ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
UNIVERSITY OF PELOPONNESE

COST IC1102 Versatile, Integrated, and Signal-aware Technologies for Antennas (VISTA)

Wireless & Mobile Communications Lab

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Performance of MISO Beamforming Systems based on Effective Radiation Patterns

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THALIS INTENTION, MIS 379489

Presentation Outline

- System Description
- Problem formulation and solution
- SIR Gain estimations in multicarrier MISO beamforming systems
- Effective Radiation Pattern
- Choosing the appropriate Effective BW and Effective SLL

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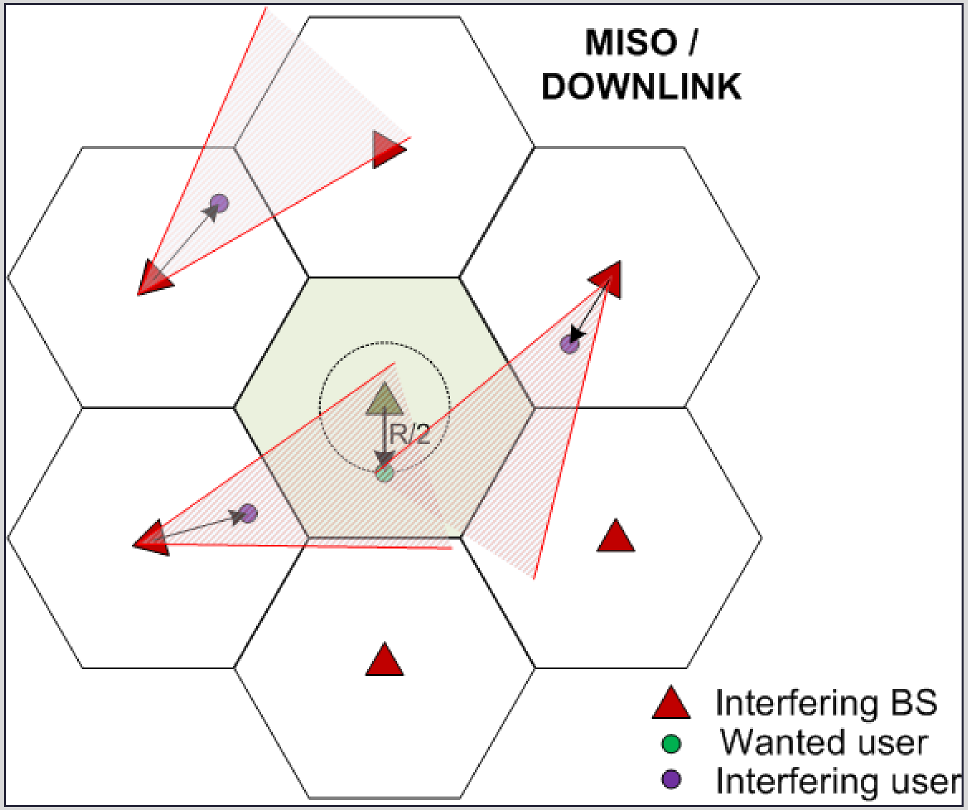
System Description

- Downlink
- Multicarrier
- 100% Loading Factor
- MISO beamforming
- All BS employ the same antenna radiation pattern
- Uniform distributed users



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The Problem

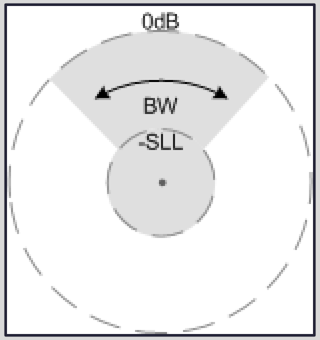
➢ **What is the SIR distribution in such a system?**

$$SIR = \frac{P_0 G_{u,b_0} d_{u,b_0}^{-n} L_{u,0}}{\sum_{i \in I} P_0 G_{u,b_i} d_{u,b_i}^{-n} L_{u,b_i}}$$

➢ **When,**

- *u:* wanted user located at R/2 in the central cell
- $L_{u,bi}$: shadowing effect, follows LogNormal(0, σ)
- The BSs employ the same

effective radiation pattern.



