

Enhanced Approximation for RBIR PHY Abstraction in TGM

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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

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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)

$$J_B = \frac{2}{3} f_1(AVE) + \frac{1}{6} f_1(AVE + \sqrt{3VAR}) + \frac{1}{6} f_1(AVE - \sqrt{3VAR})$$
$$f_1(x) = \log_e(1 + \exp(-x))$$

Numerical Integration within RBIR PHY Abstraction

- Asymptotic Approximation (new)

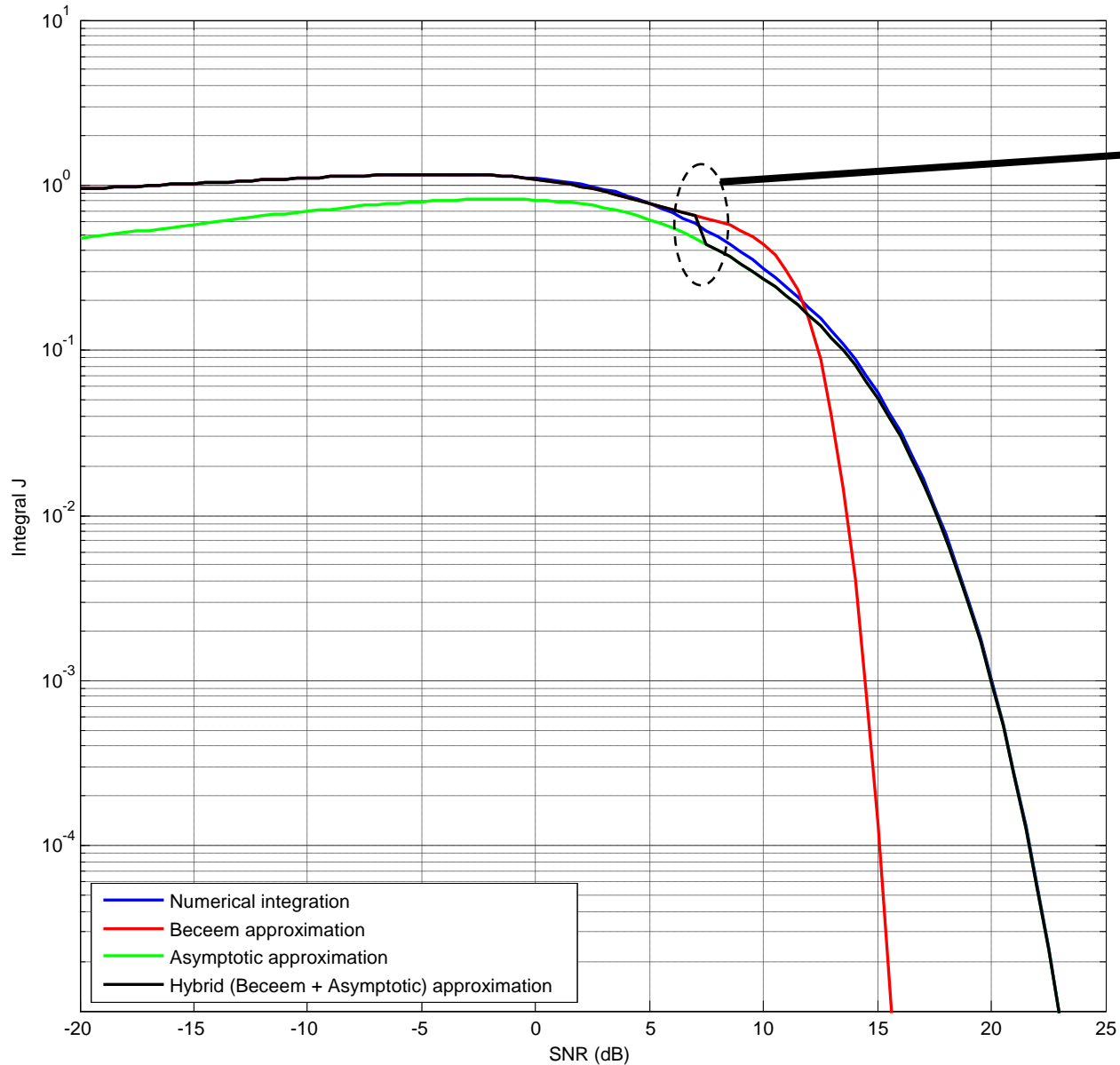
$$J_A = AVE \left(1 - \frac{1}{2} \operatorname{erfc} \left(\frac{-AVE}{\sqrt{2VAR}} \right) \right) + \sqrt{\frac{VAR}{2\pi}} \exp \left(-\frac{AVE^2}{2VAR} \right)$$

