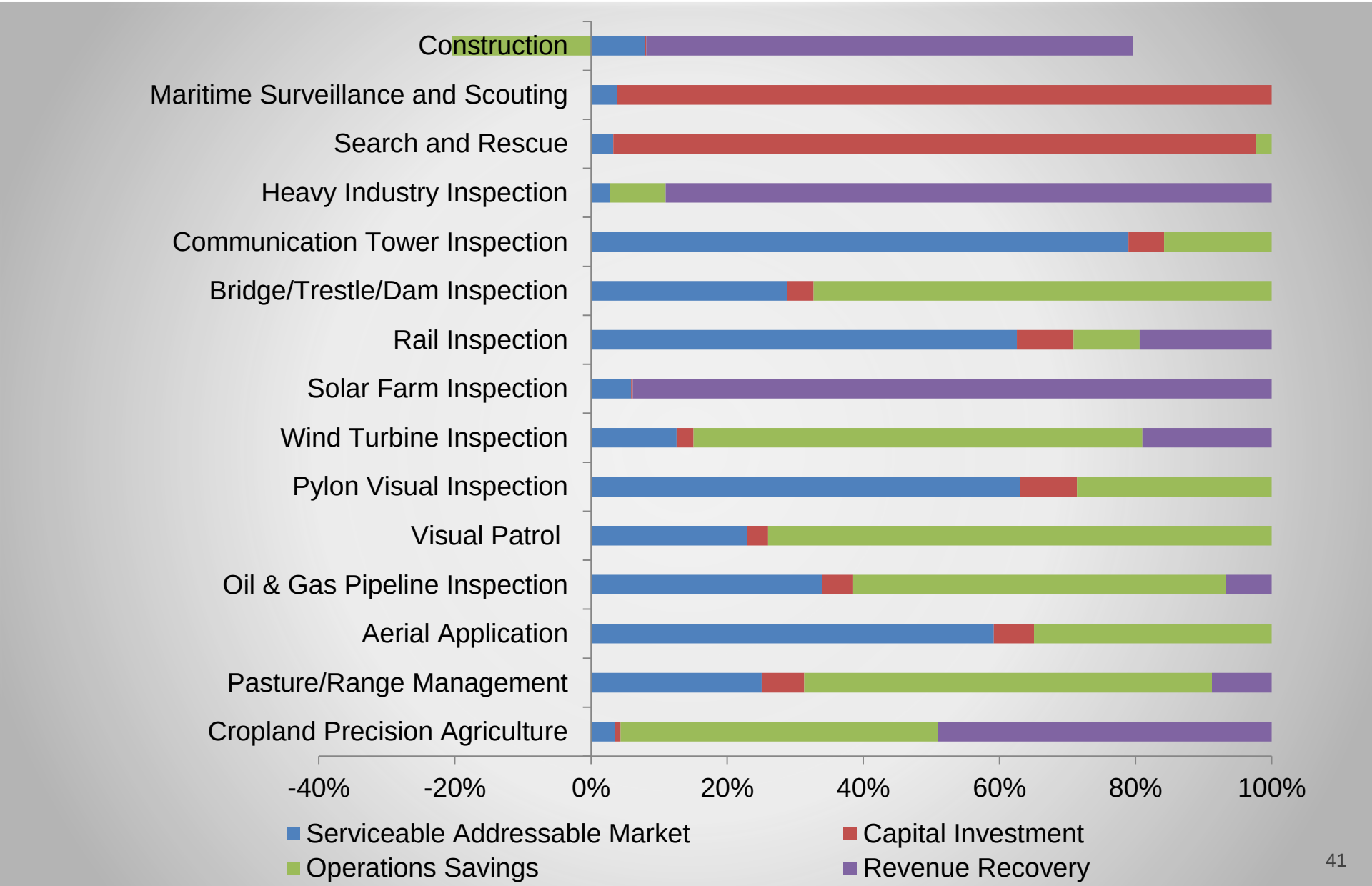
Total Capital Investment: $2,856,000,000