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The Solution (1)

$$\Pr\left(SIR < x_{SIR}, SLL\right) = \sum_{k=0}^{6} P_k \Pr\left(SIR < x_{SIR}, SLL / k\right)$$

$$P_k = \binom{6}{k} p^k (1-p)^{6-k}$$

$$\Pr\left(SIR < x_{SIR}, SLL / k\right) = \Pr\left[\left(\frac{P_0 d_0^{-n} L_0}{\sum_{i=1}^{k} P_0 d_i^{-n} L_i + \sum_{j=1}^{6-k} P_0 d_j^{-n} L_j 10^{-\frac{SLL}{10}}}\right) < x_{SIR}\right]$$

- **Sum of 6 LogN distributions**
  - Fenton-Wilkinson
  - MGF (0.001-0.036)

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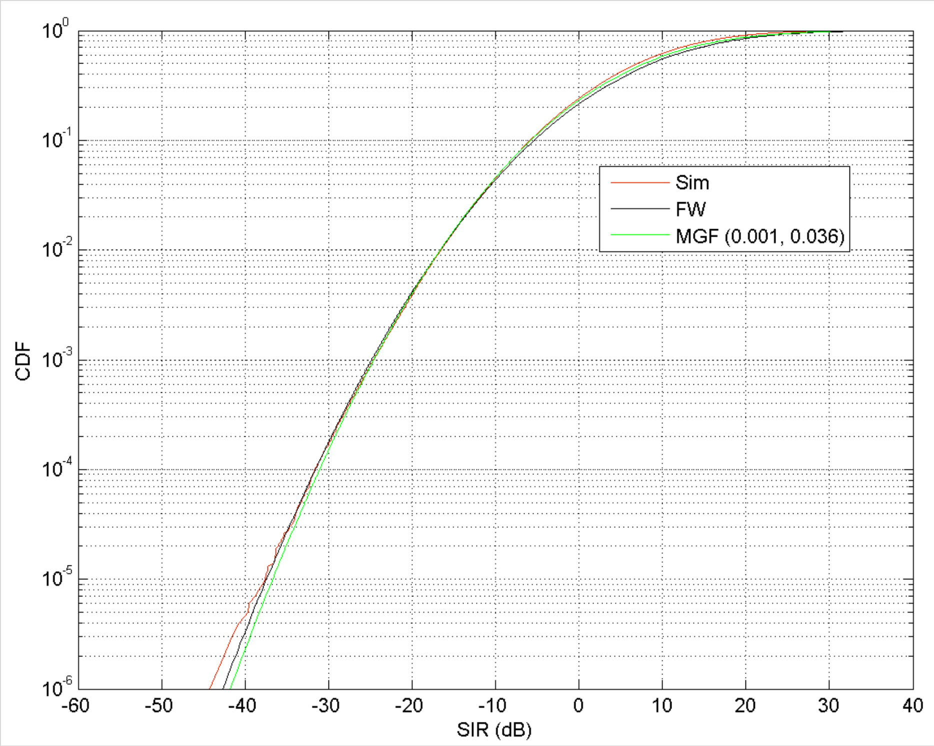
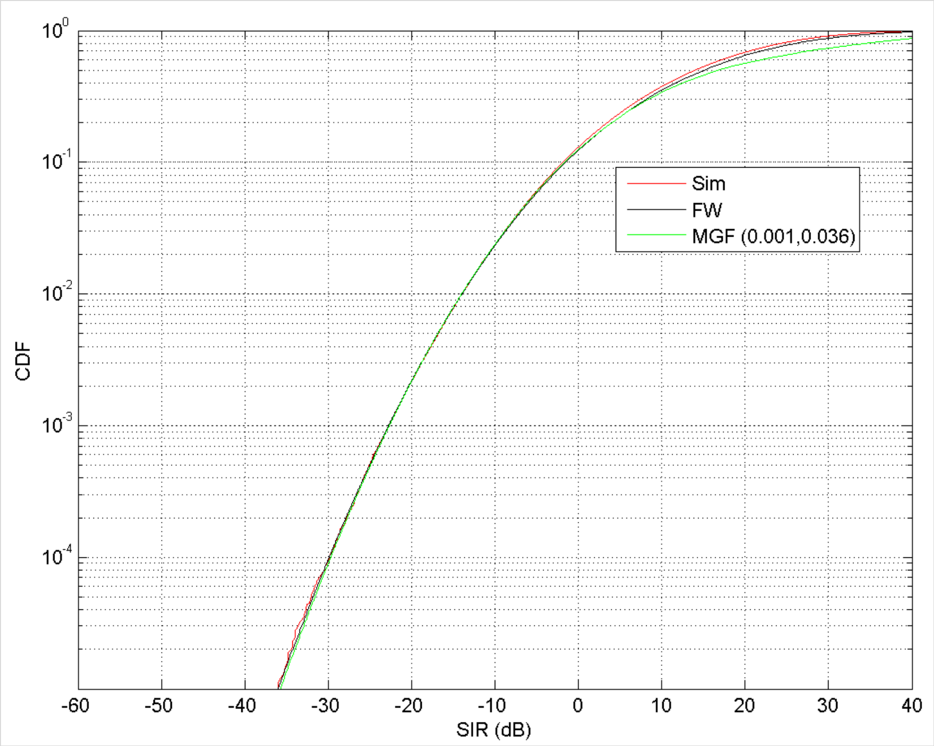
The Solution (2)

