

Versatile Deployment of FPGA Accelerators in Disaggregated Data Centers: a Bioinformatics Case Study

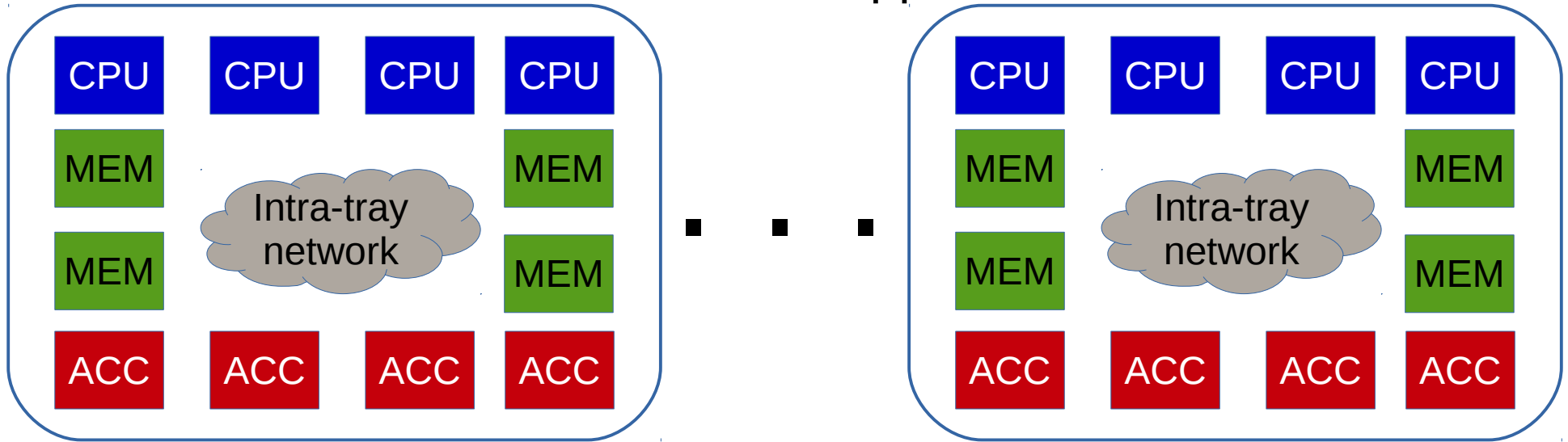
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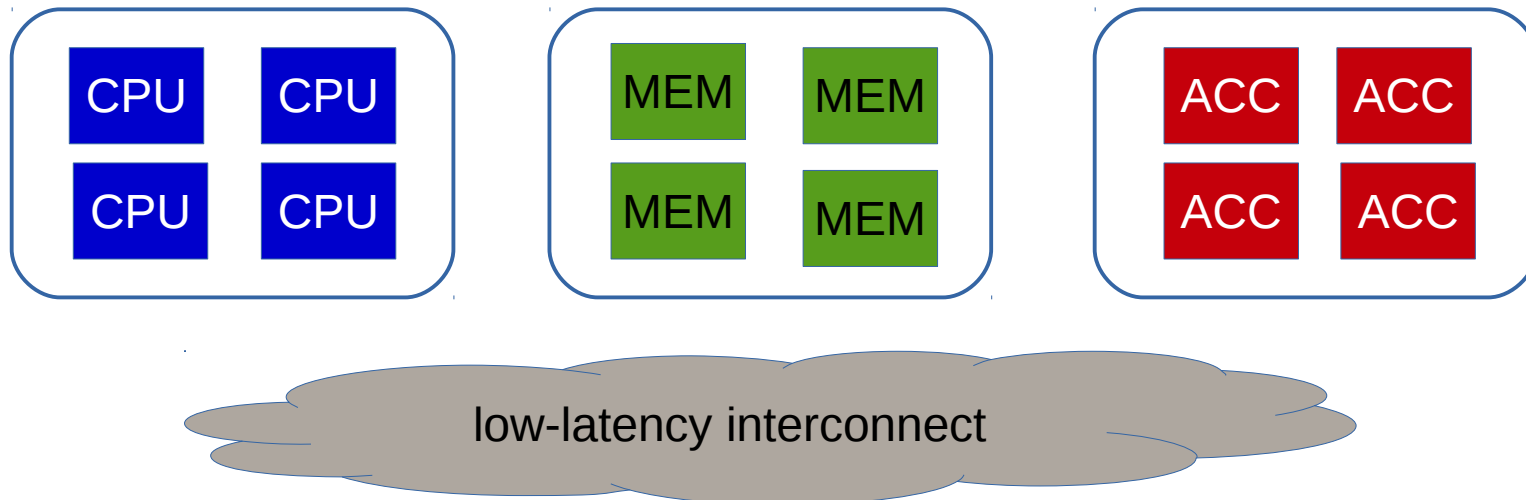


