Update on Missile Defense Technology

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Before the George Marshall Inst.
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Trends in Missile Threats

- Nations w/ missiles: six in 1972 → 16 in 2001
  - SCUDs to the Middle East, Asia, etc.
  - Pakistan tested 1,300 km Ghauri and India Shahab-3 and 2,000 km Agni II
  - China ready to deploy 8,000 km range mobile DF-31
  - North Korea tested Taepo Dong 1 and developed Taepo Dong 2
- China helping Pakistan, Iran, Libya, and North Korea
  - North Korea helping Middle East, South Asia, and North Africa
- Missile and RV technologies are now widely available.
  - Countermeasures to defenses now "readily available" include "separating RVs, spin-stabilized RVs, RV reorientation, radar absorbing material, booster fragmentation, jammers, chaff, and simple balloon decoys."—CIA
- Rogues have chosen missiles

Brief History of MD Technology

Program	object	type	elements	weakness
NIKE/Sentinel	pop.	nuc	int, radars	endo radars
Safeguard	deter	nuc	int, radars	exo radars
AMB Treaty	ABM	all	& OPP	progress
Interim				
– LoADS	deter	nuc	endo int, radars	Treaty
– DARPA	tech	DE	SBL	vulnerability,CM
– Army	tech	KE	HOE, ERIS	cost
SDI	deter	DE/KE	SBI, SBL…	cost
GPALS	protect	KE	BP, GBI, BE	Treaty
TMD	troops	KE	PAC-3,THAAD	cost, schedule
NMD	pop	KE	GBI,GBR,EWR	cost, discrim, bkgnd

GPALS Performance Issues

- Objective: high confidence of protection
  - whole US and allies
  - from limited strikes (~ 1 SSBN)
  - Independent of launch point
- Dominant attrition by Brilliant Pebble (BP)
  - Small (few kg) autonomous space based interceptor
  - several BP/missile for high Pk
- Remainder by KE underlay
  - Ground Based Interceptor (GBI)
  - Supported by Brilliant Eye (BE)—later GBR/UEWR

Lessons Learned on Layers

Element	**pro**	**con**
– terminal	cover high value	local
– midcourse	engagement time	decoys
– Boost	no countermeasures	short time
• surface	efficient	accessible
• space-based	global & survivable	absenteeism

- Effective multi-layer defenses minimize the countermeasures open to adversary
  - and options for overloading any given layer
  - hence, effective defenses, all layers, ASAP

Fig. G.5. Heavy ICBM RV kills and leakage as functions of interceptor constellation size