BW = 120º, SLL = -10dB



BW=60o, SLL=-20dB



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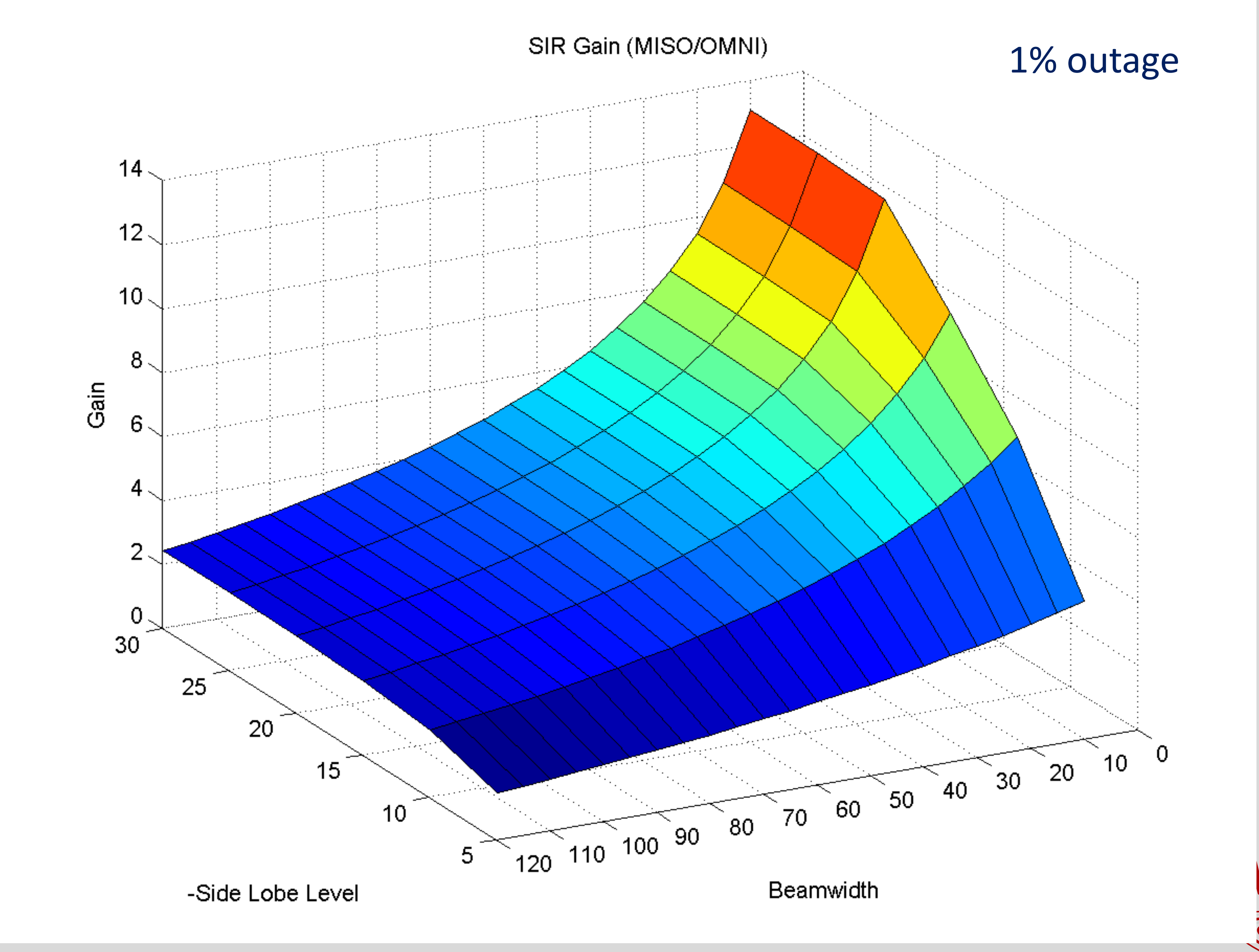
SIR gain in MISO Beamforming Systems



