Trends in Average Earth-Orbiting Spacecraft Launch Mass

Exploring market potential for a dedicated nano/microsatellite launch vehicle

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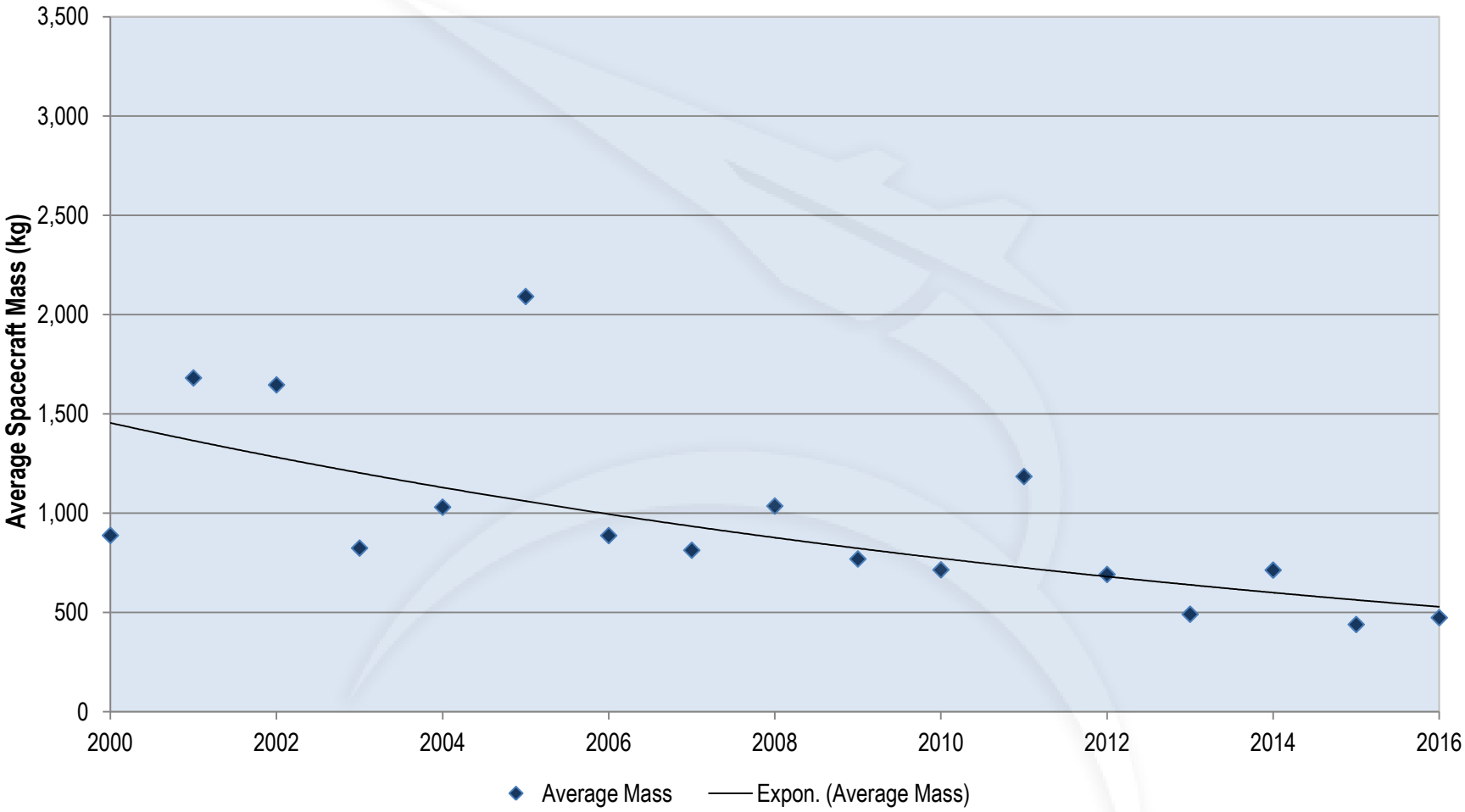
Overview of Analysis

- SpaceWorks' internally developed **Launch Demand Database** (LDDB) catalogues historic and future spacecraft missions to understand spacecraft market and launch vehicle demand
  - Documents key performance, launch, orbital, and organizational characteristics of spacecraft missions
  - Over 2,500 historical and future spacecraft launch entries regularly updated and maintained
  - Enables analysis of temporal spacecraft trends and space market assessment
- LDDB was utilized to determine historical and future trends in **Average Spacecraft Mass** in the following classifications over the range of launch years from 2000 to 2016 (Average Spacecraft Mass was calculated as total mass of spacecraft launched per year divided by the quantity of spacecraft launched that same year):
  - Missions to Low Earth Orbit (LEO)
  - Missions to Low Earth Orbit excluding missions to the International Space Station
  - Missions to Geosynchronous Earth Orbit (GEO)
  - All spacecraft missions
- The following analysis excludes the following database records from LDDB:
  - Spacecraft with unknown mass data or unknown future launch date (TBD)
  - Cancelled spacecraft missions
  - Unconfirmed future missions