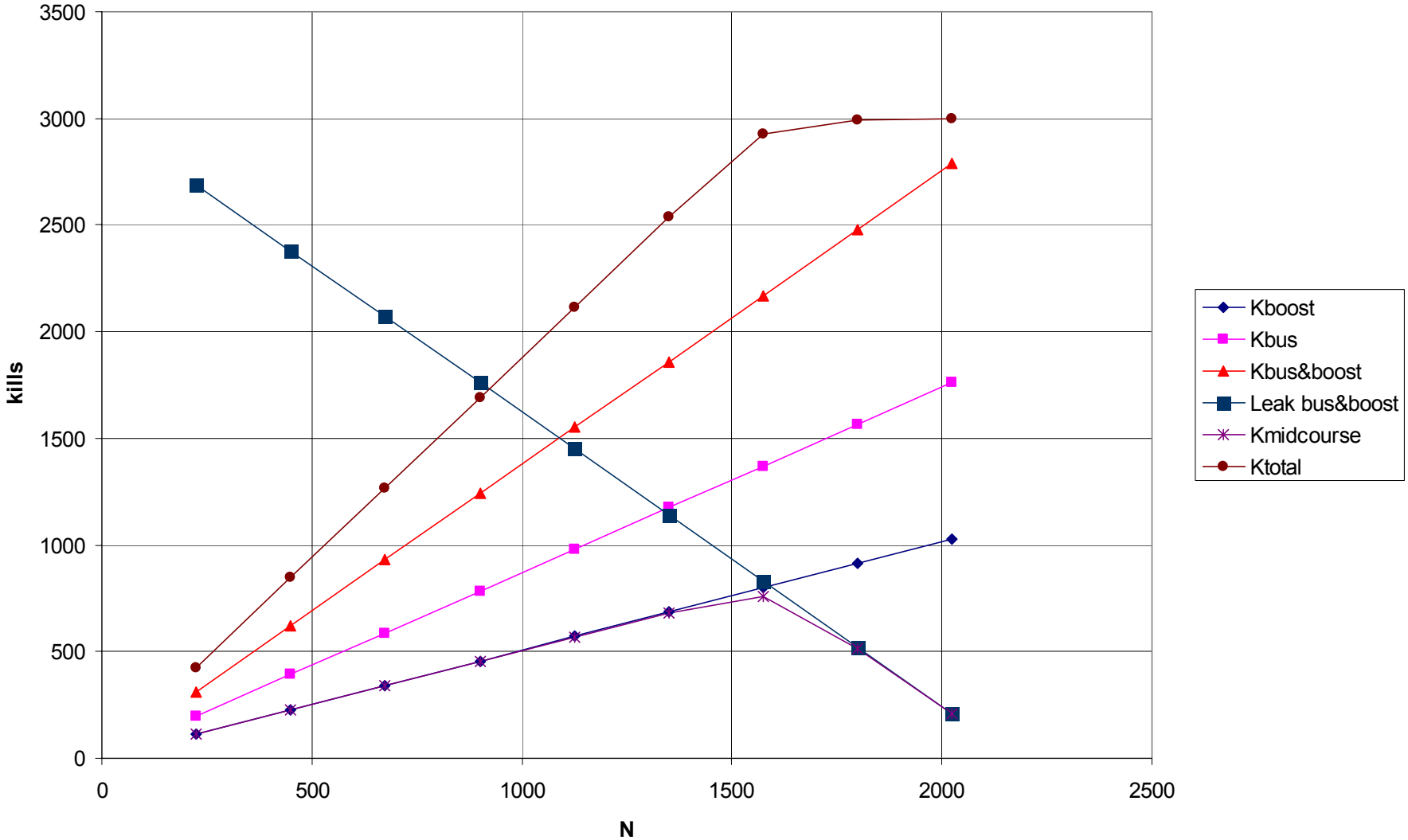


Fig. G.6. SLBM RV kills in each phase as functions of constellation size

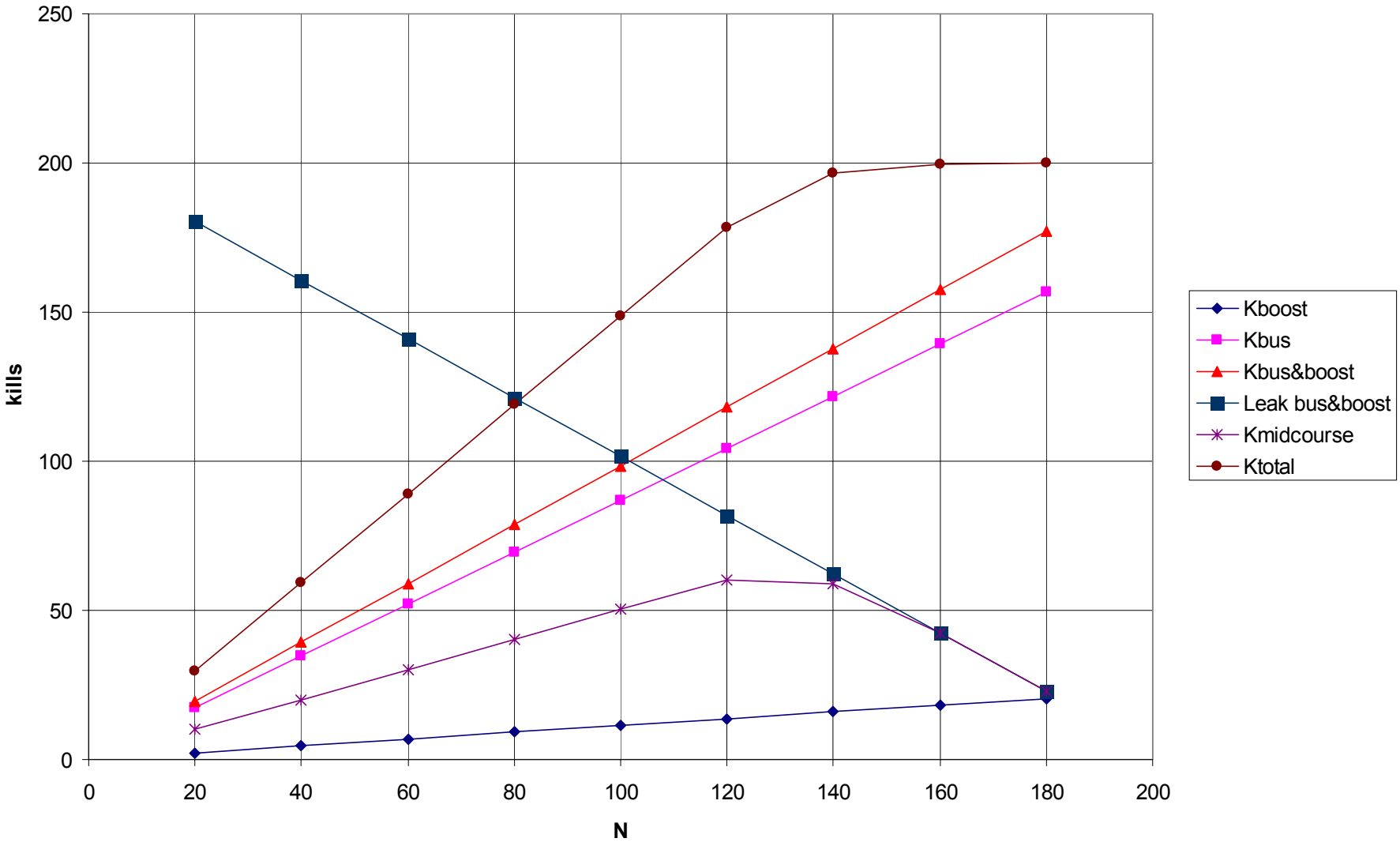
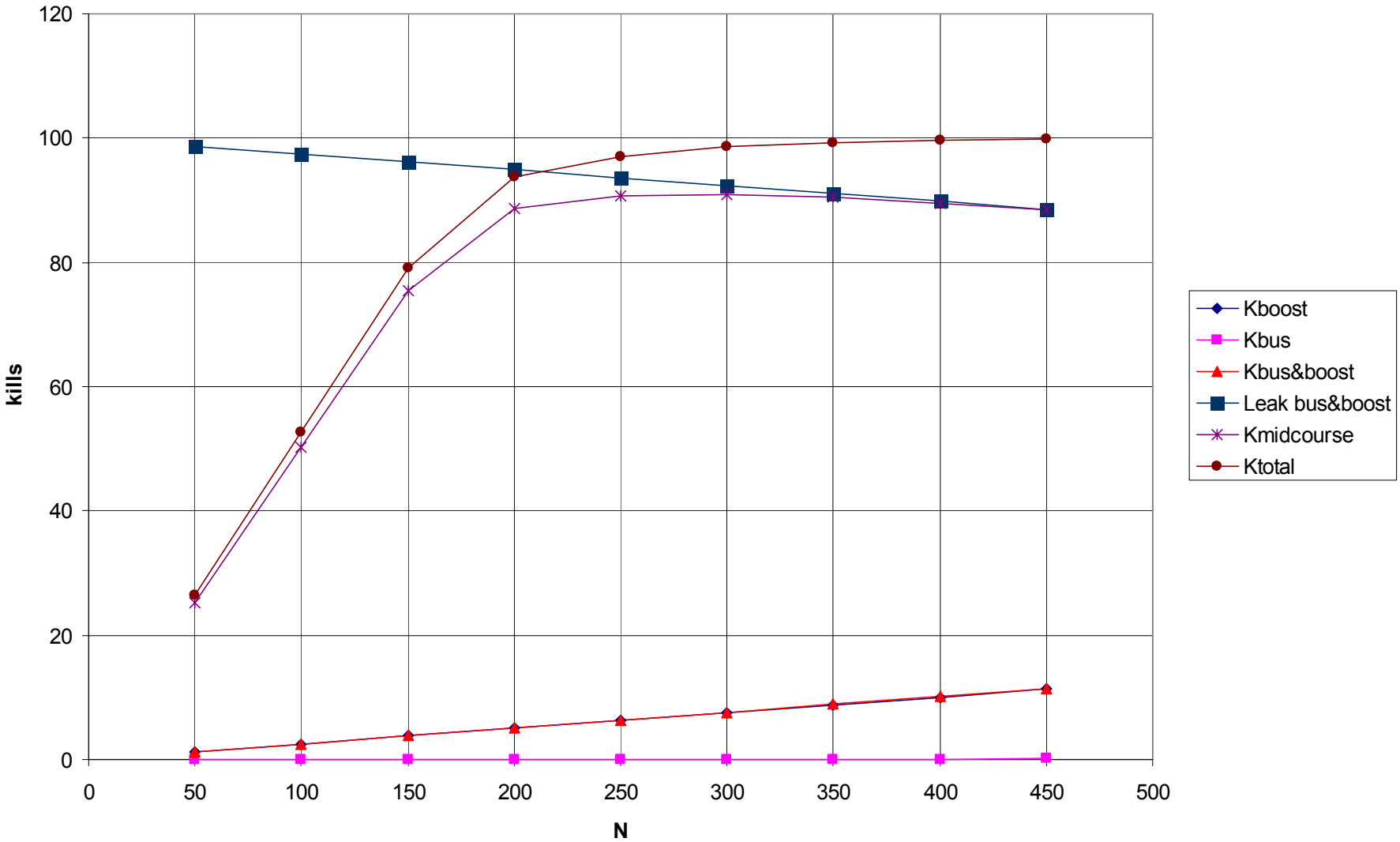


