Enhanced Approximation for RBIR PHY Abstraction in TGm

IEEE 802.16 Presentation Submission

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Thierry Lestable, Alain Mourad, Ming Jiang,
Youngkwon Cho — Voice: +44. 1784.428600 Ext 720
Samsung Electronics Research Institute, UK — E-mail: {thierry.lestable, alain.mourad, ming.jiang, youngkn}@samsung.com

Hyunkyu Yu, Taeyoung Kim, Jaeweon Cho — Voice:
Samsung Electronics — E-mail: {hk.yu, ty33.kim, jaeweon.cho}@samsung.com

*<http://standards.ieee.org/faqs/affiliationFAQ.html>

Venue:

IEEE 802.16m-07/48 – Call for Comments on Draft 802.16m Evaluation Methodology Document IEEE 802.16m-07/037r2

Base Contribution:

None

Purpose:

To modify the 802.16m EVM document related with Approximation part for RBIR PHY Abstractions

Outline

- Numerical Integration RBIR
  - Current proposal
  - New proposal
  - Comparisons
  - Conclusions

Numerical Integration within RBIR PHY Abstraction

- Exact Expression:

$$SI = \int_{-\infty}^{+\infty} p(LLR)\log_2\left(\frac{M}{1+\exp(-LLR)}\right)dLLR = \log_2(M) - \frac{1}{\log_e(2)} J(AVE, VAR)$$

- Beceem Approximation (current EVM)

$$J_B = \frac{2}{3} f_1(AVE) + \frac{1}{6} f_1\left(AVE + \sqrt{3VAR}\right) + \frac{1}{6} f_1\left(AVE - \sqrt{3VAR}\right)$$

$$f_1(x) = \log_e(1+\exp(-x))$$

Numerical Integration within RBIR PHY Abstraction

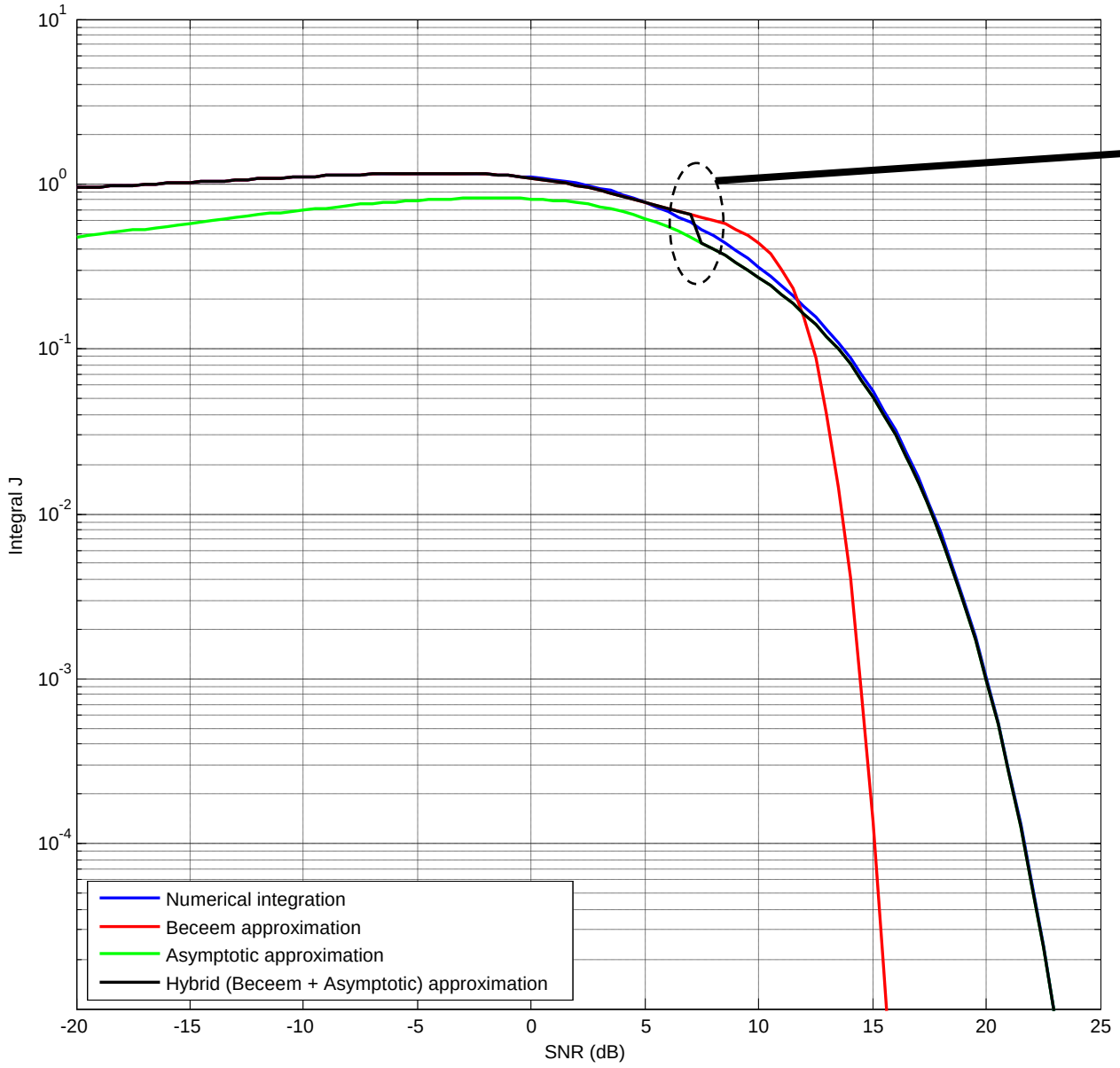
- Asymptotic Approximation (new)

