A Fully Synthesized Fractional-*N* IL-PLL Using Only Digital Library

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IEICE General Conference 2016

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Outline

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- Motivation
- Concept of Injection Locking
- Fractional-*N* Implementations
- Performance Comparison
- Conclusion

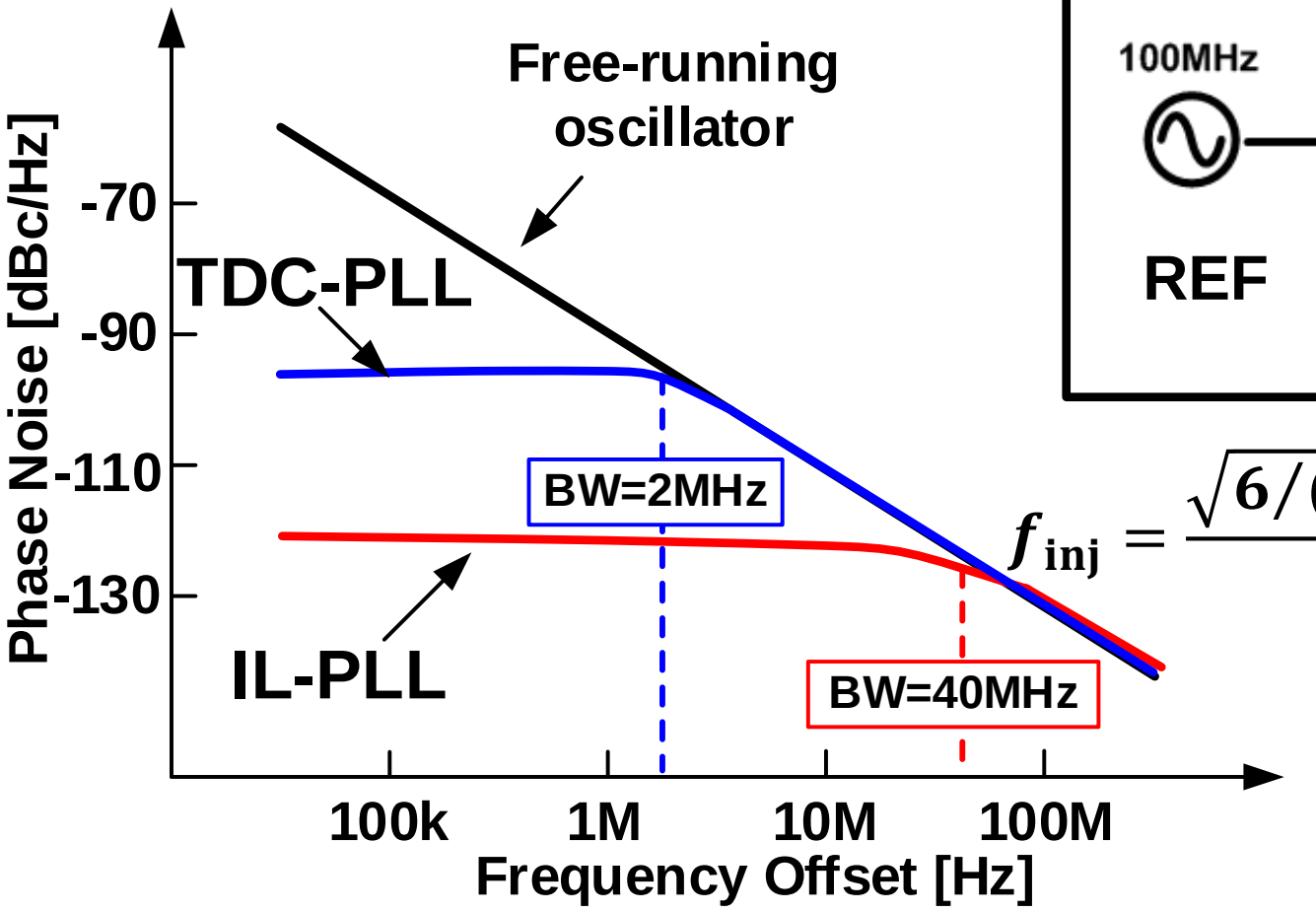
Motivation

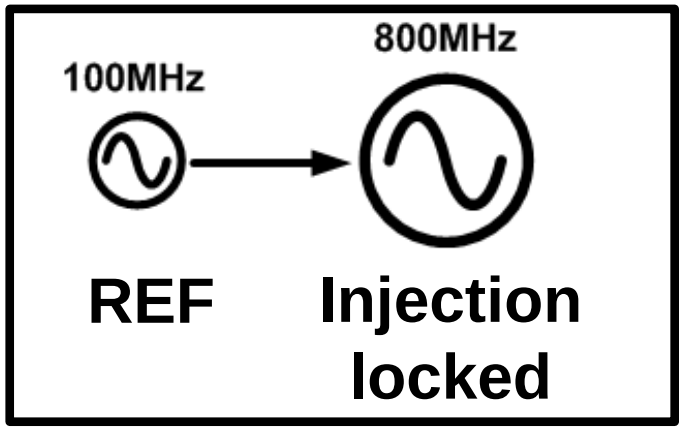
