COMPUTER AIDED DESIGN
FOR INTEGRATED SYSTEMS

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ABSTRACT
This paper describes a design framework for integrated system design. It discusses the design methodology, the design system, the CAD tools, the models and their interaction that enable optimized integrated system design. Examples of this design approach are discussed in the context of an integrated GSM chip.

1. INTRODUCTION
The continued downscaling of CMOS technologies over the last decades made CMOS not only the technology of choice for pure digital and analog design, but made it also feasible for RF circuit design, which enabled the economical integration of full systems on 1 CMOS die. Prototypes of full-integrated systems in CMOS have already been demonstrated [1,2]. In the coming years we can therefore expect to witness the introduction of numerous system on chip products in the marketplace.

The rational behind the integration is that it allows to combine more functionality on the same substrate, and have circuits benefit from the existence of each other (functionality reuse). It reduces the system overhead, and can reduce system test time. It also avoids unnecessary signal degradation (from package parasitics), power consumption (to drive external loads) and increased area (for bond pads with ESD protection) related to crossing the pad boundaries and interfacing with other dies and or external components.

On the other hand integration does not come for free. If the integrated system is not core limited, the die size will increase by integrating...
more functionality, which reduces the yield compared to the combined yield of two smaller dies. Since all circuits share the same substrate and same technology, signal integrity can deteriorate and you might be paying a premium to have simple digital circuitry integrated together with RF functionality, which sometimes requires special process steps. You also give up on visibility because less signals are accessible, which can translate into longer debugging times and increased system test cost, unless testability and observability is taken into account during the design phase.

Clearly just combining functionality in the same technology will not result in a successful system on chip product. In order to benefit from integration, the system needs to be re-engineered with integration in mind rather than combining existing dies on one substrate [5]. A clear example is the trend in wireless transceivers. Just integrating all the active circuitry involved with dual heterodyne architectures, is not optimal, because they were architected to minimize the (at that time) expensive active circuitry, and exploit the relative cheap passive components like bandpass filters. The increased interest in low and zero IF receivers as ideal candidates for full integrated systems, stems from the fact that they are re-engineered with integration in mind, and exploit the cheap active circuitry to minimize external component cost and interfaces related to it.

So, what does it take to enable efficient re-engineering for system integration? To answer that question it pays to realize that an integrated system encompasses not only the integrated circuit, but also a package, external components, a PCB and software. In order to optimize the overall system performance, all these components and their interaction need to be understood and their behavior with respect to each other needs to be scrutinized. This process used to be managed by system engineering. Based on their experience, knowledge and discussions with the different engineering disciplines involved, they come up with an interface specification that the individual engineering groups design to. This divide and conquer process is inherently limited by the shared knowledge and complexity that both engineering teams can handle and can therefor severely restrict the solution space and obscure an optimized system solution. Since nowadays computers and CAD tools can handle larger and larger databases more and more efficiently, they are ideal candidates