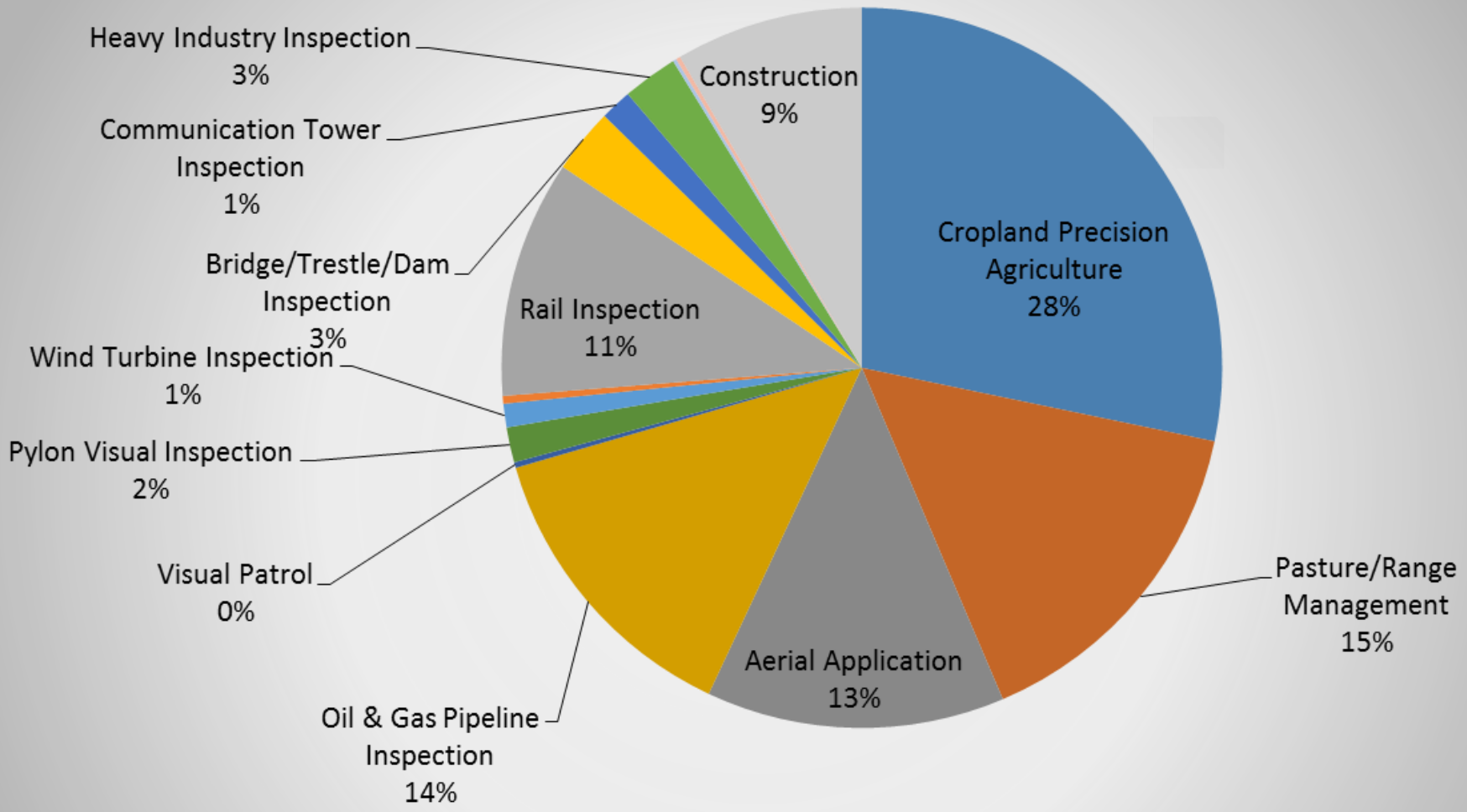
Assumptions

- UTM TCL 2 supported sectors
- base level market penetration

Sector Snapshots for UTM TCLs 1 & 2



UTM TCL 2 Sector SAM Snapshot

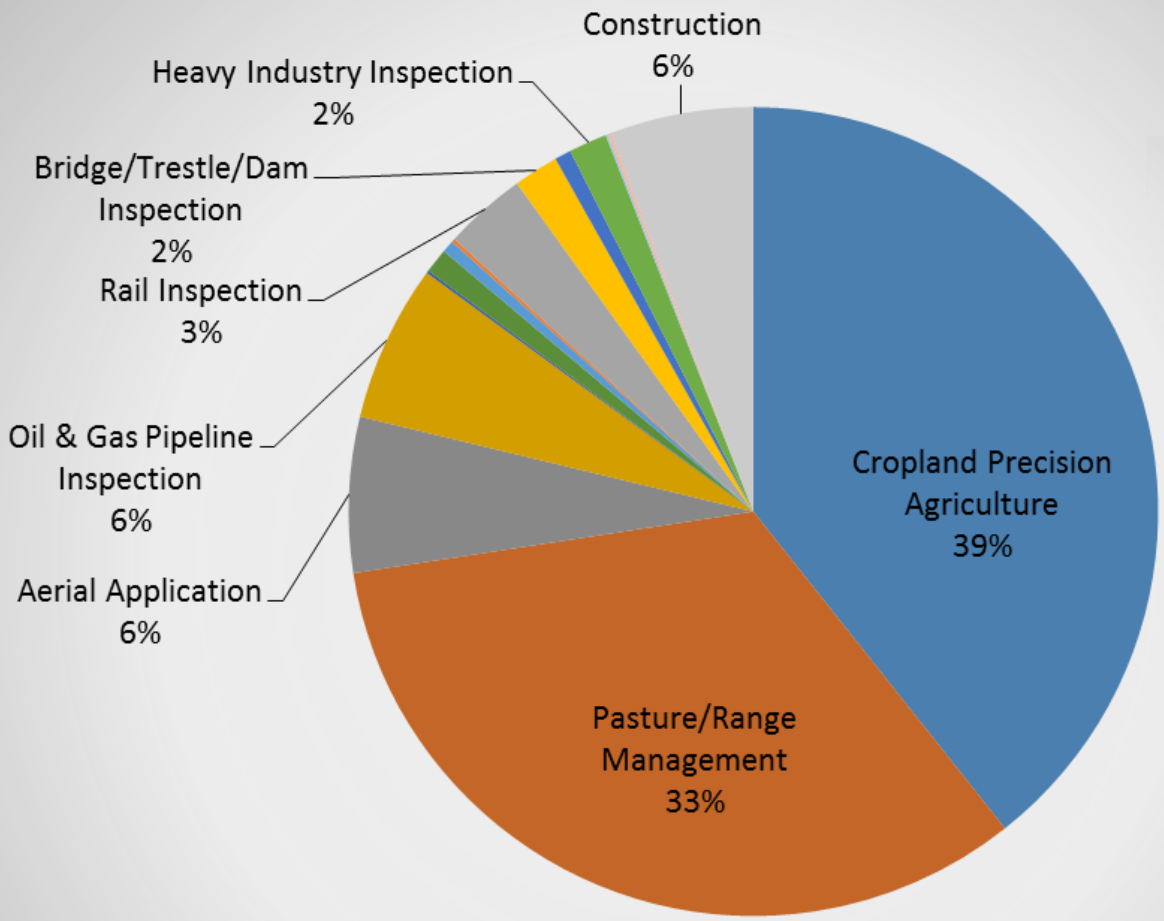


Assumptions

- medium level market penetration
- independent service provider model

Total SAM: $542,000,000

UTM TCL 2 Sector SAM Snapshot



Assumptions

- high level market penetration
- independent service provider model

Total SAM: $1,987,000,000