Low Earth Orbit (LEO) Spacecraft

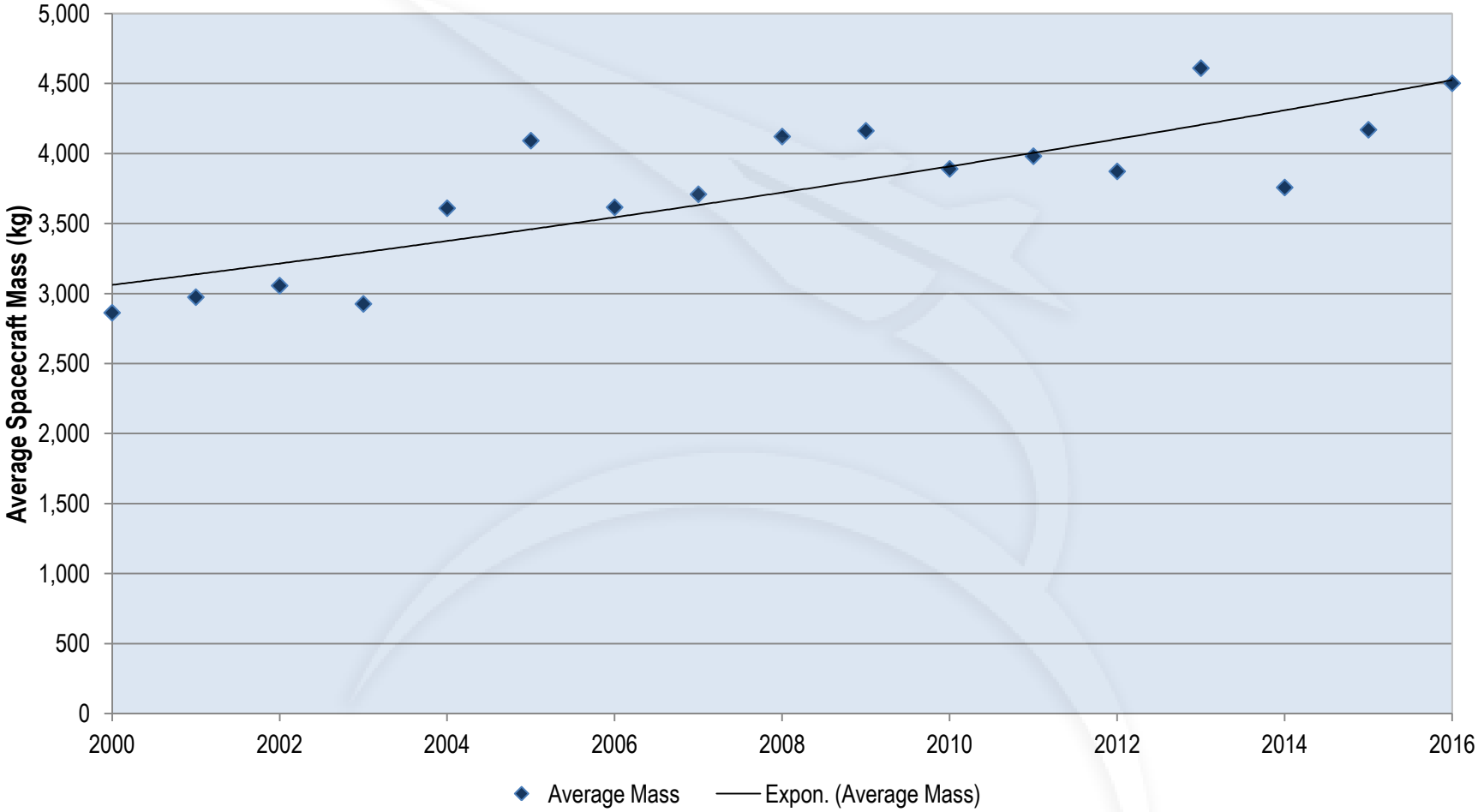
Missions to LEO are increasingly dominated by large constellations of CubeSat class missions resulting in a downward trend in average mass

