CONSTRUISONS ENSEMBLE
LA DÉFENSE DE DEMAIN

Problématique et perspective d'emploi du GaN dans les systèmes de défense
Trade-off and forecast in using GaN for defence systems

Francis Doukhan francis.doukhan@intradef.gouv.fr
François Reptin francois.reptin@intradef.gouv.fr

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MINISTÈRE
DES ARMÉES

HISTORY

- Since the 90' GaN is identified as a breakthrough technology for RF&MW applications
  - Labs, academic

- DGA initiated several R&D projects as well in a national context as in a EU (EDA) or bilateral cooperation context.
  - Eg EDA: KORRIGAN (2005), MANGA (2010), MAGNUS (2012), EUGANIC (2016)...

- The R&D effort must apply as well to material as to technology and devices
  - Material => MANGA, EUGANIC
  - Technology => KORRIGAN
  - Devices => MAGNUS

CONTEXT OF USAGE

- RF&MW power technologies are localized in the front-end of radars, seekers, jammers and communication equipment covering:
  - A wide frequency domain (UHF to W)
  - A wide RF power domain operating either in compressed mode (radar) or in linear mode (com).

- All of these are to be deployed on various platforms
  - planes, drones, surface radars (sea, ground), missiles

CONTEXT OF USAGE

- **Naval systems:**
  - **High RF power (several 10th kW)**
    - Protection range
  - **Multifunction radar (surveillance, track and guidance)**
    - Frequency range, wide band
  - **High reliability (life time > 20years)**
  - **Minimized weight**
    - Minimum cooling requirement
  - **Minimized power supply requirement**

CONTEXT OF USAGE

- **Ground systems:**
  - **High RF power (several 10th kW)**
    - Protection range
  - **Multifunction radar**
    - Frequency range, wide band
  - **High reliability (life time > 20years)**
  - **Small size (jammers, communication…)**
  - **Limited power source (vehicles…)**
  - **Hard environment:**
    - Limited cooling capability
    - Vibration/shock

CONTEXT OF USAGE

- **Airborne systems:**
  - **Medium RF power**
  - **Multifunction radar**
    - Frequency range, wide band
  - **High reliability (life time > 20years)**
  - **Small size**
  - **Low weight**
  - **Limited / very limited power source**
  - **Hard environment:**
    - Limited cooling capability
    - Vibration/shock

CONTEXT OF USAGE

- **Seekers:**
  - **Very small size**
  - **Very low weight**
  - **Very limited power source**
  - **Hard environment:**
    - High operating temperature
    - Almost no cooling capability
    - Vibration/shock
  - **High robustness (dedicated mission profile)**

COMMON NEEDS

- **While different, planes, drones, surface radars, missile seekers and communication systems all share and expect a RF front end with high power per liter and kilogram efficiency.**
  - **A limited power source because most of the platform space must be devoted to the active load**
    - Size (tank for the primary energy source)
    - Capacity (battery, generator)
- **The RF front end must accommodate**
  - **Small size => maximize the space for the active load**
  - **Low power consumption => increase the platform autonomy in a context where the power source is limited.**
  - **Low weight => minimize the requested energy, space for the active load**

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USING GAN

- **GaN vs other power technologies**
  - **TWT: very high power, high power wide band, high power high frequencies (>Ku)**
  - **Si (LDMOS): high power, low frequencies (<3GHz)**
  - **GaAs: low power, high frequencies (>Q)**
- **GaN is not a "Swiss knife", it has to be used where it brings a real differentiator**
  - **Covers applications from UHF to Ku, next will cover above Ka**
    - Delivers more power than GaAs or Si when frequency increases
  - **Maximum operating temperature covers the defence needs**
    - Appropriate MMIC designs operate well within Safe Operating Area >> GaAs or Si
  - **Used at the appropriate cost to deliver a RF watt**
    - €, kg, dm^3

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GOING FORWARD

- While GaN technology offers a high power density and a high operating temperature, present applications are limited by
  - Dissipated power exceeding the system dissipation capability => cooling system
  - Power consumption exceeding the system supply capability => PSU capability (supply / autonomy)

GOING FORWARD

- **Need to improve the technology PAE so that to**
  - **Save power supply (size, weight)**
  - **Save cooling capacity (size, weight)**
- **Beside the technology improvement**
  - **Need to improve the packaging / drain technology**
    - Low Rth
    - high integration (high frequency AESA)
    - SMD compatible with standard manufacturing process
  - **Need to improve the PSU density**
    - High efficiency (new active and passive devices)
    - Small size / weight (operating at high frequency)
    - Envelope tracking

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