- **Why High Performance PLL**
  - **Clock generation/distribution**
- **Key Specifications for SoC Clocking**
  - **Small area**
  - **Low power consumption**
  - **Low jitter**
  - **Insensitive over environment variations**
  - **Scalable with technology advancement**

[1] W. Deng, *et al*., ISSCC2014

Injection Locking Technique

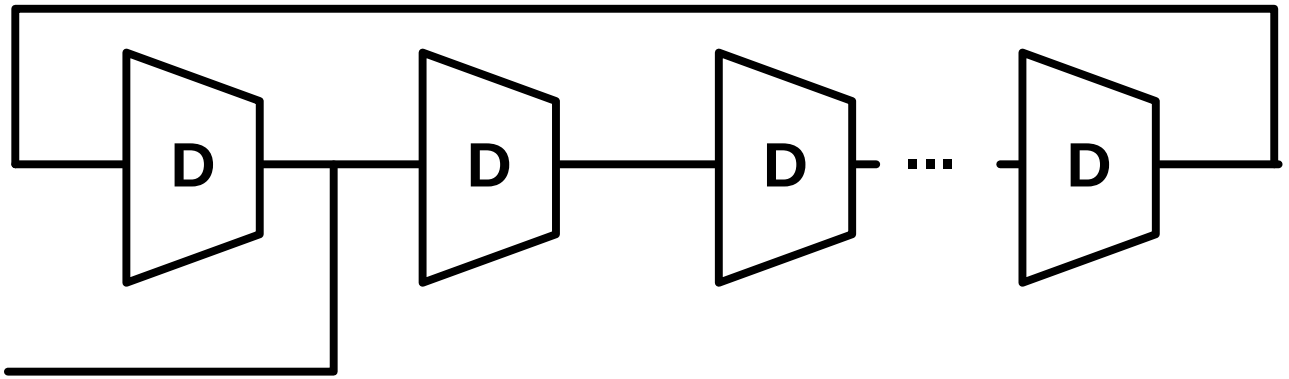
$Jitter_{TDC\text{-}PLL}$=6.4ps $Jitter_{IL\text{-}PLL}$=1.5ps