Fig. G.7. SS-25 kills for boost and midcourse phases vs constellation size



Interceptor Technology Development in SDI & GPALS

- 7 major reviews (DSB, JASON, APS, etc.)
- Defense Acq Board--Major Defense Acq Prog
  - Cost ~ $10B w/ $1M/BP on orbit
- Testing ~ midcourse NMD
- Reduced to "robust" technology program 1991
  - abolished in 1993 for non-technical reasons
- Nucleus in national laboratories & industry
  - executed Clementine, Astrid demos in 1994

Transition to TMD & NMD

- Gulf War showed need for TMD
  - TMD started during GPALS
- Clinton administration cut 25% & splintered
  - disestablished NMD, Global defenses
- Rumsfeld Commission
- North Korea Taepo Dong Launch
- Resumption of NMD
  - Treaty limited
  - Midcourse only

National Missile Defense Elements

- Sensors:
  - DSP/SBIRS-High & -Low
  - UEWRS
  - GBR/XBR
- Interceptor
  - GBI
- BMC3

NMD Test Results

- Results of IFT-1A, -2, -3 / -4, -5 / -6, -7,…
- Criticism of tests: elements, geometry, CM
- Specific Countermeasures
  - Balloons
  - Shrouds
  - Submunitions
- Antisimulation

Boost Phase Intercept Options

- Surface-based boost phase systems preferred where trajectories allow access to boost from
  - Ships in international waters
  - Secure land bases
  - Require high velocity, acceleration, response
- Space based interceptor (SBI) preferred
  - No secure bases with useful access
  - Numerous, separated launch areas

Fig. J.1. Flyout distance and range for fast ground based interceptor vs delay time

