MOBILE EXPERTS

# OPENRF:

## FOCUSED DIFFERENTIATION TO DRIVE ADVANCED TECHNOLOGIES

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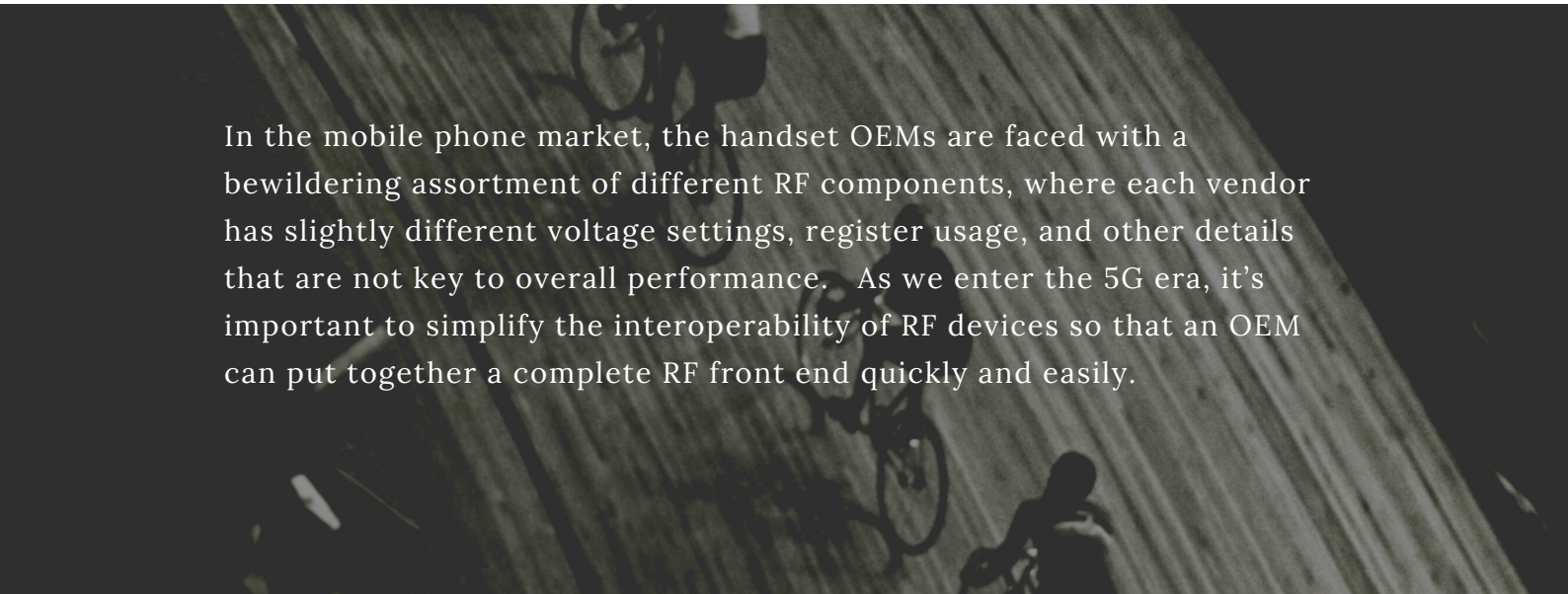
When John Dunlop developed the rubber tire for bicycles in 1887, a local Irish bicycle racer used the tire to dominate the cycle racing circuit, and rubber tires swept across the market. A clever American named George Schrader added a valve stem design in 1891 that quickly became the preferred valve for most bicycles. As a result, the Schrader valve was well established when the auto industry was invented in the 1900s…and practically all of the 50 billion tires produced over the past hundred years have used the basic Schrader valve dimensions.

Everybody uses the Schrader valve for tires, because of the obvious benefit of pulling into a gas station and knowing that the air compressor will fit on the tire. No tire supplier would get much benefit from changing the size or shape of their tire's valve stem. And if every auto manufacturer installed tires with different valve sizes, our global economy would literally grind to a halt.

This example is instructive in looking at the market for RF semiconductors for smartphones. Currently, a great deal of effort is invested every year in the design of components that create no competitive advantage for anyone: CMOS controllers, power supplies, and basic routing circuits are different for every module.