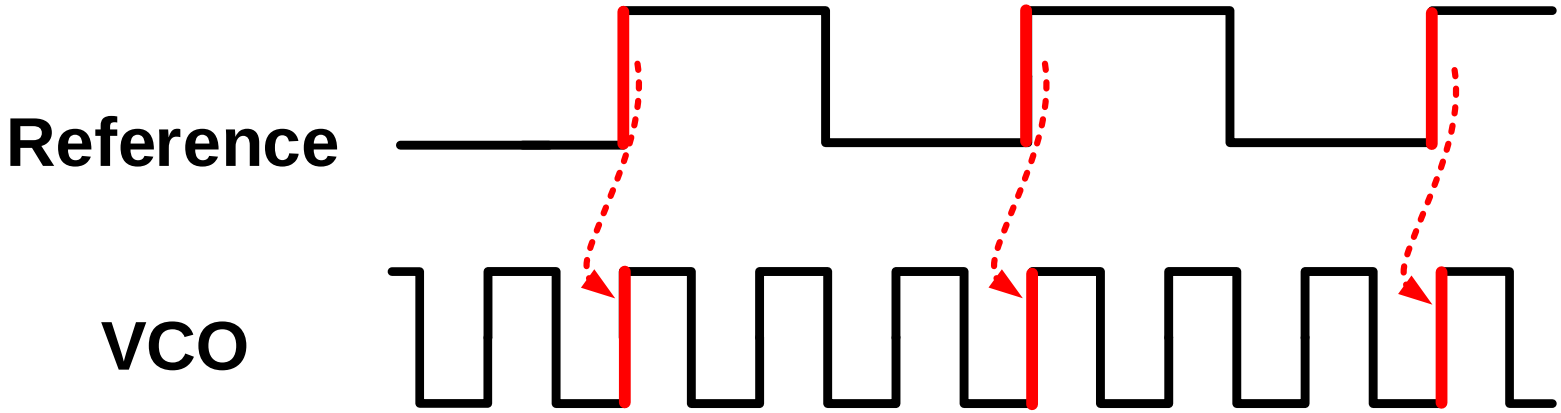


$$f_{inj} = \frac{\sqrt{6/(N(N-1))}}{2\pi} \cdot f_{ref}$$

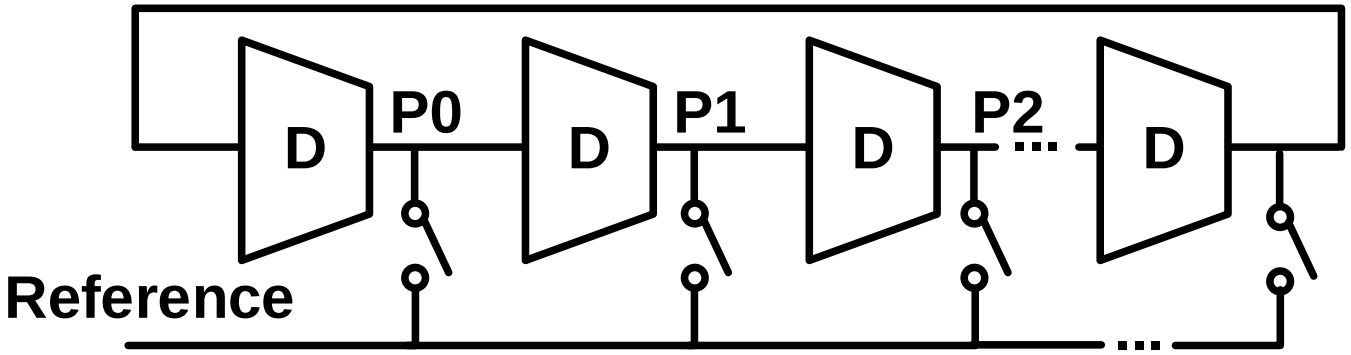