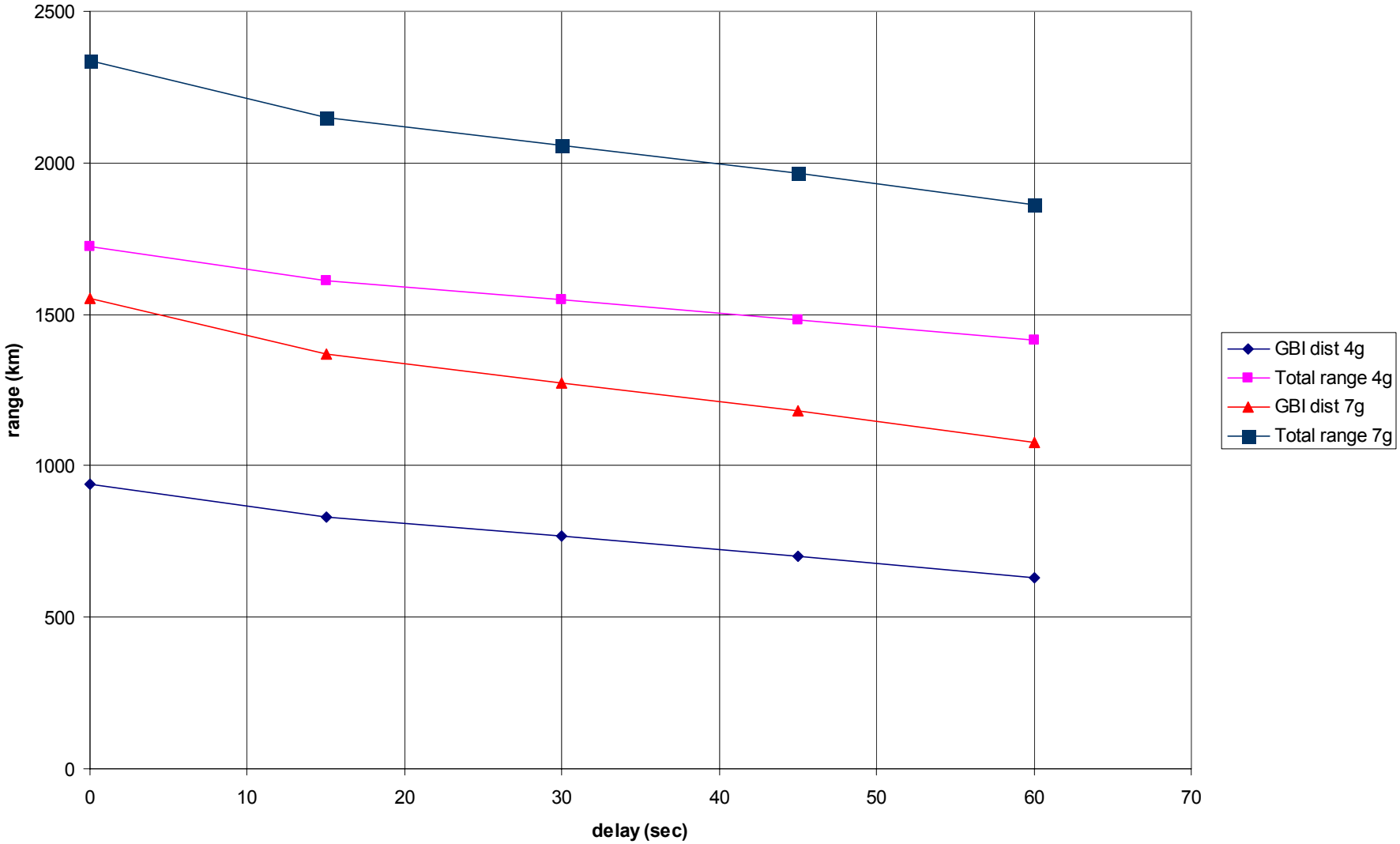


Fig. J.2. Constellation cost vs Vmax for 240 sec rogue ICBM
(space segment procurement only)