Disaggregation

Server-centric approach



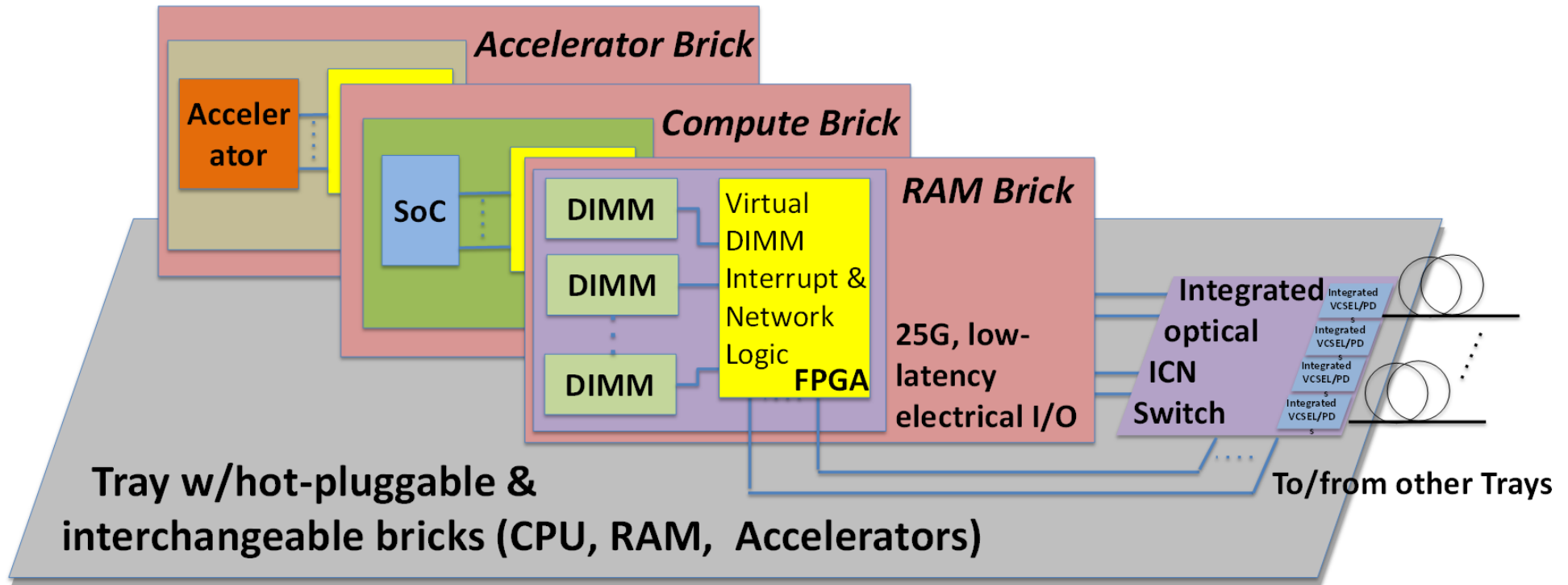
Resource-centric approach



