



Trajectory Shaping for CRV7-PG 70mm Guided Rocket

Richard Lestage, Camille Alain Rabbath

Precision Weapons Section
DRDC Valcartier
2 March 2010



Defence Research and
Development Canada

Recherche et développement
pour la défense Canada

Canada



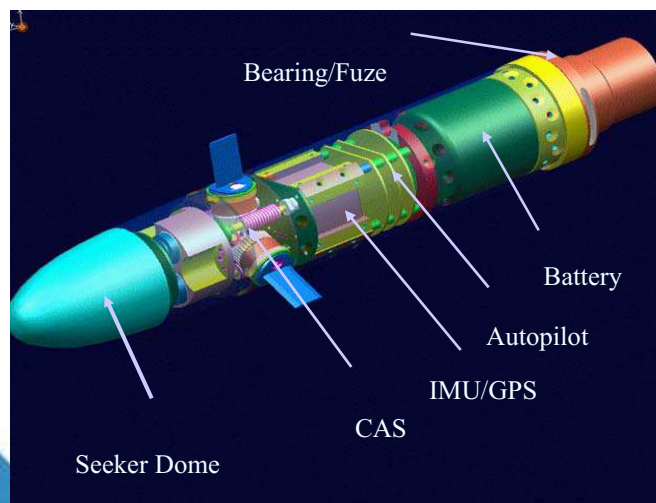
Objective

- Investigate performance of Biased Proportional Navigation Guidance (BPNG) to control terminal angle and reduce miss distance of a guided 70mm rocket.



CRV7-PG Concept

- Improve, integrate, and demonstrate an off-the-shelf mid-flight and terminal guidance package to the existing, lightweight, inexpensive, 70mm CRV7 rocket system, with required range, accuracy, and lethality performance for air and land applications.
 - Low cost IMU
 - Mid-course GPS guidance
 - Terminal Semi-active Laser Seeker guidance





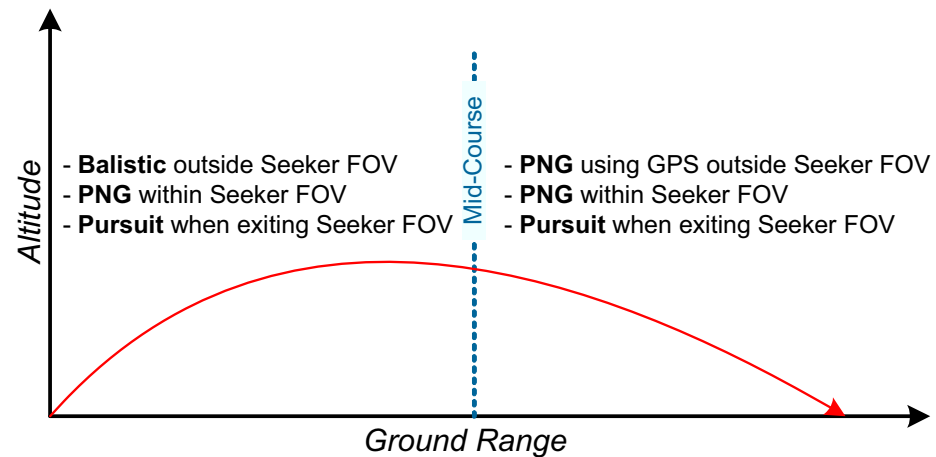
Surface-to-Surface Concept of Ops

- 70mm rockets were designed for air-to-surface direct fire.
- GPS guidance permits employment for long-range surface-to-surface indirect fire up to 12km.
- Motivation for employment of trajectory:
 - Tailor terminal angle and reduce miss of rocket to optimise lethality against different types of targets.
 - Steeper terminal angle is desirable for some targets
 - Light Armoured Vehicle
 - Field fortifications
 - Troops in the open