$$J_A = AVE\left(1-\frac{1}{2}erfc\left(\frac{-AVE}{\sqrt{2VAR}}\right)\right)+\sqrt{\frac{VAR}{2\pi}}\exp\left(-\frac{AVE^2}{2VAR}\right)$$

- NEW Proposal:
  - ***Hybrid* {Beceem + Asymptotic}**

$$J=\left(\frac{J_A+J_B}{2}\right)+\left(\frac{J_A-J_B}{2}\right)\text{sign}\left(J_A-T\right)\quad;\quad T\approx 0.65$$

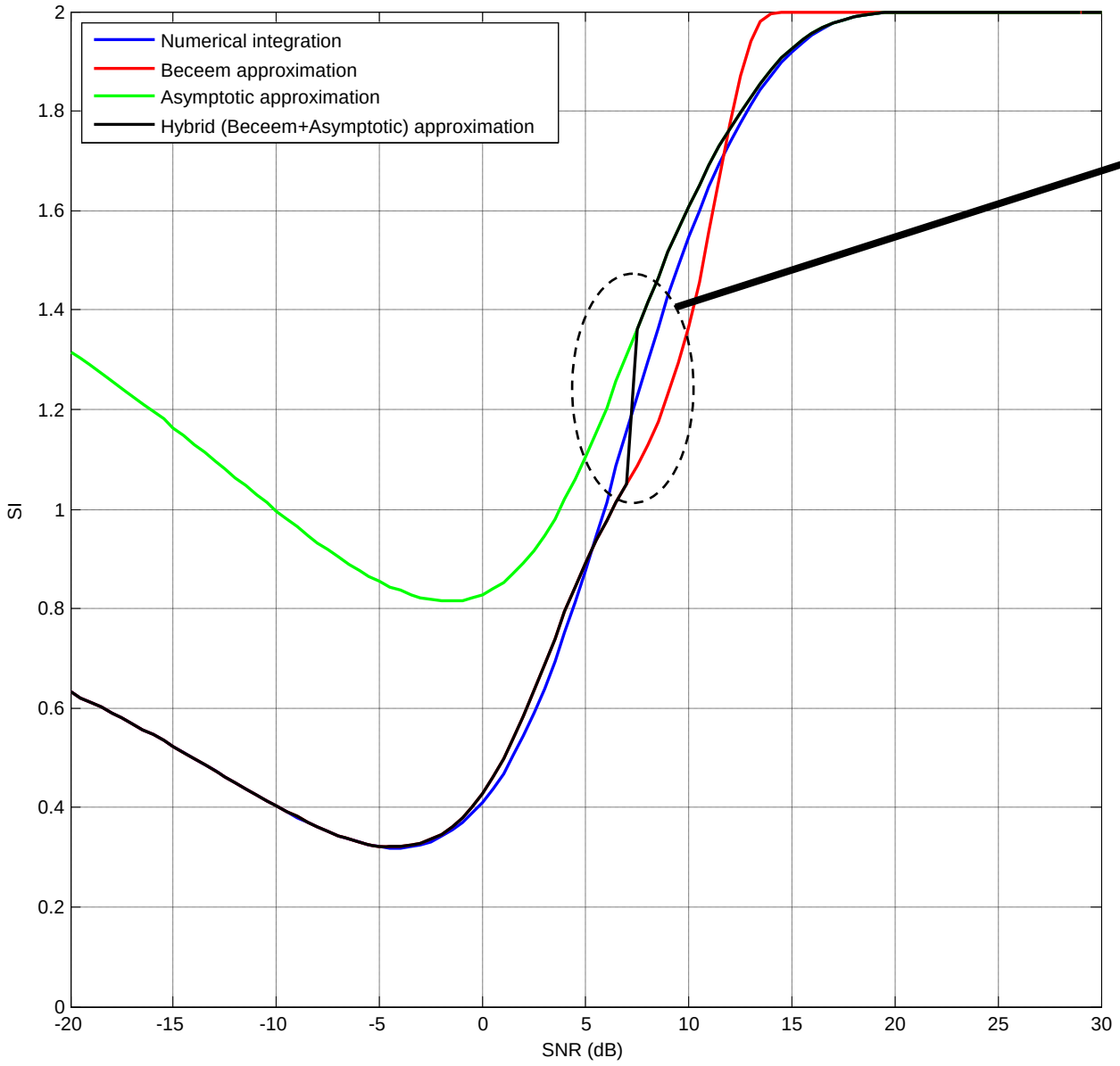
Accuracy of J approximation



Switching point (J ≈ 0.65)