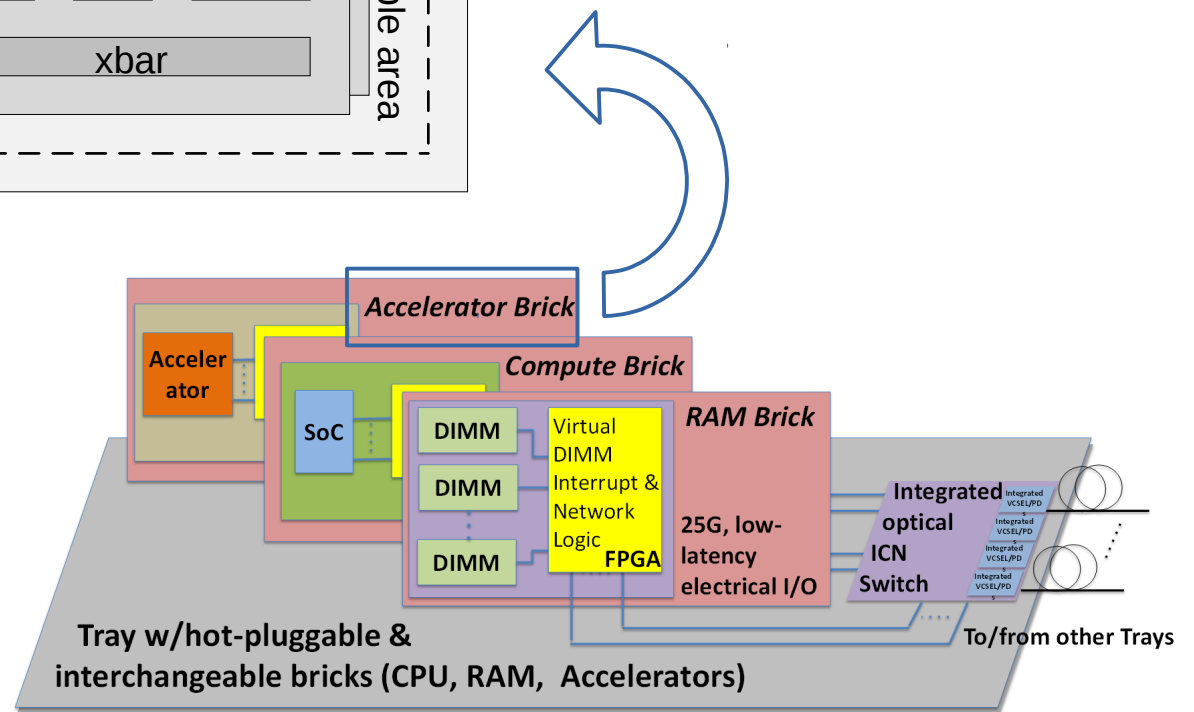
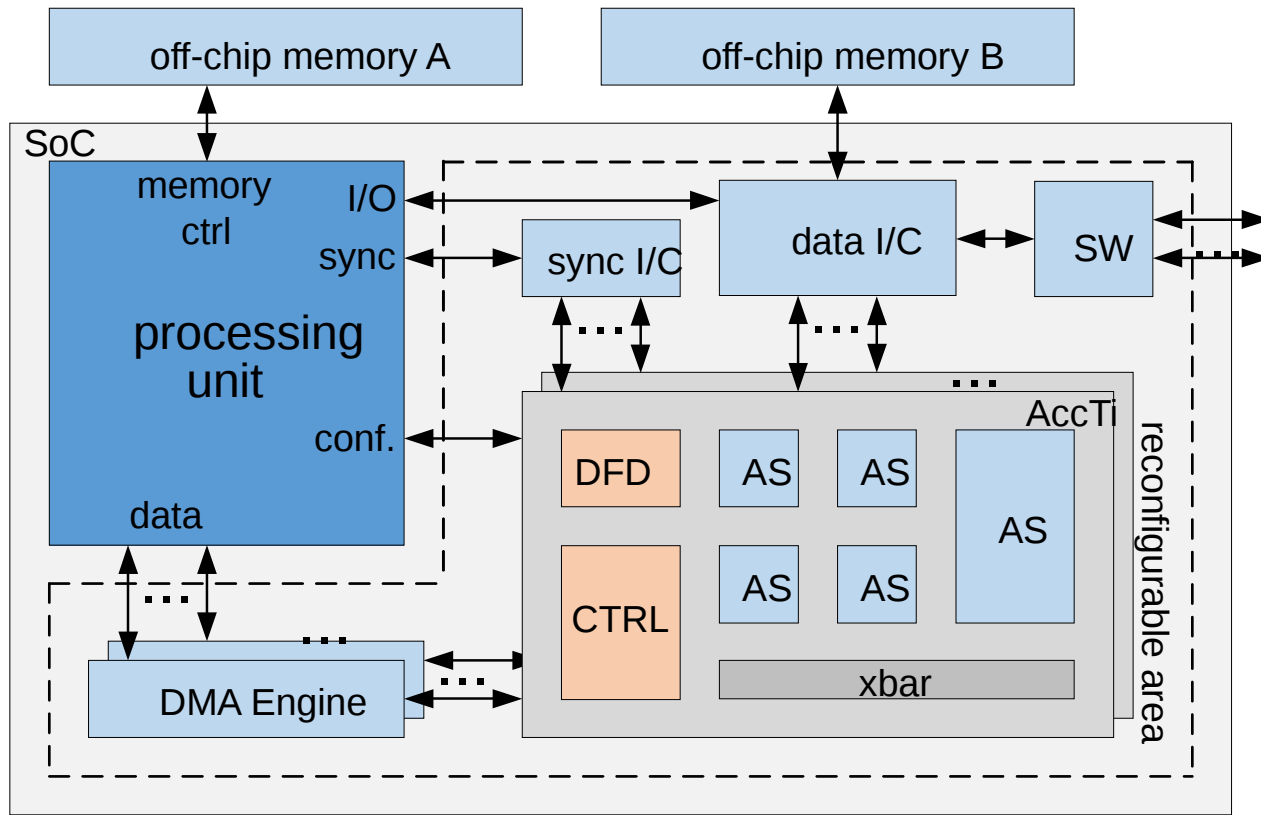
The dReDBox Architecture

