GaAs Panel Session – EuMIC 2011

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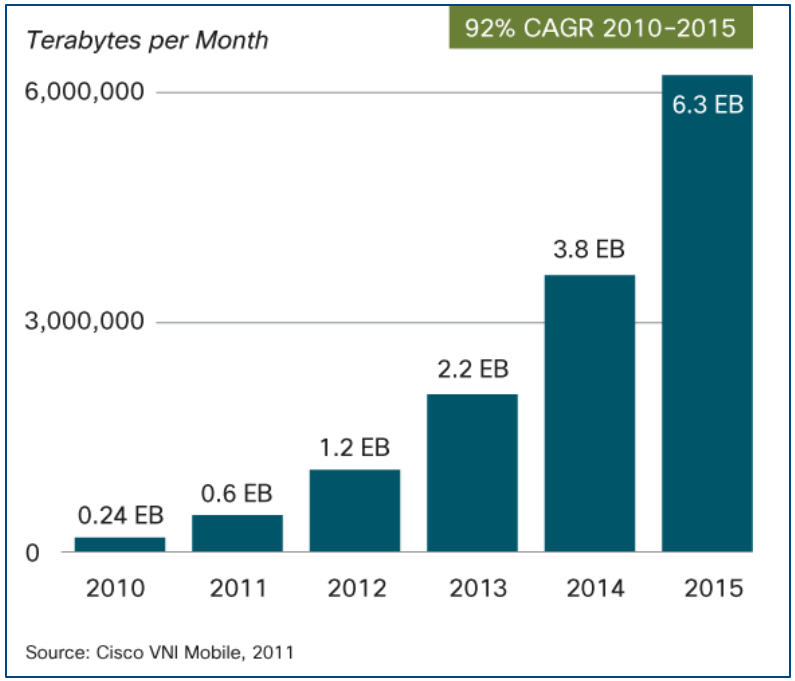
Agenda