Integer-*N* Operation



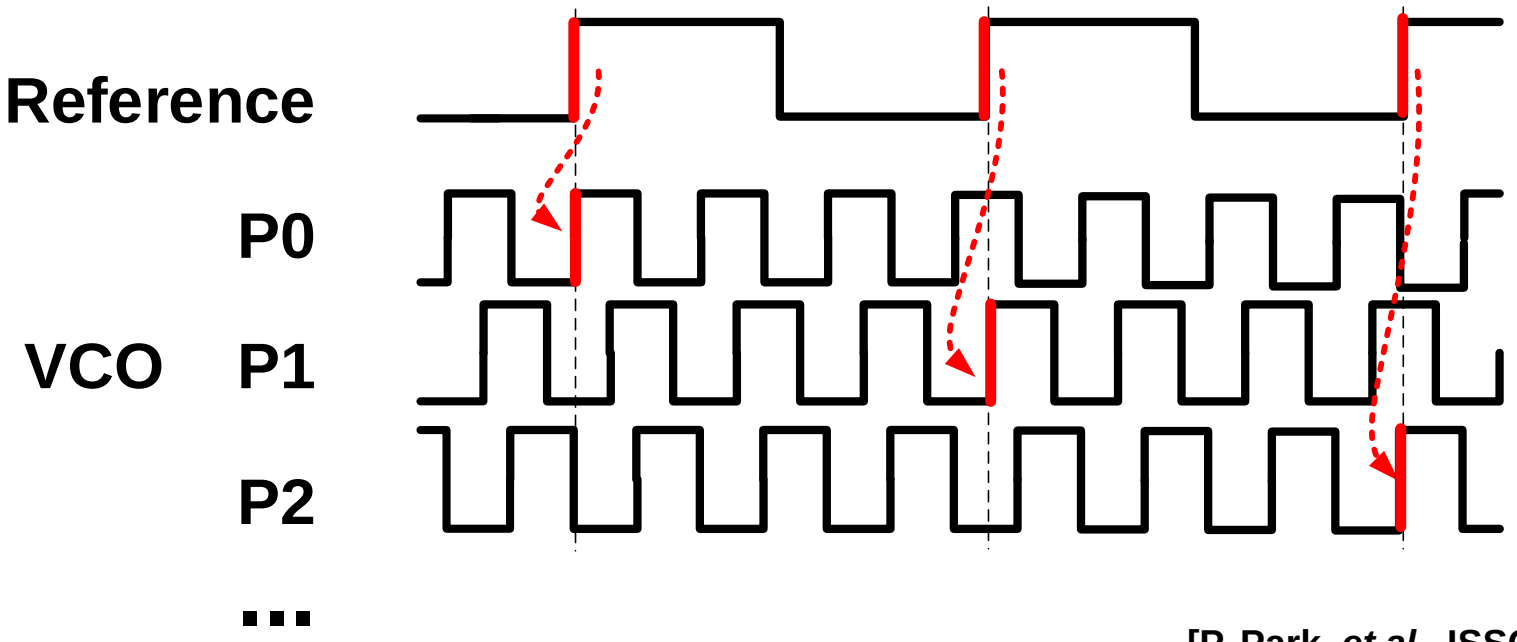
e.g. *N*=3



Sub-Integer-*N* Operation

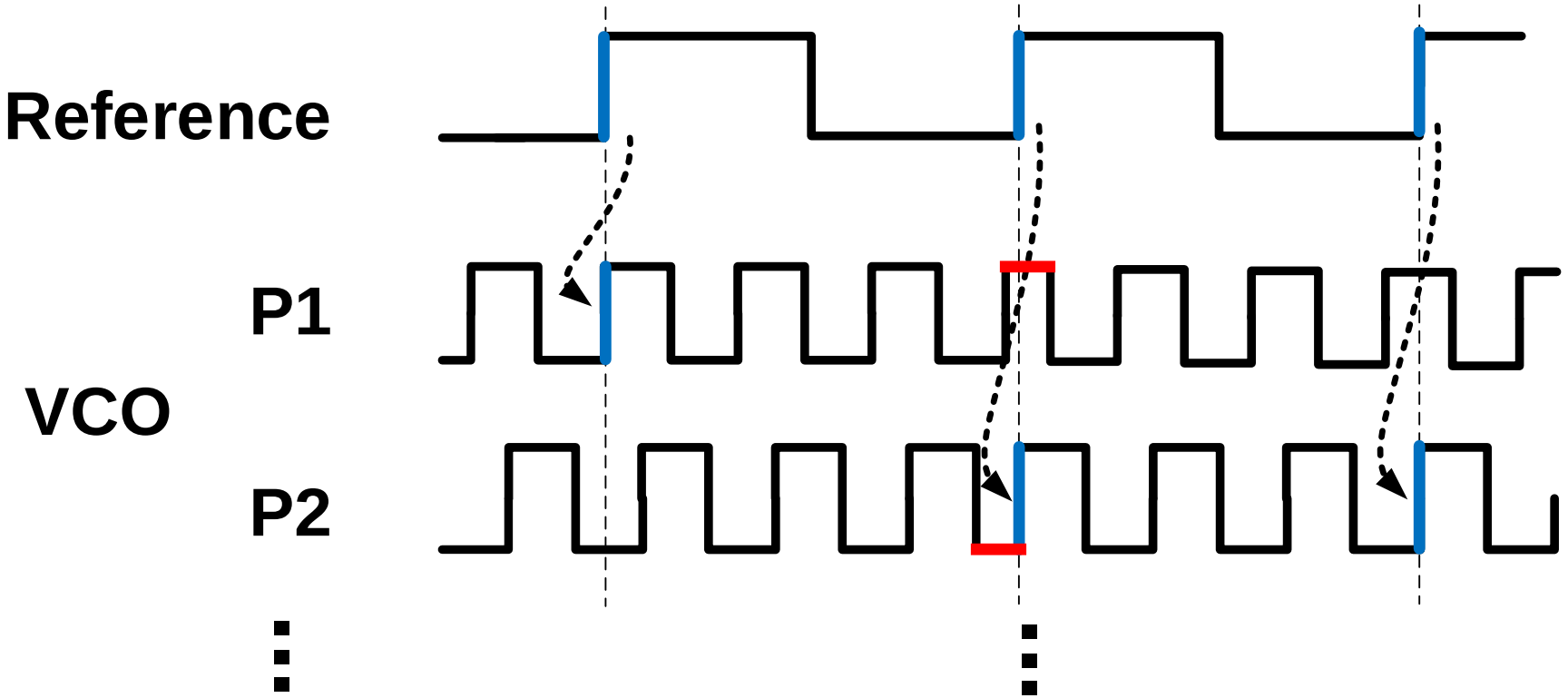