- NEW Proposal:

– **Hybrid {Beceem + Asymptotic}**

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

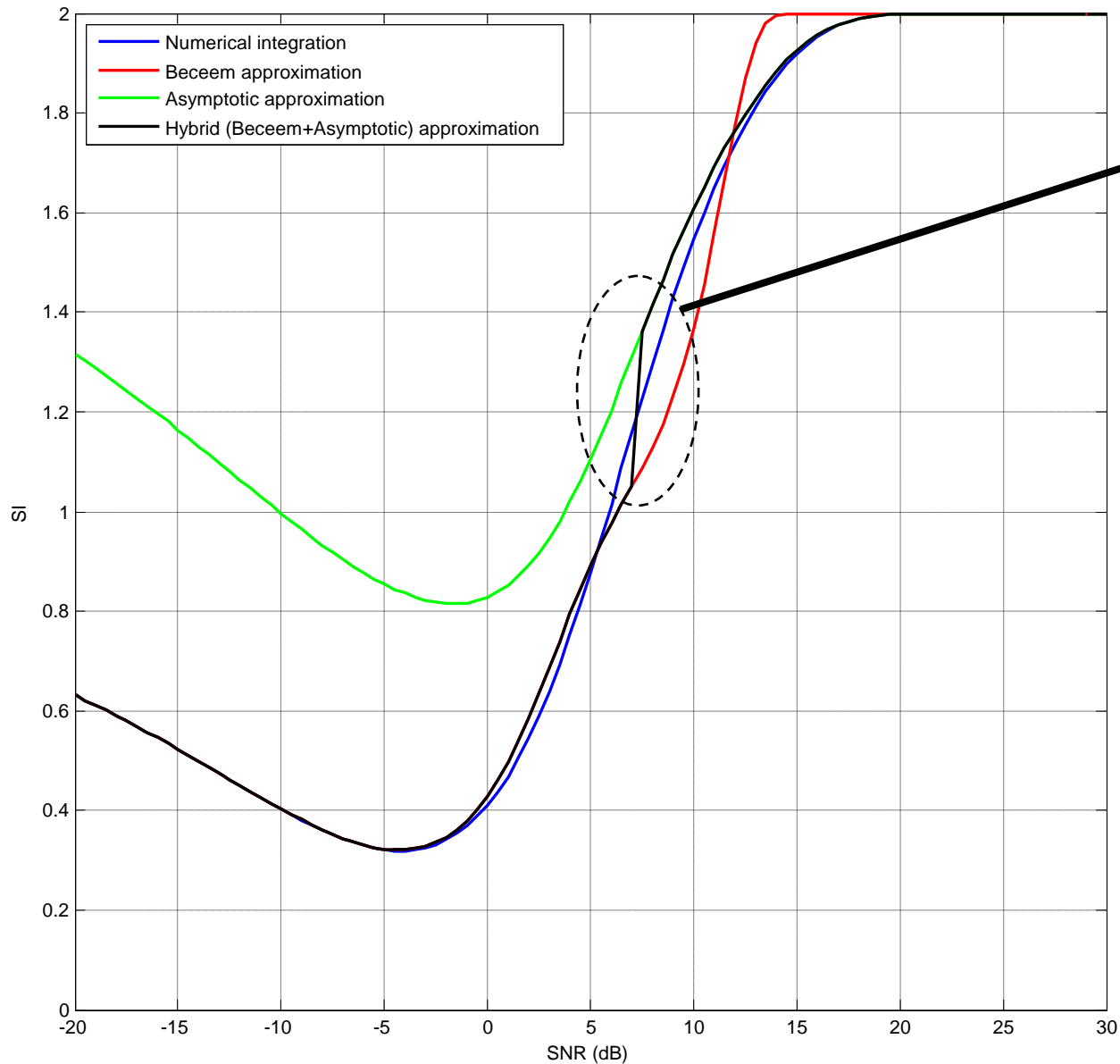
Accuracy of J approximation



**Switching point
($J \approx 0.65$)**

**Perfect matching
of hybrid scheme**

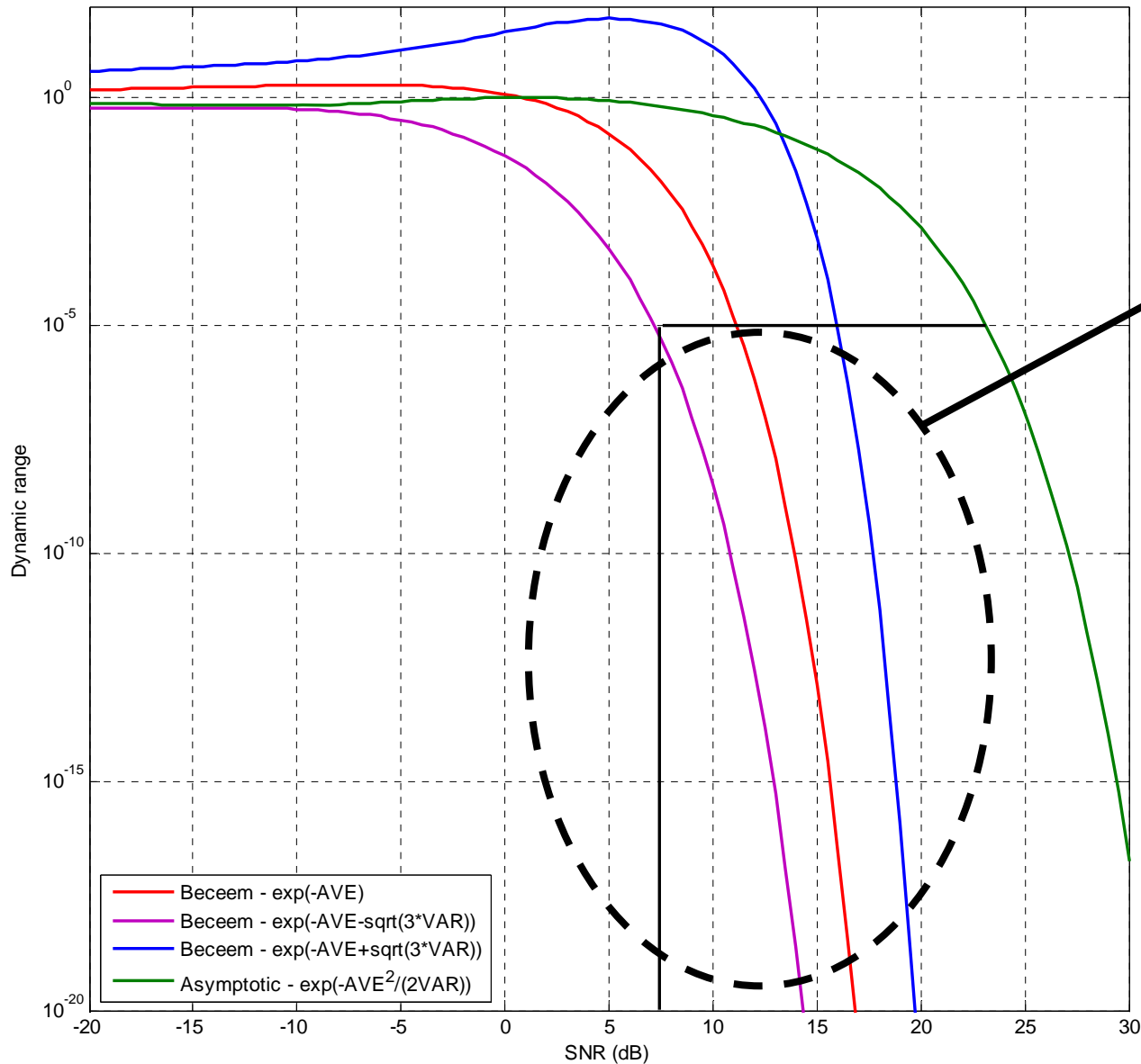
Accuracy of SI approximation



**Switching point
($J \approx 0.65$)**

**Perfect matching
of hybrid scheme**





Accuracy of Implementation



Region of high dynamic range for Beceem elementary functions

Avoided by Hybrid scheme

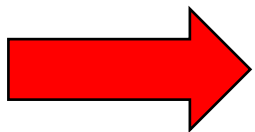
Computation Time

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

- 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

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

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

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