In the mobile phone market, the handset OEMs are faced with a bewildering assortment of different RF components, where each vendor has slightly different voltage settings, register usage, and other details that are not key to overall performance.  As we enter the 5G era, it's important to simplify the interoperability of RF devices so that an OEM can put together a complete RF front end quickly and easily.

# COMPLEXITY IN RF FRONT ENDS

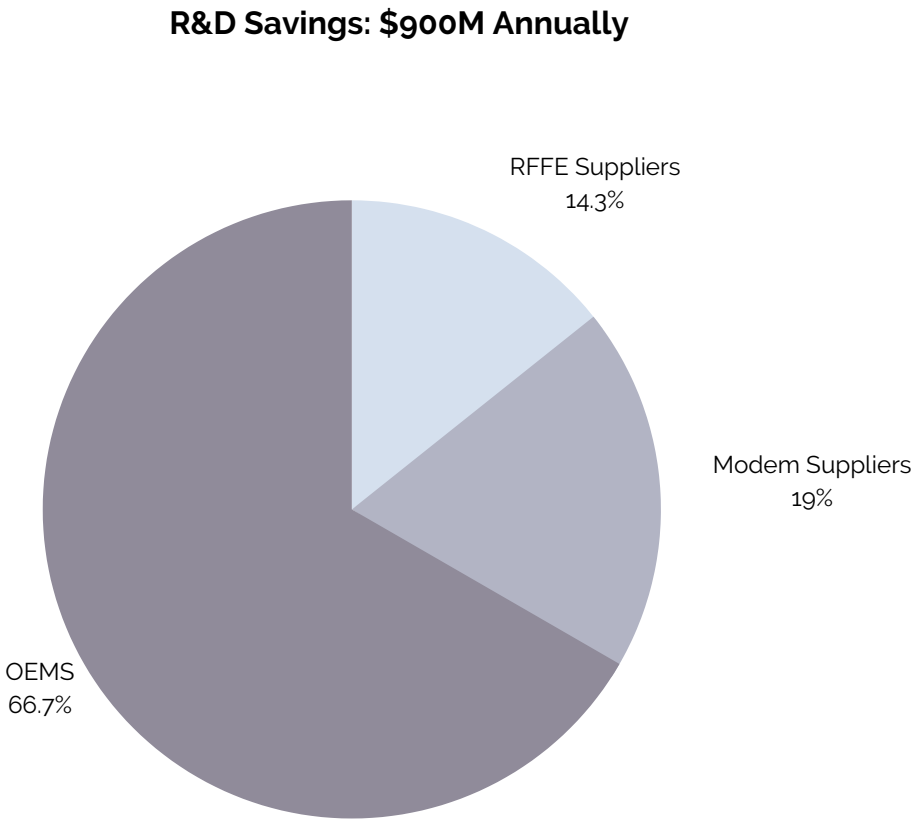
Today's market for RF semiconductors has become extremely complex. Considering the various combinations of frequency bands, MIMO configurations, and Carrier Aggregation combinations, there are at least 10,000 possible RF configurations, and nearly infinite choices for ways to implement the amplifiers, filters, switches, and tuners. The number of smartphones sold each year has stopped growing, but the level of complexity for the RF chain continues to grow and has become truly mind-boggling.To cope, a farsighted group of technology companies have formed the OpenRF Association, which is devoted to standardizing and simplifying the use of some basic building blocks, so that each company can direct its attention to adding new features and higher performance in smartphones and other devices.

## R&D SAVINGS AT THREE LEVELS

The smartphone industry spends a huge amount of money each year to develop new handsets. RF Front End suppliers spend about $1.5B annually on research and development, while modem suppliers spend an even higher amount in interfacing with the RFFE community and developing RF features. Then, the handset OEMs themselves put huge teams of people into the job of folding these components into a working system.