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Effective Radiation Pattern (1)

- The **Effective Radiation Pattern (ERP)** models the result of the **convolution** of the **power azimuth spectrum** with the **ideal antenna pattern**.
- The environment is modeled with the Laplace Distribution.
- So, the actual radiation pattern of an *N*-element array is:

$$G_{real}(\varphi_0) = \frac{1}{\sqrt{2}\sigma}\int_0^{\pi}\left|\frac{\sin\left(\frac{N}{2}\cos\varphi\right)}{\frac{N}{2}\pi\cos\varphi}\right| e^{-\frac{\sqrt{2}|\varphi-\varphi_0|}{\sigma}}\,d\varphi$$

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Effective Radiation Pattern (2)

- Our goal is to model G_{real} with an ERP, G_{eff}.

$$G_{eff} = \begin{cases} 1 & \varphi \in \left[\varphi_m - \frac{BW}{2}, \varphi_m + \frac{BW}{2}\right] \\ 10^{-\frac{SLL}{10}} & \varphi \in \left(0, \varphi_m - \frac{BW}{2}\right) \cup \left(\varphi_m + \frac{BW}{2}, \pi\right) \end{cases}$$

- So as to minimize the optimization function:

$$\{BW_{opt}, SLL_{opt}\} = \arg \min_{\substack{BW \in (0,\pi) \\ \mathrm{SLL} \in (a,0)}} \int_0^{\pi} \left| G_{eff}(\varphi) - G_{real}(\varphi) \right| d\varphi$$

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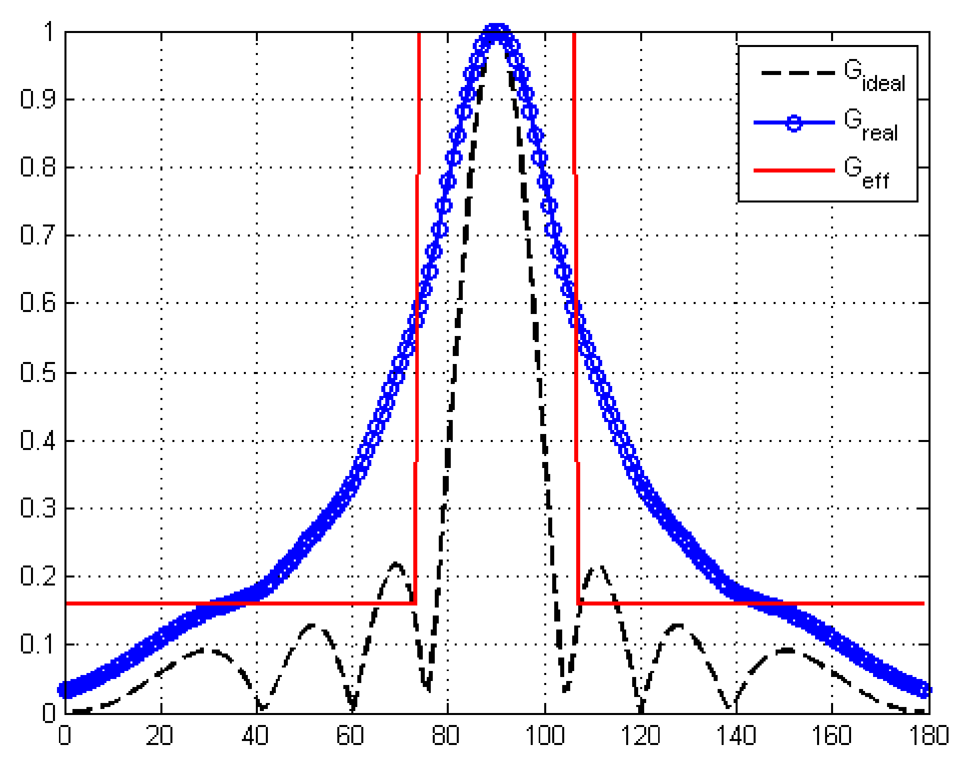
Choosing Effective BW and SLL (1)

- Ideal Radiation Pattern: 8-element array antenna (12° 3dB beamwidth)
- Highly NLOS environment with AS=20°
- BW_{opt} = 33°, SLL_{opt}=-8dB