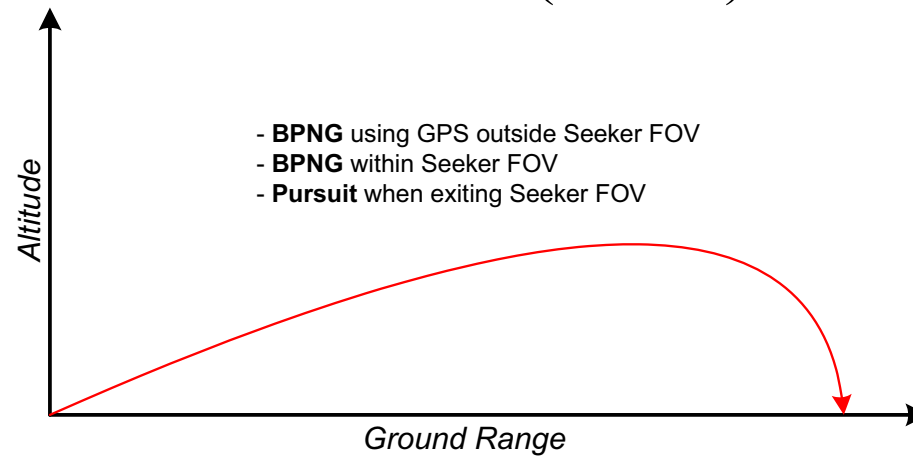


Guidance Types

- PN Guidance (PNG)



- Biased PN Guidance (BPNG)





BPNG Algorithm

- Basic PNG

$$A_c(t) = NV_m \dot{\sigma}(t)$$

- Biased PNG

$$A_c(t) = NV_m (\dot{\sigma}(t) - \dot{\sigma}_b(t))$$

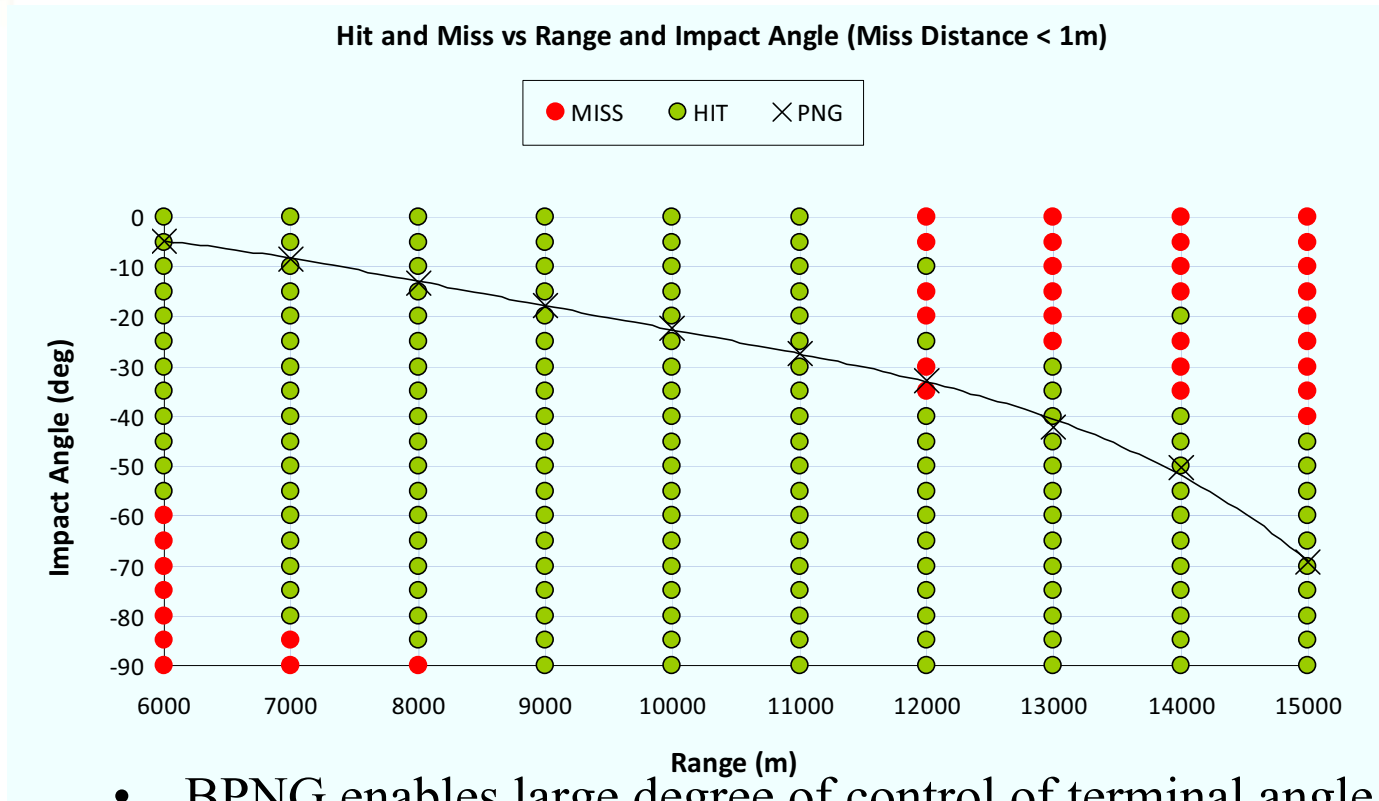
- Bias term:

$$\dot{\sigma}_b(t) = \frac{\eta V_m (\sigma_d - \sigma(t))}{Nr(t) \max\{\cos\theta_m, \sqrt{1 - (\rho + \beta)^2}\}}$$

- The implementation of the BPNG algorithm requires selecting a value for both η and β



Surface-to-Surface Feasible Terminal Angle

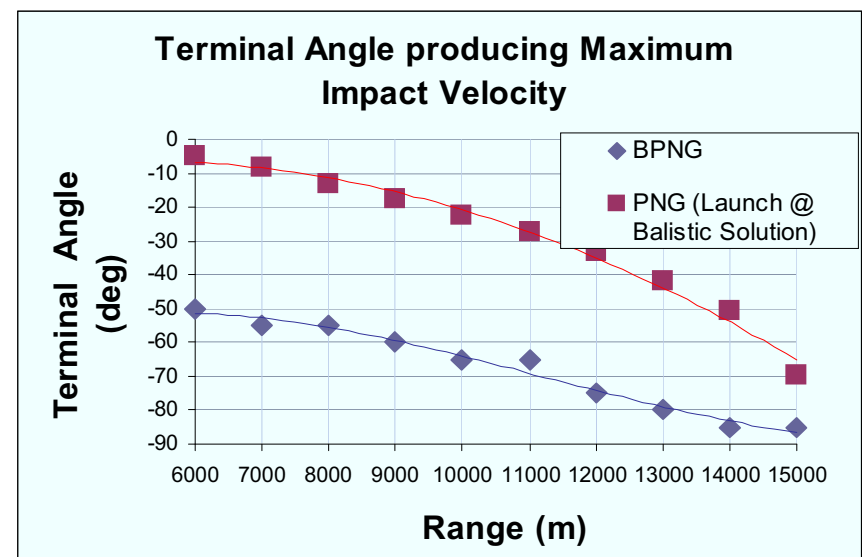
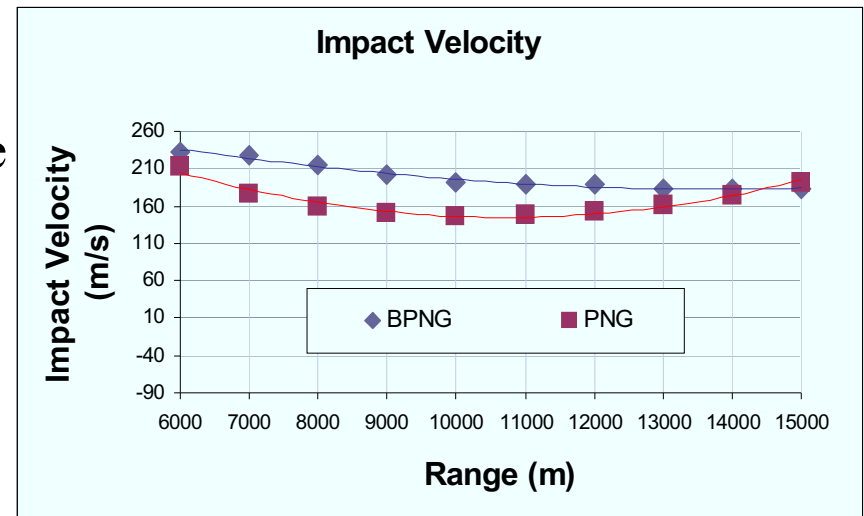


- BPNG enables large degree of control of terminal angle for various ranges
- Similar results obtained for air-to-surface



Effect of Angle on Terminal Velocity

- Commanded terminal angle has an effect on terminal velocity
- With BPNG, terminal angle can be used to increase velocity and penetration against hard targets.





Conclusion

- BPNG could be used to tailor terminal angle of guided rocket.
- BPNG provides increase in terminal velocity over PNG.
- Further work planned to quantitatively assess effect on lethality.

DEFENCE



DÉFENSE