Low Earth Orbit (LEO) Spacecraft excluding Missions to ISS



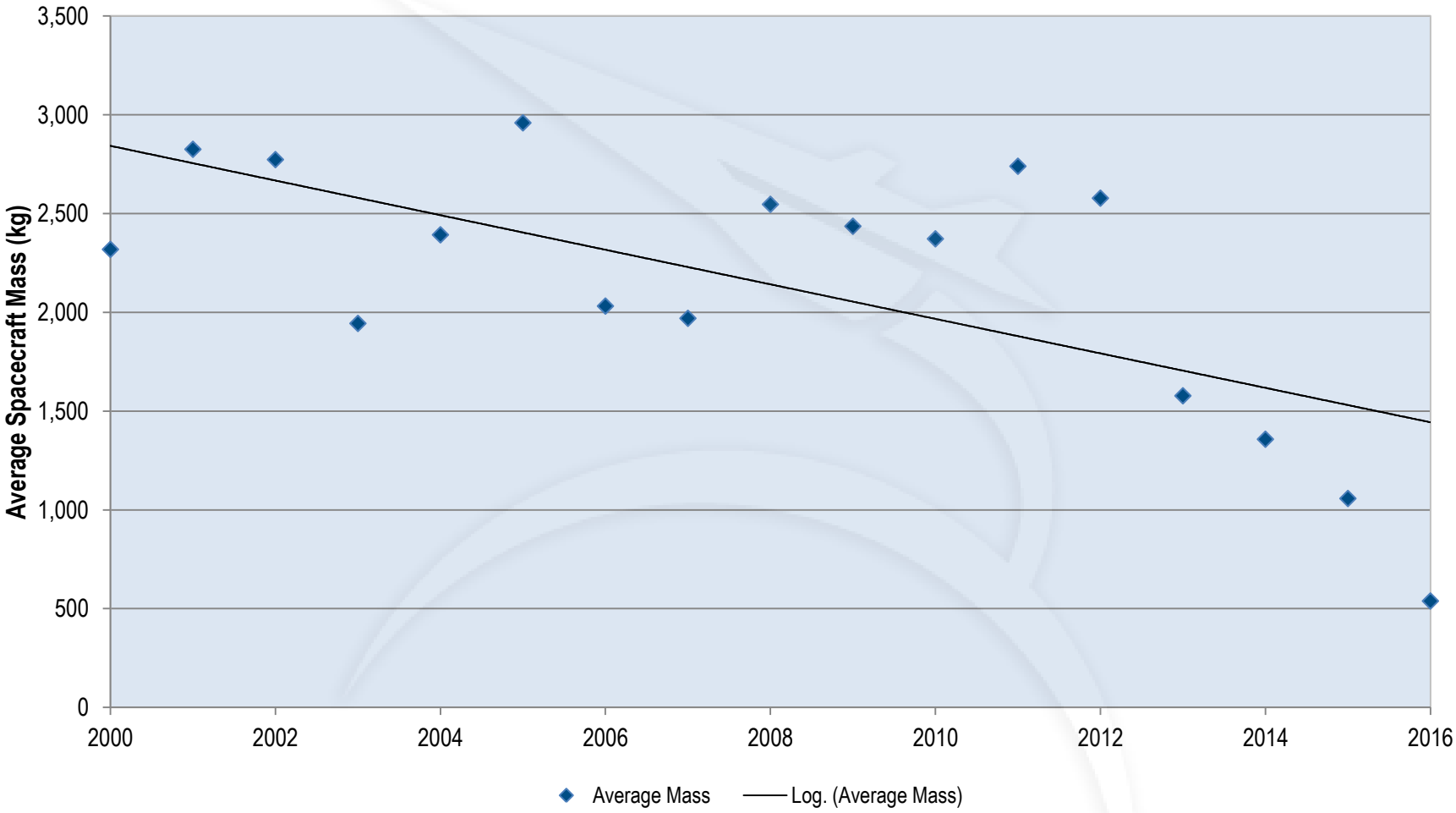
- Average spacecraft mass is significantly reduced when removing missions to ISS
- Still demonstrates the continual decrease in average spacecraft mass

Geosynchronous Earth Orbit (GEO) Spacecraft



- Satellite missions to GEO increase in mass as launch vehicle capabilities continue to grow
- GEO missions are increasingly few in number due to maintained/increased quality and lifetime of these large satellites

All Spacecraft Missions



Higher quantity of nano/microsatellite missions results in an expected 79% decrease in average spacecraft mass from 2012 to 2016

Summary

- As seen in the spacecraft trend data, the average mass of spacecraft with Low Earth Orbit destinations is decreasing rapidly given the rise in popularity of CubeSats and microsatellites
  - Over the next few years an even sharper decrease in average mass is expected (significant mass drop from 2012 to 2016 across all Earth-orbiting missions)

- Anticipated decrease in spacecraft mass underscores the utility of future launch services focused on the growing nano/microsatellite market
  - As spacecraft masses continue to decrease, the launch market for small payloads to LEO continues to show promise
  - As "traditional" launch vehicles focus on serving the growing spacecraft masses with GEO destinations, the challenges of rideshare opportunities will increase and may be unable to keep up with the growing demand in the emerging small payload sector
  - Emerging launch services companies focused on delivering small satellites to LEO appear to be well-timed to meet rising market demand

SpaceWorks and Generation Orbit

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- **SpaceWorks** is an integral partner on Generation Orbit's **GOLauncher** team working to develop a fast, flexible, and dedicated nano/microsatellite launch vehicle for the emerging satellite market
- SpaceWorks' roles on the GOLauncher team include small satellite market research and analysis, advanced concept design, mission analysis, digital media, and engineering technical support

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