Reconfigurable RF PA and FEM with RF-SOI
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5G Major Categories of Service Types

**Enhanced Broadband**
Capacity Enhancement

- Gigabytes in a second
- 3D video - 4K screens
- Work & play in the cloud
- Augmented reality
- Industrial & vehicular automation
- Mission critical broadband
- Self driving car

**Massive IoT**
Massive Connectivity

- Improved link budget
- Low Device Complexity
- Long Device Battery Life
- High Density Device Deployment

**Low Latency**
Ultra-High Reliability & Low Latency

- High Reliability (Low Packet Error Rate)
- Low Latency

Source: 3GPP

mMTC (massive Machine Type Communications)

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Evolution from 4G to 5G

LTE -> LTE+ -> eMBB

eMTC/NB-IoT -> mMTC

Complex Scenarios lead to Fragmental Implementation

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RF Front End Market

Sources: Navian

Content Increase Driving Market Growth

LTE | LTE+ | 5G

>50B MIMO CA New Services
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New Challenges in 5G

- Higher Performance, Power and PAE
- More Bands and Configurations

- More PAs
  - Higher through SW
  - More filters

- Software defined RFFE

Cost / Size ↑

MIMO and Uplink CA
We have a dream

Dream of Communication and Network
- Self Awareness (SAN, sensing)
- Self Learning (AI, deep learning)
- Self Evolution (SD, reconfigurable)

Software-Defined Network
- SDN, NFV

Software-Defined Systems
- Base station, Terminal

Software-Defined Chips
- AP, BB, TRX, RFFE
Software Defined Chips

- AP+Memory: √
- Radio (SDR): ?
  - Baseband √
  - Transceiver √
  - RF Front End: the missing piece of the puzzle

Broadband Switch: √
Tunable PA: √
Tunable Filter: on going

Same Hardware for Multiple Modes, Bands, Power and Standards
Approach: Reconfigurable FEM

One TX Chain for ALL

Software control
**Current Solutions**

Multiple PAs+filters to support multiple bands

**Frequency Bands**

**Reconfigurable Solution**

Single reconfigurable PA+ tunable filter software tuned to each band
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Basic technology requirements for the software defined RF front end.

- Capable of accommodating complex analog and digital function blocks.
- Providing very good RF performance for the RF switches.
- Enabling low cost and high volume production.

SOI technology provides an ideal platform for the software defined RF front end module.
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<th>SmarterMicro</th>
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<td>Reduced the number of RF paths</td>
<td>More RF paths are needed</td>
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<tr>
<td>Single band optimization</td>
<td>Performance/bandwidth compromise</td>
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<tr>
<td>Co-evolving with CMOS technology</td>
<td>Based on GaAs HBT technology</td>
</tr>
<tr>
<td>ET friendly due to lower capacitive load</td>
<td>Less ET friendly</td>
</tr>
<tr>
<td>More advantageous to the situation with fragmental operation bands</td>
<td>Limited by the number of RF paths</td>
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<tr>
<td>Compatible with 5G mm wave technology</td>
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Requirements:
1. Small size with large tunable range. (multiple octaves)
2. Electrically tunable with reasonable tuning voltage.
3. Planar structure with mass manufacturing capability.

You can have anything, but you can’t have everything
Available technologies:
1. FBAR based electrical tunable resonator.
2. Varactor based planar band pass filters.
3. Lump element based high order filters.
4. ....

1. This is a bigger challenge.
2. It needs a tunable system with very high Q.
3. The attempts have been made to achieve fully tunable filter. And we will win the battle!
1 5G and its Impact
2 Software Defined Chip and Software Defined RF Front End
3 Key Technology for Reconfigurable RF Front End
4 Summary
• 5G demanding cost-performance effective solution for complex services, multiple frequency bands, multiple antenna, and multiple modes.

• The status quo solution is not sustainable to accommodate the total solution of 5G system

• Reconfigurable RF Front End: the keystone of the software-defined world.

• SOI technology provides an excellent platform for the software defined RF front end module.
Thank You!