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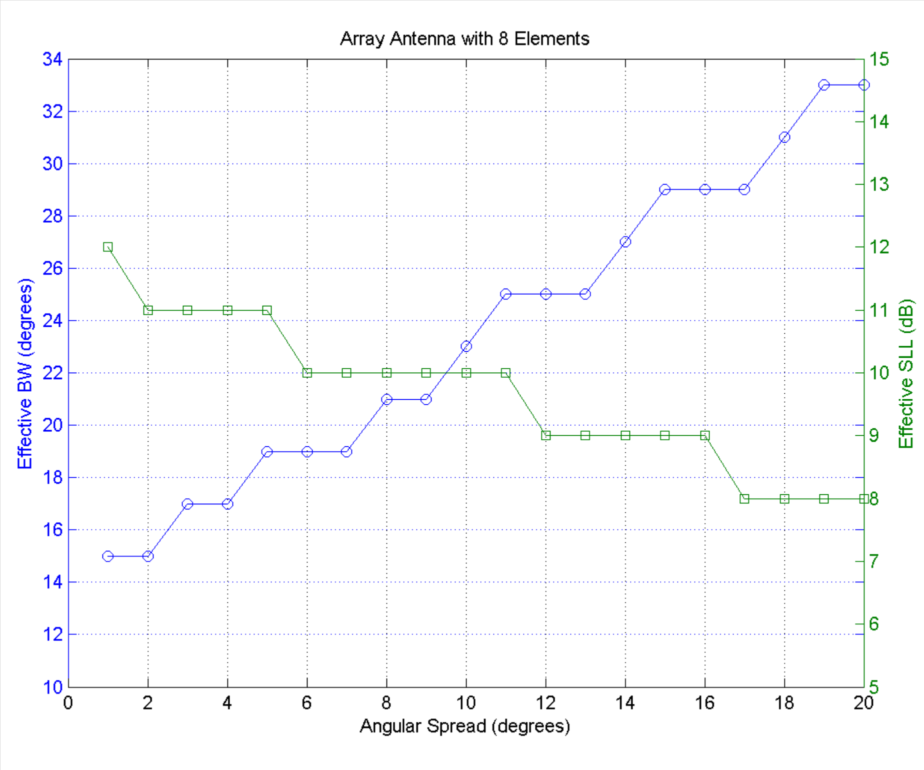
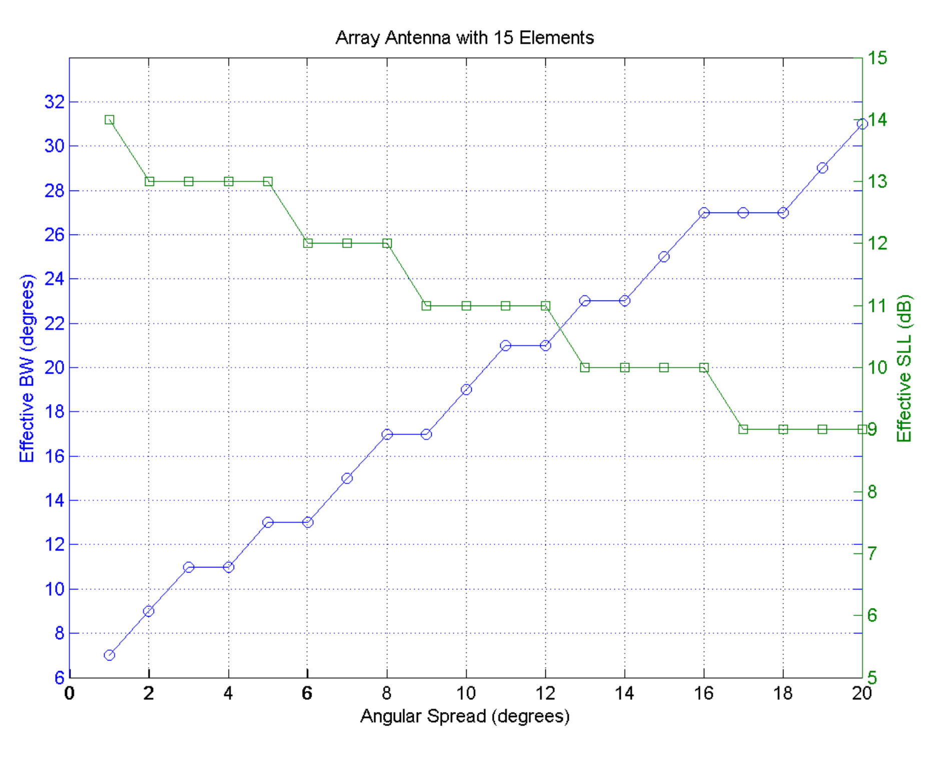
Choosing Effective BW and SLL (2)





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Thank you for your attention!!

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