Perfect matching of hybrid scheme

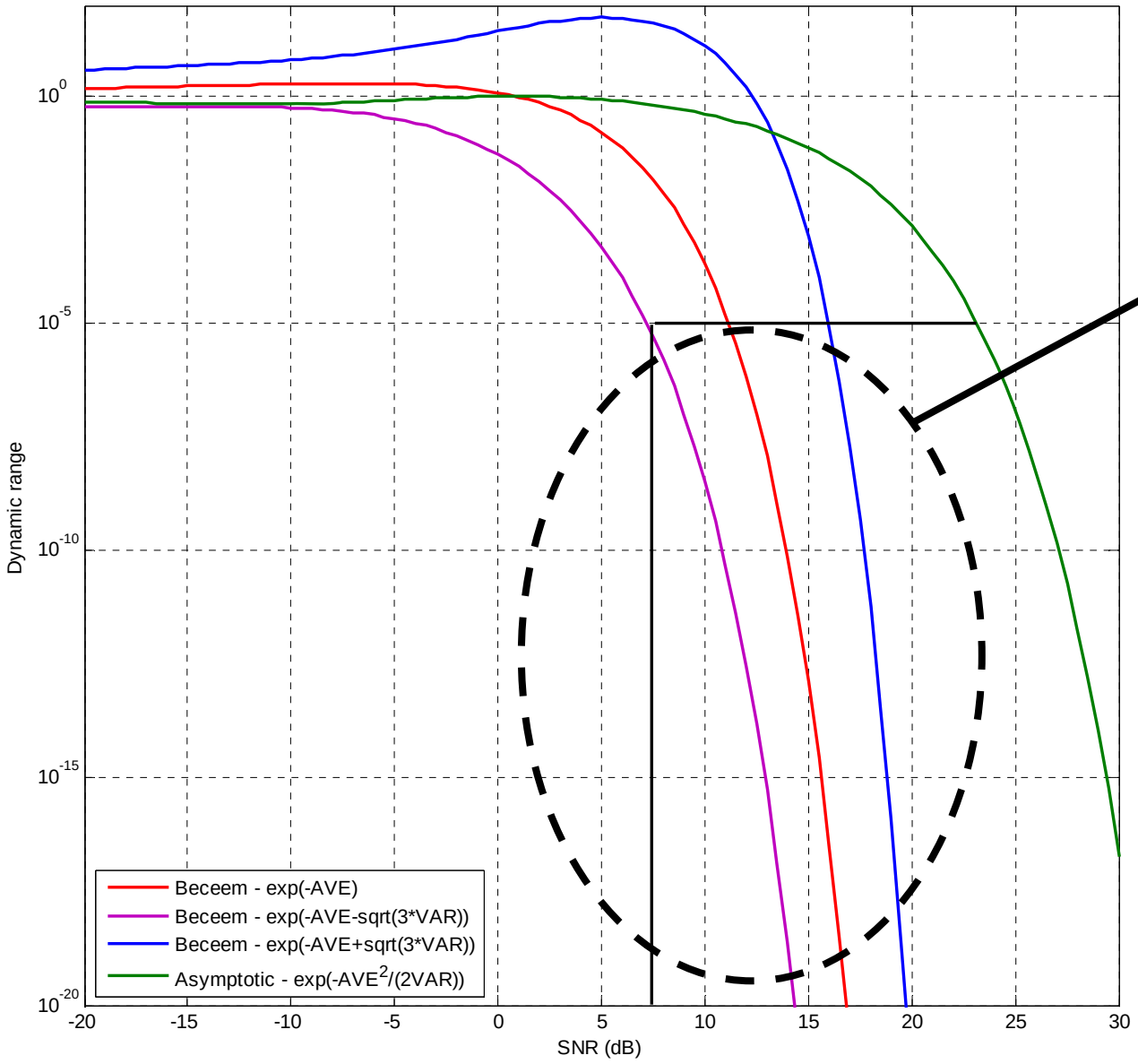
Accuracy of SI approximation



Switching point (J ≈ 0.65)

Perfect matching of hybrid scheme

Accuracy of Implementation



Region of high dynamic range for Beceem elementary functions

Avoided by Hybrid scheme

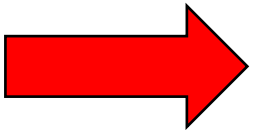
Computation Time

Function Name	Calls	**Total Time**	Self Time*	Total Time Plot (dark band = self time)
Hybrid	100001	4.866 s	2.339 s	
erfc	100001	2.527 s	1.872 s	
beceem	100001	1.201 s	1.201 s	
erfcore (MEX-function)	100001	0.655 s	0.655 s	

Self time is the time spent in a function excluding the time spent in its child functions.
Self time also includes overhead resulting from the process of profiling.

Impact on adjustment parameters (a,p_1,p_2)

- The proposal **does not impact the concept** behind introducing parameters (a,p_1,p_2)
  - a introduced to enhance the accuracy of derivation of AVE and VAR
  - p_1 and p_2 introduced for the mixture of two LLR Gaussians in MIMO Matrix B + vertical encoding