- RF Markets
- Advantages of Compound Semiconductors
- RF Process Technologies

RF Applications Markets Exploding

- Mobile Devices Data Traffic



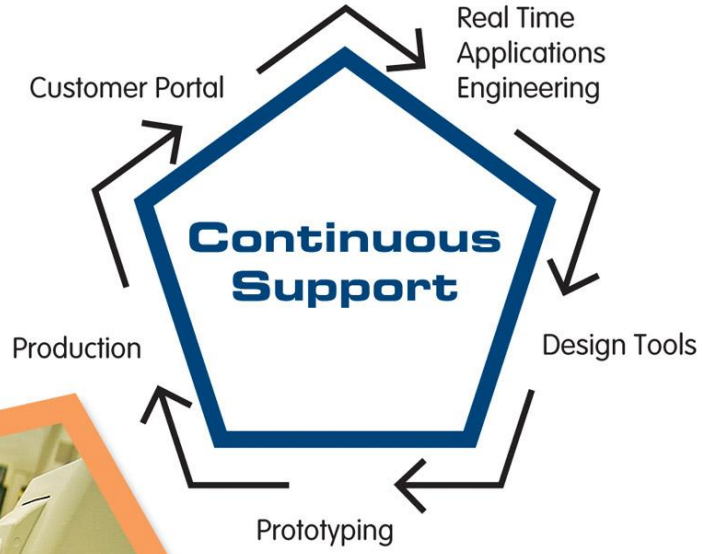
- Higher Power, Higher Efficiency

Advantages of Compound Semiconductor for RF

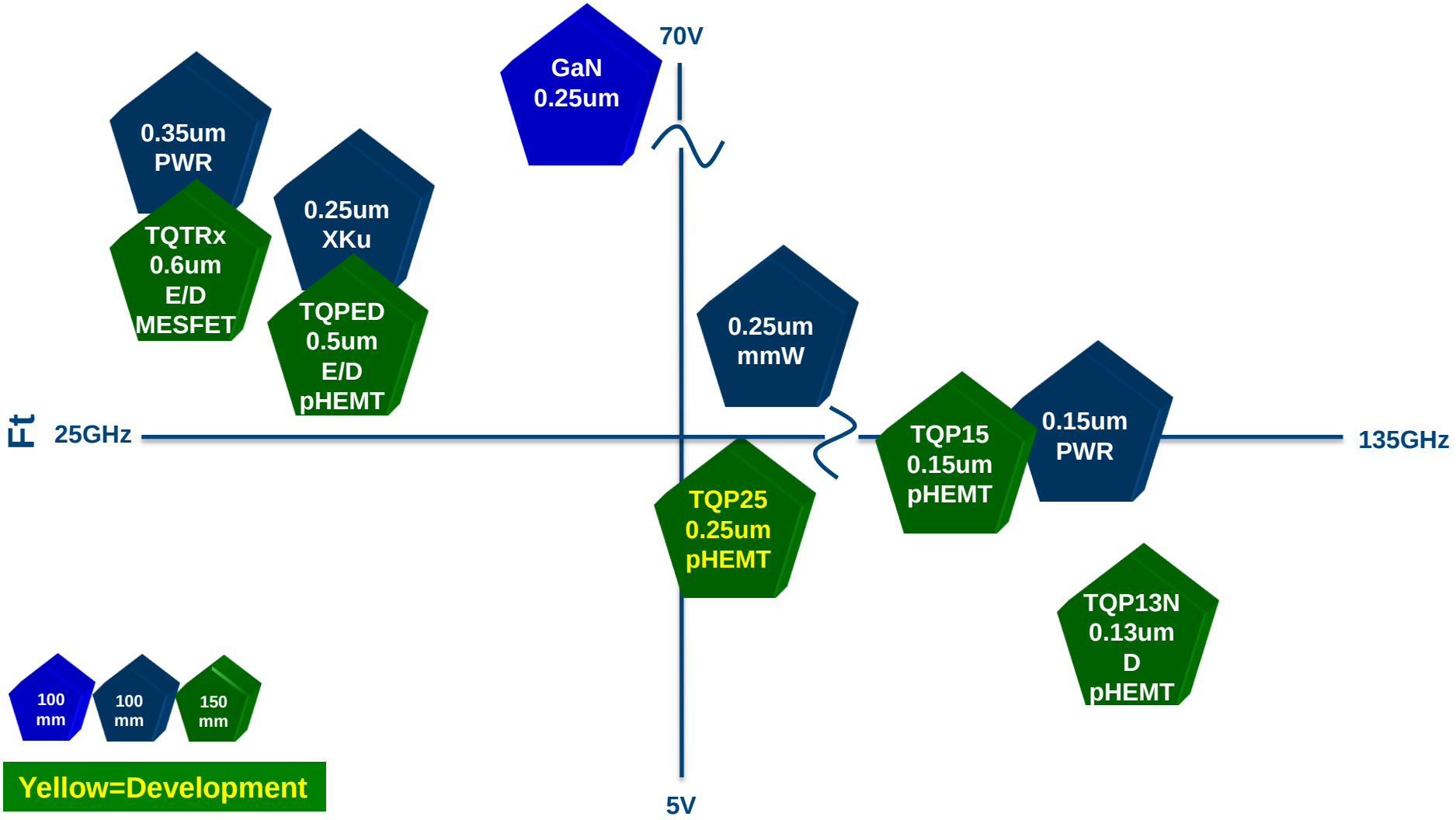
- Superior material properties vs silicon technologies
  - GaAs: larger band gap, higher mobility, hetero structures
  - GaN: very large band gap, high voltage, high T_j operation
- GaAs
  - Superior noise figure, low insertion loss linear RF switch and PA performance
  - Semi-insulating substrate (better isolation, higher Q passives)
  - High-voltage PA solutions
  - Lower development cost
- GaN
  - Superior high-voltage, high-frequency, high-temperature performance
- Competition
  - SiGe
  - Low / high voltage LDMOS
  - SOI-CMOS, bulk CMOS