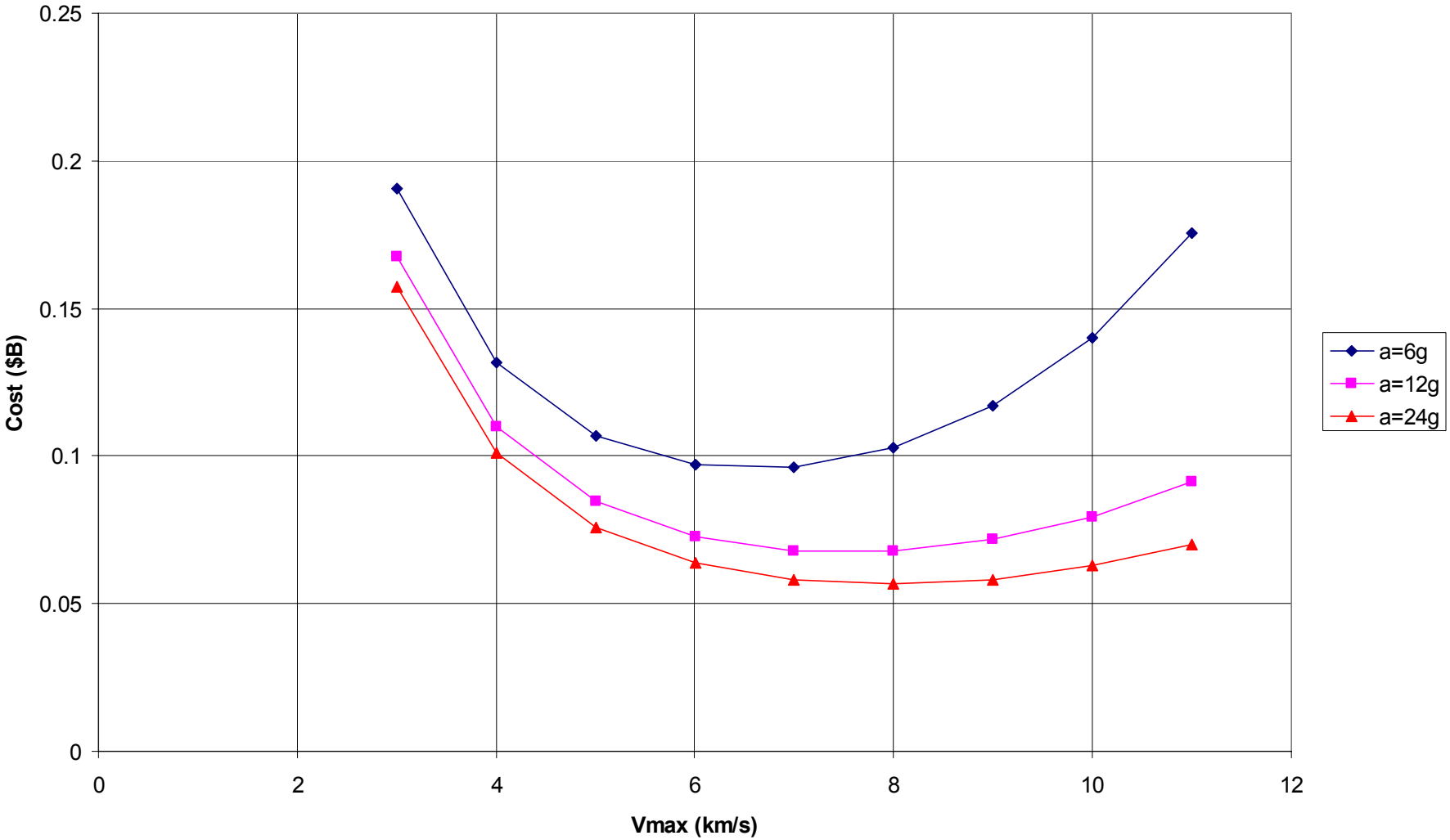


Fig. J.4. Interceptor range as a function of theater missile range (point launch of 4g