e.g. *N*=3+(1/M)



[P. Park, *et al.*, ISSCC 2012]

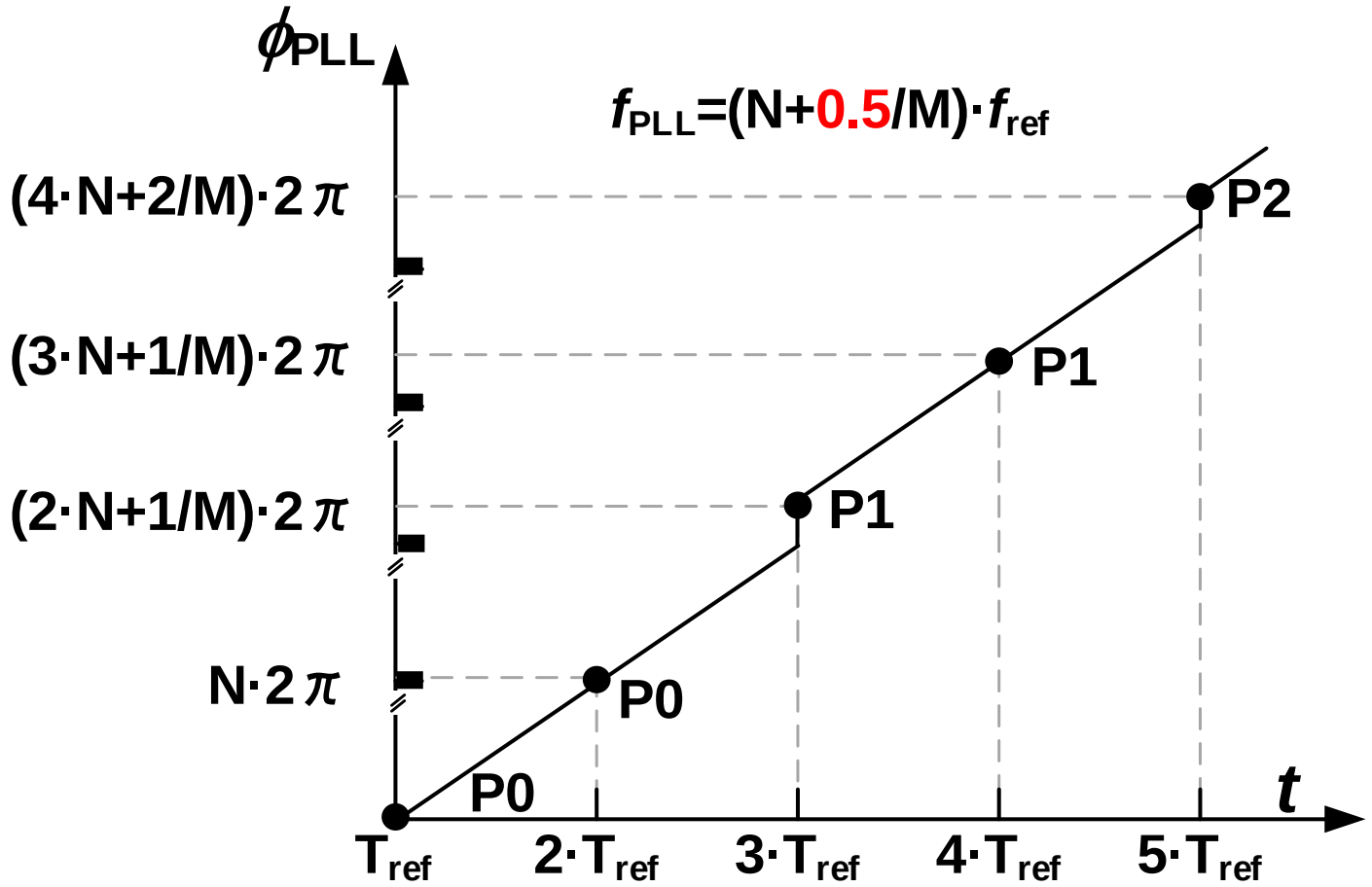
Time Domain (Fractional-*N*)