Paradigm shift

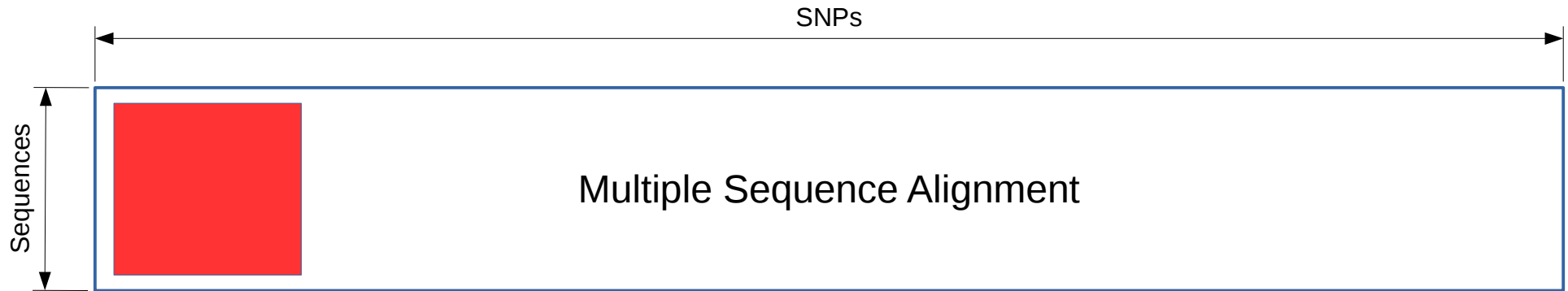
Mainboard-as-a-unit → disaggregated function-block-as-a-unit



Accelerator Brick Architecture

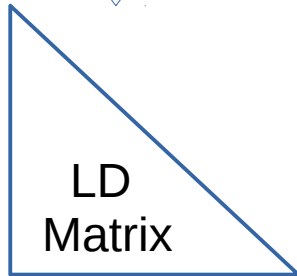


Scanning for positive selection



Linkage Disequilibrium (LD):

$$r_{ij}^2 = \frac{[P(v_i \& v_j) - P(v_i)P(v_j)]^2}{P(v_i)P(v_j)(1 - P(v_i))(1 - P(v_j))},$$



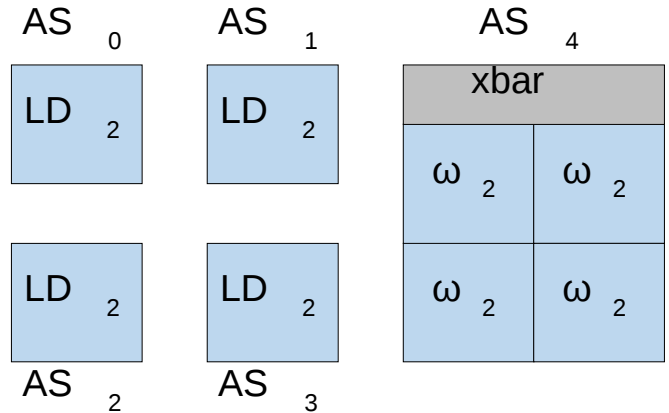
Omega statistic:

ω kernel

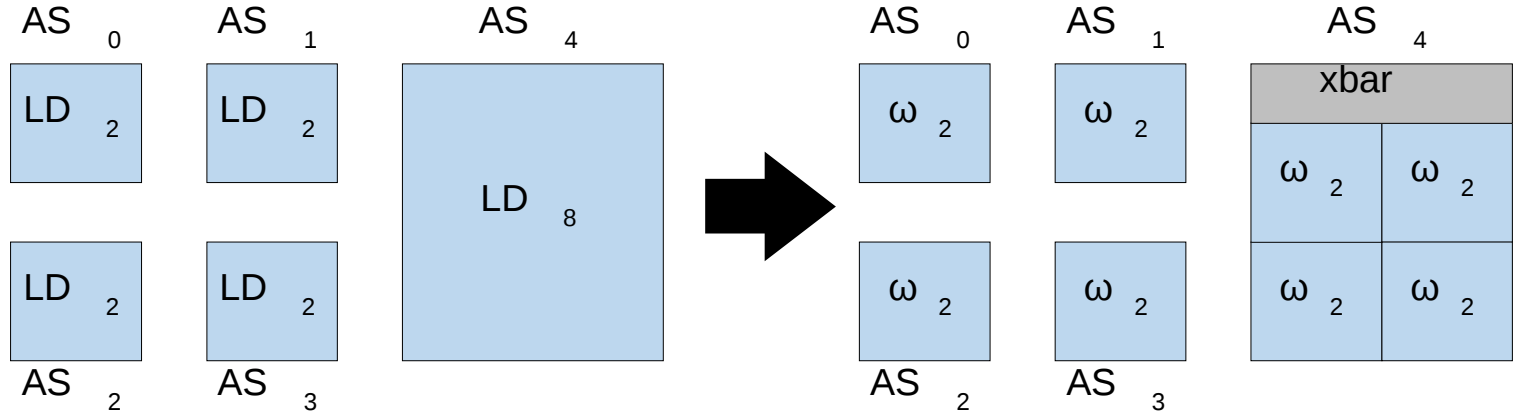
$$\omega = \frac{\left(\binom{l}{2} + \binom{W-l}{2} \right)^{-1} \left(\sum_{i,j \in L} r_{ij}^2 + \sum_{i,j \in R} r_{ij}^2 \right)}{\left(l(W-l) \right)^{-1} \sum_{i \in L, j \in R} r_{ij}^2}.$$

AccTi Configurations

scenario A



scenario B



Performance comparison

Intel Xeon E5-2630 6-core
@2.60 GHz (12-thread runs)

vs. Zynq 7045 MPSoC
(Kintex 7 prog. Logic)

	Dataset (#sequences : #SNPs)		
	[A] $10^3:10^4$	[B] $10^4:10^4$	[C] $10^4:10^5$
OmegaPlus-G			
LD	2.6 (14.54)	19.1 (2.63)	308.2 (2.89)
ω	32.9 (85.63)	21.5 (74.22)	7.1 (75.03)
Total	35.9	43.7	358.7
Accel. Map A			
LD	0.78 (48.39)	9.89 (5.09)	175.1 (5.08)
ω	4.41 (639.29)	2.66 (600.09)	0.81 (660.17)
Total/Speedup	5.59 / 6.42X	15.65 / 2.79X	218.8 / 1.64X
Accel. Map B			
LD	0.57 (65.76)	6.67 (7.52)	126.8 (7.03)
ω	5.84 (481.99)	3.89 (409.47)	1.37 (389.65)
Total/Speedup	6.81 / 5.27X	13.66 / 3.19X	171.57 / 2.09X

Conclusions

- Hardware resources to increase generality and flexibility of the employed accelerators
- Application- and/or data-driven mapping to improve performance

Thank you!