theater missile, 30 sec interceptor delay)

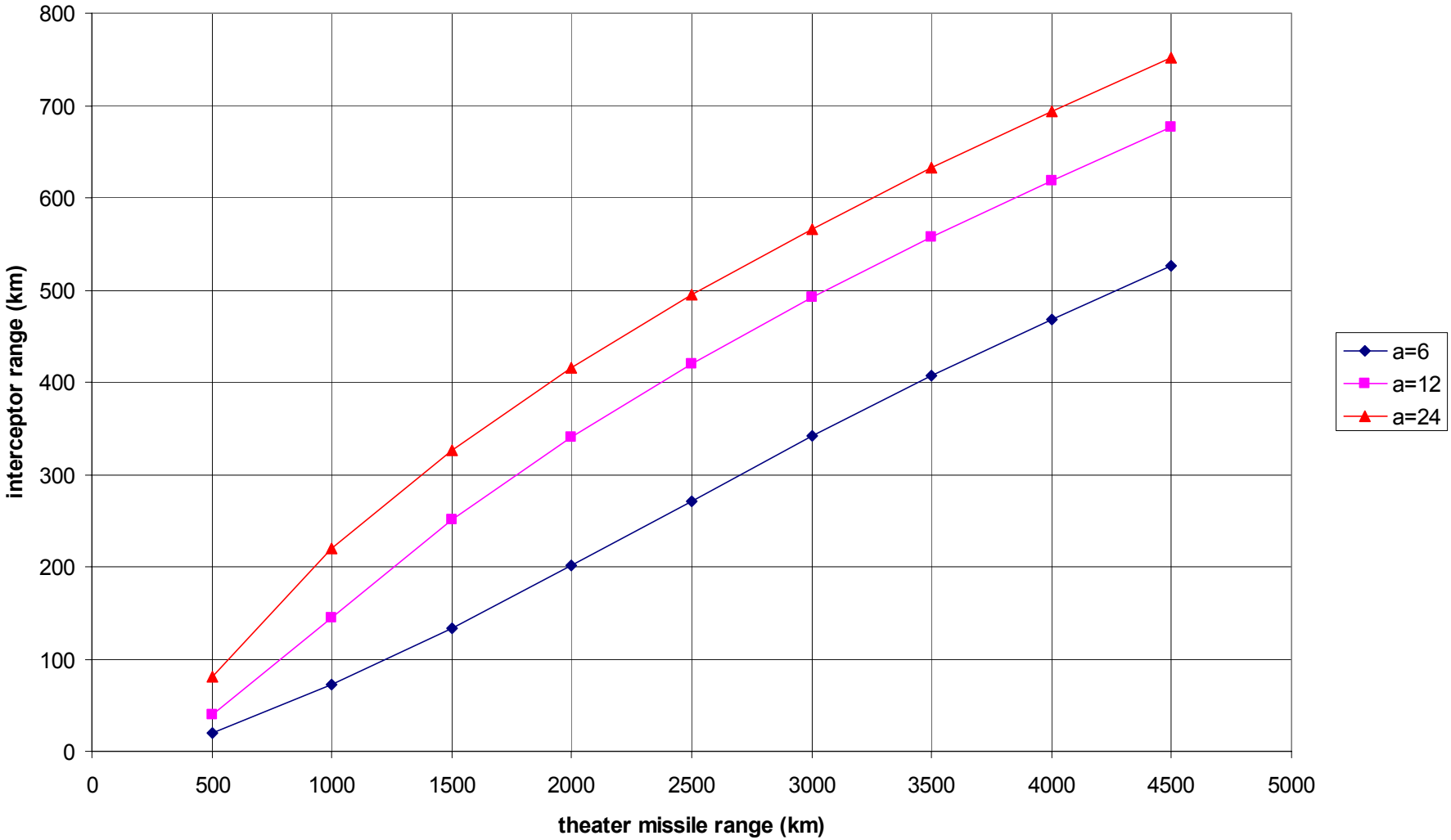
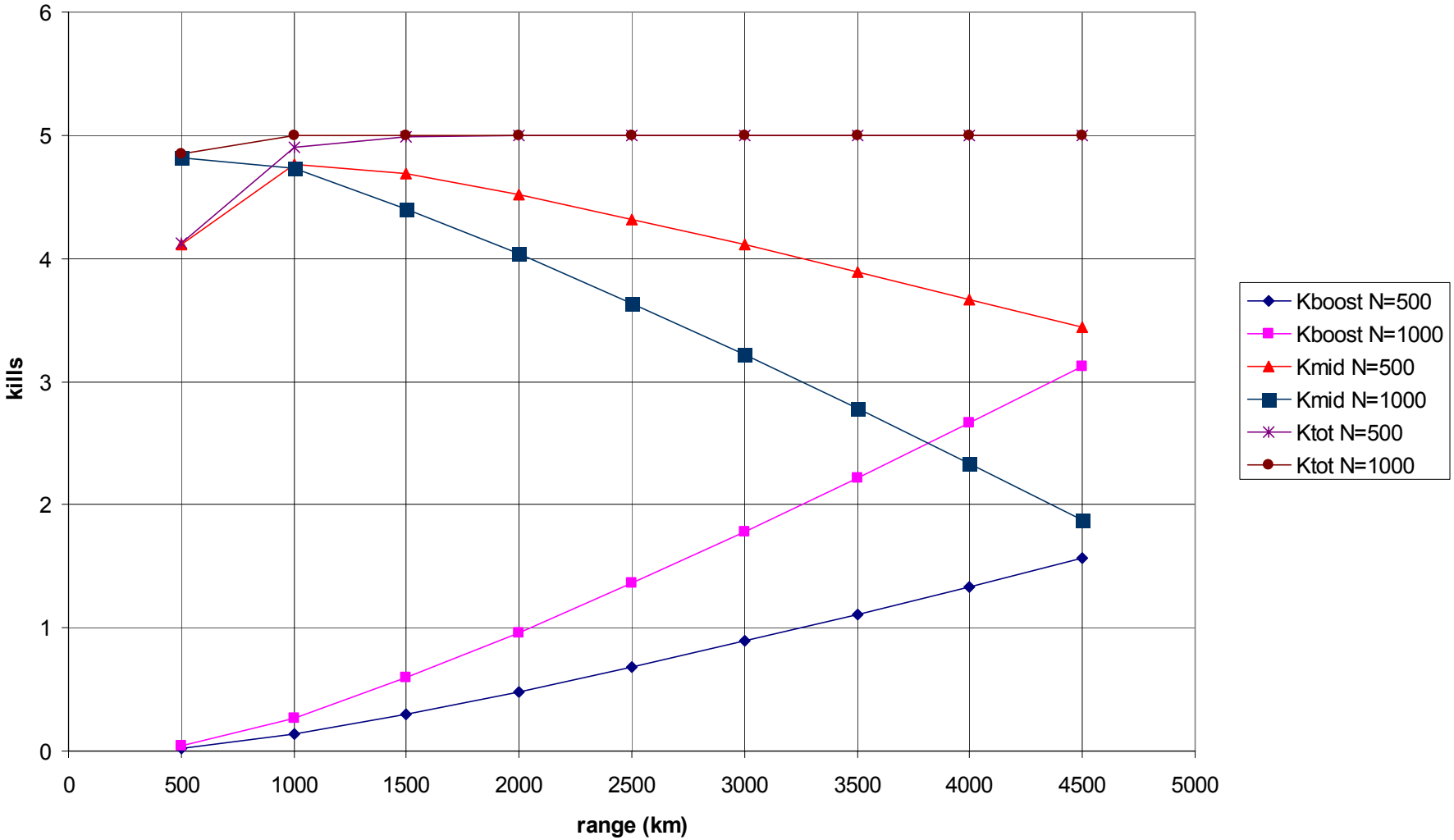