- **Injection at the same phase two times**

[2] W. Deng, *et al*., ISSCC2015

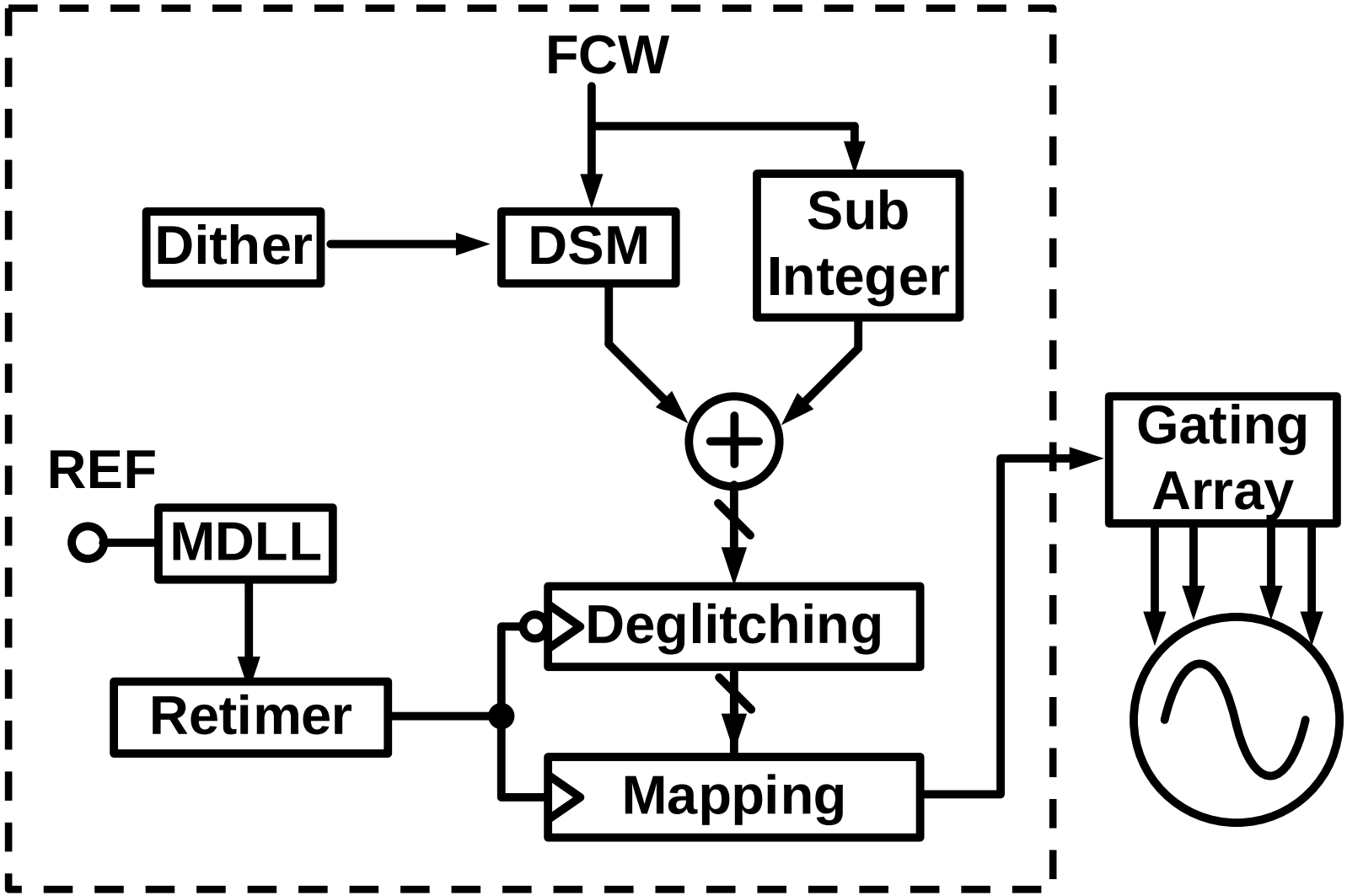
Phase Domain (Fractional-*N*)