For each group of companies, a common set of interfaces and building blocks can save huge amounts in R&D spending and applications development:

- At least 15% of R&D spending in RF Front Ends can be eliminated with a set of common blocks used by multiple customers. Net savings: $130M per year.
- The modem suppliers can slash the time spent in testing and RF development, since a great deal of their time in software development is spent in adapting to differences in RF product settings. We estimate savings of about $220M per year for this group.
- The biggest savings is likely to be seen in the handset OEMs, where costs of implementation are magnified by their high degree of complexity and heavy costs of testing and qualifying new products. We estimate that the OEM community could save about **$550M per year.**



Of course, the actual savings achieved through OpenRF will depend on how many companies adopt the new approach and the depth of standardization. Based on the statements of players that have already signed up, we see almost a billion dollars per year that can be redirected to the leading edge of R&D, instead of basic drivers and register settings.

**TIME TO MARKET:**
One of the biggest unknowns in the smartphone business lies in the uncertainty surrounding a project. With fifty or more new ideas implemented in a new phone model, the OEM is always concerned that something could go wrong. Cooperation between the RF front end suppliers can remove one risk from the list of possible problems.The benefit here is not easily quantified, because the impact of a mistake can vary so widely. In the early stages of a handset project, an OEM can recover from a mistake quickly, and for simple RF interface issues the impact could be very small. On the other hand, an error discovered during qualification testing or FCC testing can set back the entire platform by several weeks, possibly missing a consumer launch window. In other words, the risk of any technical error can range from $10K to $1B+ from the OEM's point of view.OpenRF reduces the risk of surprises in the later stages of handset development, where the stakes are highest. By re-using the control elements and setup parameters for the RF front end, the OEM team incurs much lower risk that the modem-to-RF interface will experience a glitch during the critical phases of testing. In essence, if the modem-to-RF interface is pre-qualified, the number of possible errors can be reduced in half or even more.

**ECONOMY OF SCALE:**
Every semiconductor supplier and OEM must manage their inventory, with thousands of different product variations that use different hardware and software elements. Part of this is unavoidable, as the mobile phone market must support a wide variety of modes, and band combinations. The OpenRF Association will reduce the complexity of managing product variations by setting common parameters for MIPI controllers and their registers, for voltage settings on amplifiers, as well as common software APIs and RFIC commonality. In this way, the savings in 'economy of scale' involves simplification of the hardware, but also saves companies at every level of the food chain in terms of specifying, coordinating, manufacturing, and using different variations of similar products.  The variations in settings, software loads, and customization to match with a specific modem or a certain handset platform can get complex, and creates a need to track different part numbers and configurations.

We estimate that the cost of keeping up separate inventory and managing variations in simple sub-components can cost the industry about $50-100M per year. So, in addition to the larger benefits in R&D savings and risk mitigation, all companies involved can benefit from simplified inventory management and larger scale for a single configuration.

**FUTURE INNOVATION:**
The smartphone market is entering a new phase of innovation, in which the RF front end can be adjusted and shaped dynamically to suit the actual RF channel in use, instead of an entire range of RF frequencies. This new level of innovation requires more information sharing between handset OEMs, modem vendors, and RF vendors on a real-time basis. OpenRF creates a venue for joint development along these lines…handset software developers, chipset suppliers, and amplifier or filter experts can get together to create industry specifications, white papers, and methods for "RF Artificial Intelligence" without locking the design into a single vendor.

**OVERALL:**
Each of the players in the ecosystem gives slightly different reasons for supporting the OpenRF initiative. OpenRF will make life simpler for the OEM customers, save money in R&D, improve economy of scale, reduce inventory costs, and reduce risk. We surveyed the industry and did not find a compelling downside to this initiative.

| | R&D Savings | TTM/Risk | Economy of Scale |
|---|---|---|---|
| RF suppliers | ✓✓ | ✓ | ✓ |
| Modem vendors | ✓✓ | ✓✓ | ✓ |
| OEMs | ✓✓ | ✓✓✓ | ✓ |

The overall theme is that OpenRF is a win-win-win scenario: OEMs, chipset vendors, and RF suppliers are all getting on board because each of them expects to save cost and reduce risk. Everybody has pumped up a flat tire, and for a hundred years nobody had to think about the compatibility of the pump and the tire. OpenRF will make life much easier for device OEMs, chipset suppliers, and RF vendors for the next hundred years.