Fig. J.5. Number of RV kills as a function of TBM range (6 km/s, 25 g BP)



Current (Core) MD Program

- All three layers—ASAP—w/ existing elements
- Terminal: Patriot, THAAD & derivatives
- Regional:THAAD derivatives
- National:DSP, UEWR, GBI
- Boost: ship & air based; space experiment
- BMC3
- Space based interceptor as global complement

Summary

- Most MD systems could have met original objectives
- Radars could not address large exo threats
  - KE early—DE for faster missiles, longer term
- GPALS survive & protect with developed layers
  - Affordable for large threats
- TMD did not cover emerging threats
- NMD coverage of small, unsophisticated threats
  - expensive & lacked robustness

Conclusions

- Current elements could provide protection
  - Not large, accidental, or unauthorized
  - Program is narrow—little R&D, few options
  - designed by a committee
- Space elements essential for robust protection
- Goal should be to put missile threats out of reach
  - A balanced program to do that must use all technologies

Backup

Fig. E.1. Proportional & Augmented Proportional Navigation

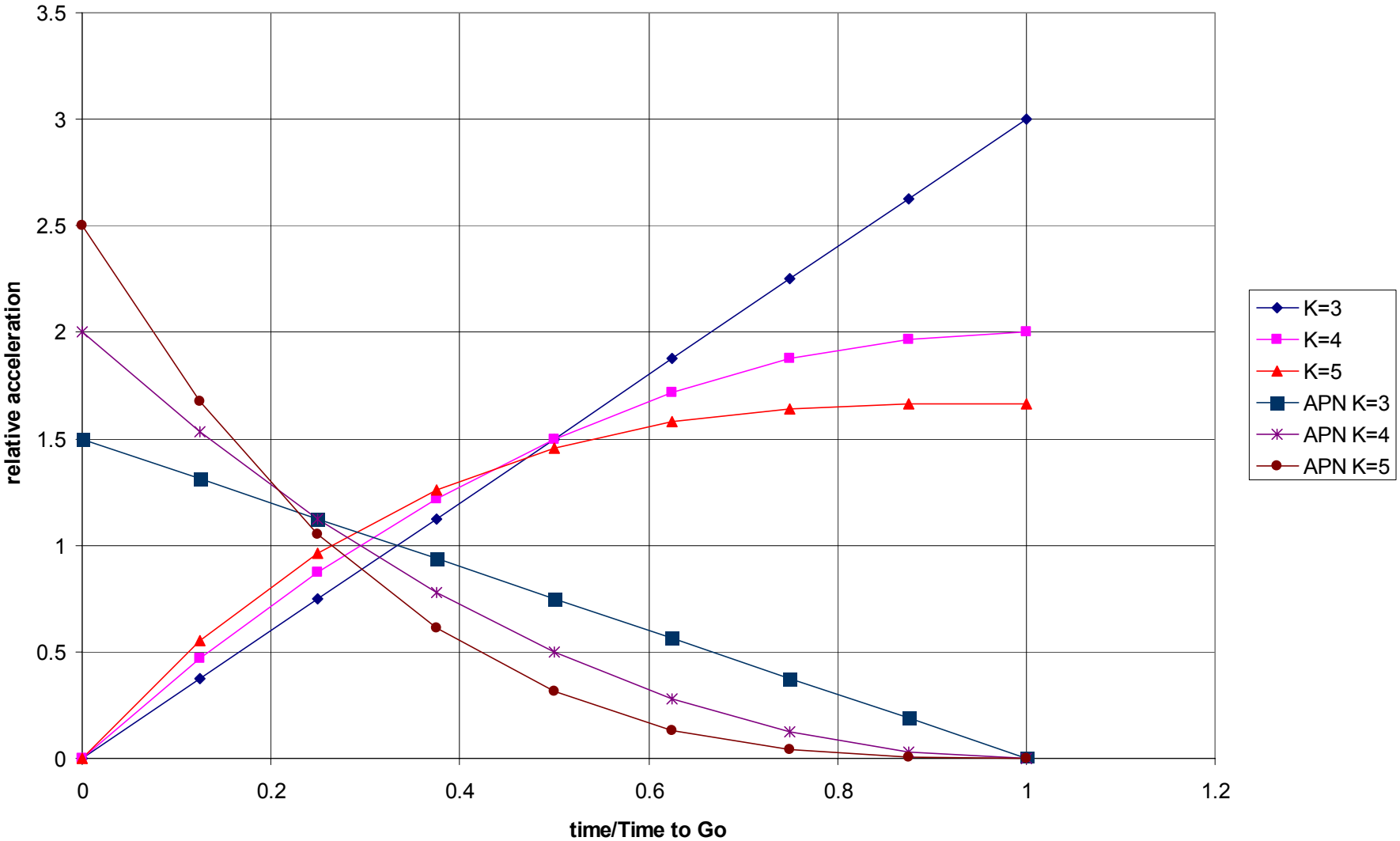


Figure G.1. Resolution versus time during BP fly in

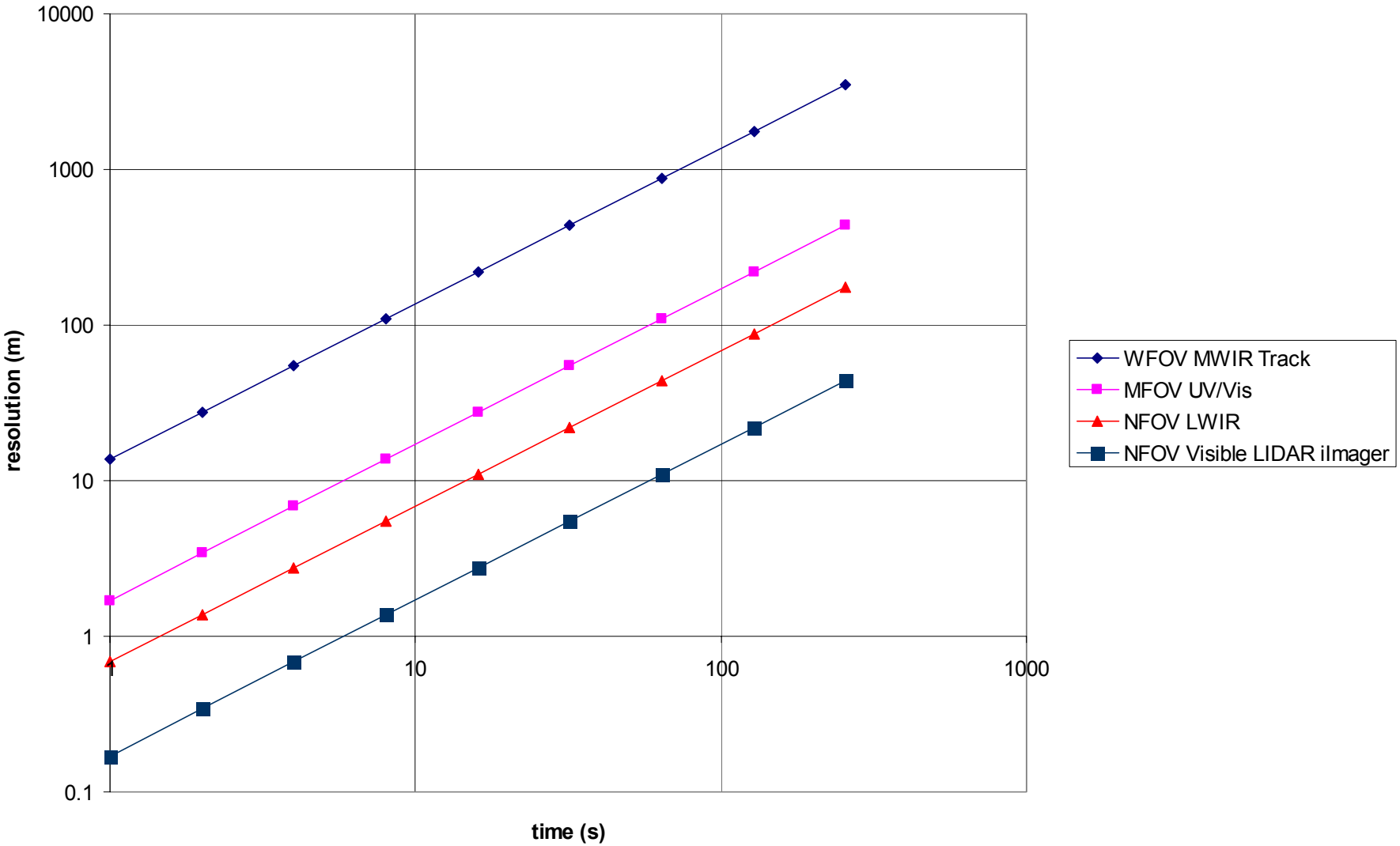


Fig. I.1. Resolution versus range for various optic diameters

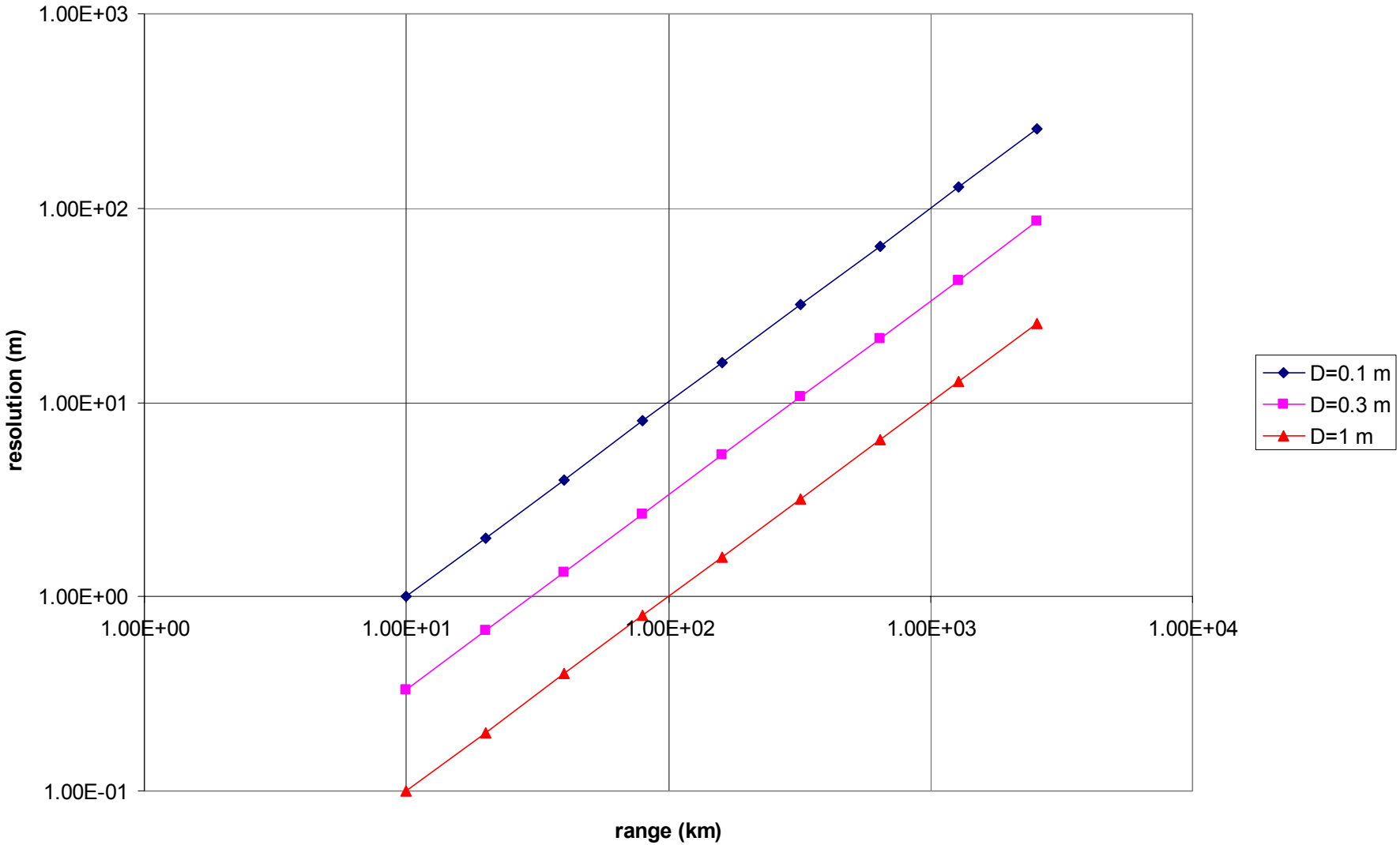


Fig. I2. Sensor diameter and masses as functions of operating range