P0 → P0 → P1 → P1 → P2 → P2 → P3 …

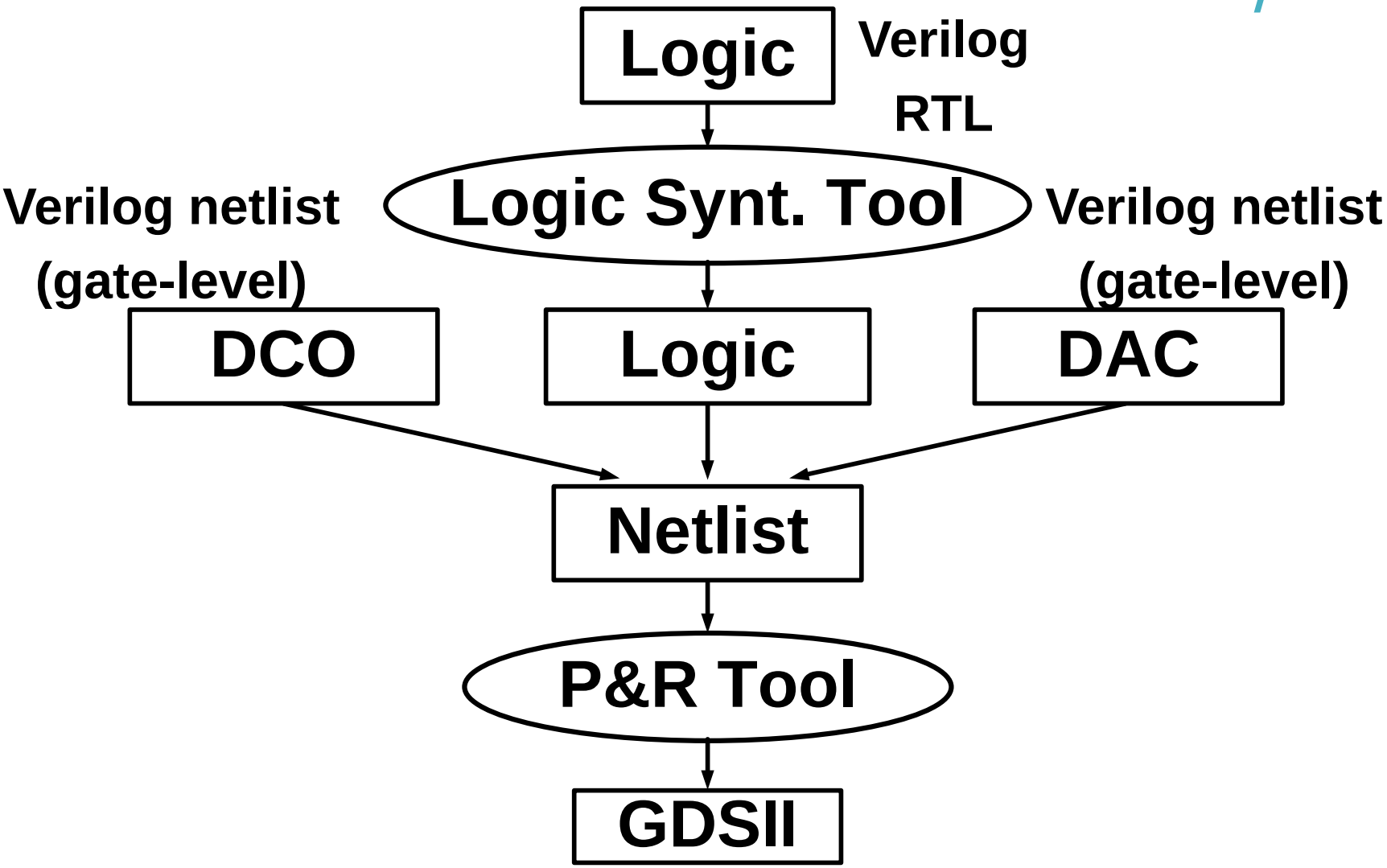
[2] W. Deng, *et al*., ISSCC2015

Fractional-*N* Controller

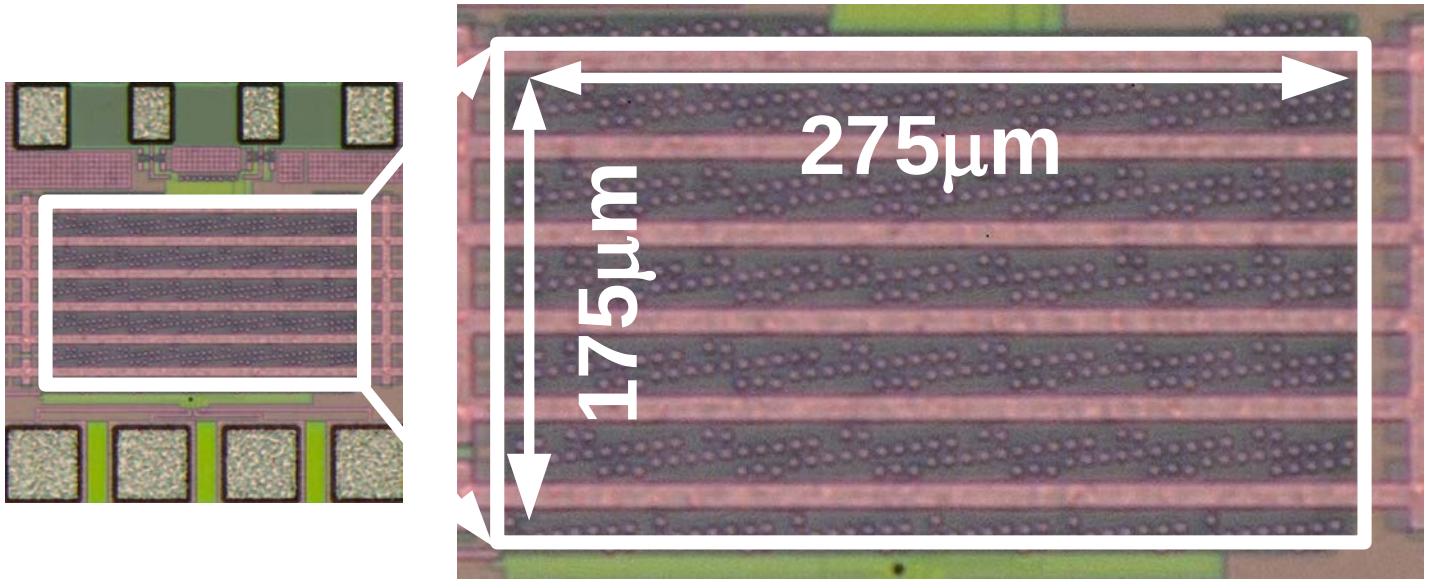


[2] W. Deng, *et al*., ISSCC2015

Design Procedure



Chip Microphotograph



CMOS 65nm technology

Comp. of State-of-art PLLs

	This work	[1]	[4]	[5]
CMOS	65nm	65nm	65nm	65nm
Topology	Soft Injection locking	Injection locking	DTC-based MDLL	Injection locking
Type	Frac-*N*	Int-*N*	Frac-*N*	Sub-Int-*N*
Frequency [GHz]	0.8-1.7	0.39-1.41	1.6-1.9	0.25-1.65
Power [mW]	3 @1.5222GHz	0.78 @0.9GHz	3 @1.7GHz	10.5 @0.58GHz
FoM [dB]	-224.2	-236.5	-232	-221.9
Synthesizable ?	Yes		No	

*FOM is calculated based on RMS jitter.

Conclusion

- **A fully synthesizable fractional-*N* IL-PLL is presented.**

- **Only digital library is used in the whole design.**

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Thank you for your attention

Q & A