- But as far as **SINR-RBIR mapping** is used for calibration, the **values of (a,p_1,p_2) might be affected**



It might be interesting to agree also about the numerical integration itself.

Conclusions RBIR

- Proposal to replace current EVM RBIR Numerical Approximation of SI given by Equation (43), p.70:

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$$SI \approx \log_2 M - \frac{1}{\log_e 2}\left[\begin{array}{l}\frac{2}{3} f_1(AVE) \\ + \frac{f_1(AVE+\sqrt{3VAR})}{6} \\ + \frac{f_1(AVE-\sqrt{3VAR})}{6}\end{array}\right] \qquad (43)$$

- With

$$SI \approx \log_2(M) - \frac{1}{\log_2(2)} \cdot J$$

$$J = \left(\frac{J_A + J_B}{2}\right) + \left(\frac{J_A - J_B}{2}\right)\text{sign}(J_A - T) \quad ; \quad T \approx 0.65$$

where

$$J_A = AVE\left(1 - \frac{1}{2} erfc\left(\frac{-AVE}{\sqrt{2VAR}}\right)\right) + \sqrt{\frac{VAR}{2\pi}} \exp\left(-\frac{AVE^2}{2VAR}\right)$$

$$J_B = \frac{2}{3} f_1(AVE) + \frac{1}{6} f_1\left(AVE + \sqrt{3VAR}\right) + \frac{1}{6} f_1\left(AVE - \sqrt{3VAR}\right)$$

$$f_1(x) = \log_e(1 + \exp(-x))$$