TriQuint Foundry

- Leading compound semiconductor foundry supplier for more than 25 years
- Broadest range of GaAs and GaN foundry technologies
- Unmatched support and service

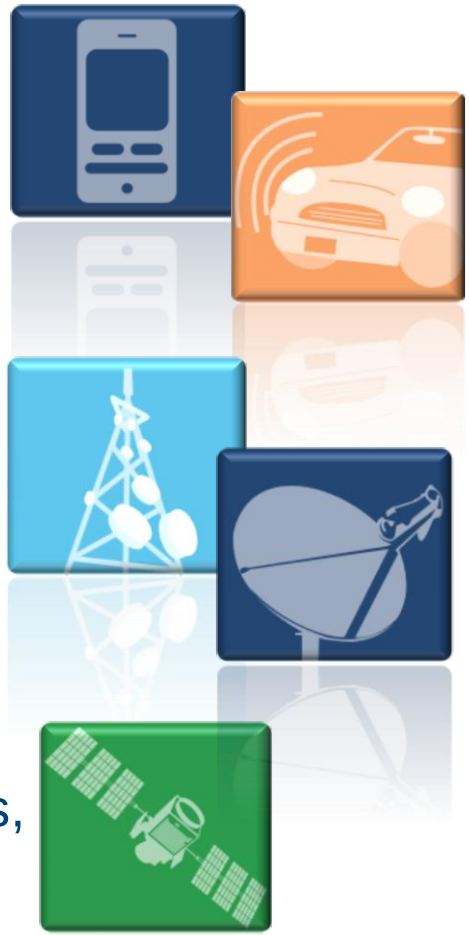


Foundry FET Processes



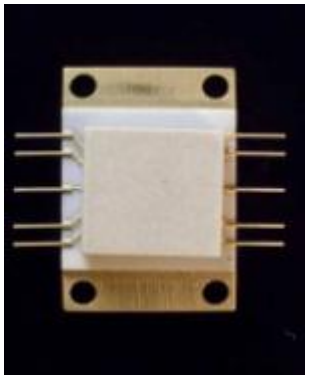
Commercializing mmWave Markets – Optical Gates

TQPED **0.5µm E/D**	Ft = 27 GHz	Integrated WLAN, Switches
TQP25 **0.25µm D** **0.35µm E**	Ft = 55 GHz	Handset Switches, LNAs, PtP, Ku-band PAs
TQP15 **0.15µm D**	Ft = 80 GHz	VSAT, PtP, Ka-band PAs
TQP13 **0.13µm D**	Ft = 100 GHz	Low Noise Amplifiers, Auto Radar, WPAN, Satellite, Imaging

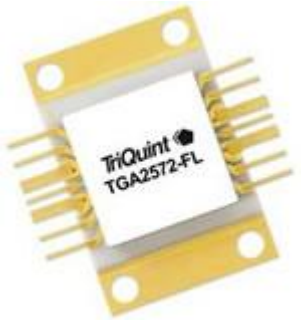


Advantages of Gallium Nitride on SiC

- GaN provides 2x to 4x Power Density for RF amplifiers
  - Combination of high current and high voltage operation
  - Higher W/mm enables less combining loss, hence increased PAE
  - Higher Vd operation enables system power efficiency improvement
- Very high thermal conductivity SiC substrate
  - ~10x that of GaAs, benefit for higher power/CW operation
- Reliable at high junction temperatures
  - MTTF of 1E6 Hours at 200ºC
- Capable of high frequency operation
  - GaN applications span UHF to W-band to THz
- Excellent noise figure
  - NF_{min} equivalent to comparable GaAs pHEMT
  - Higher input survivability



TGA2514; 6.5W Ku-band GaAs HPA



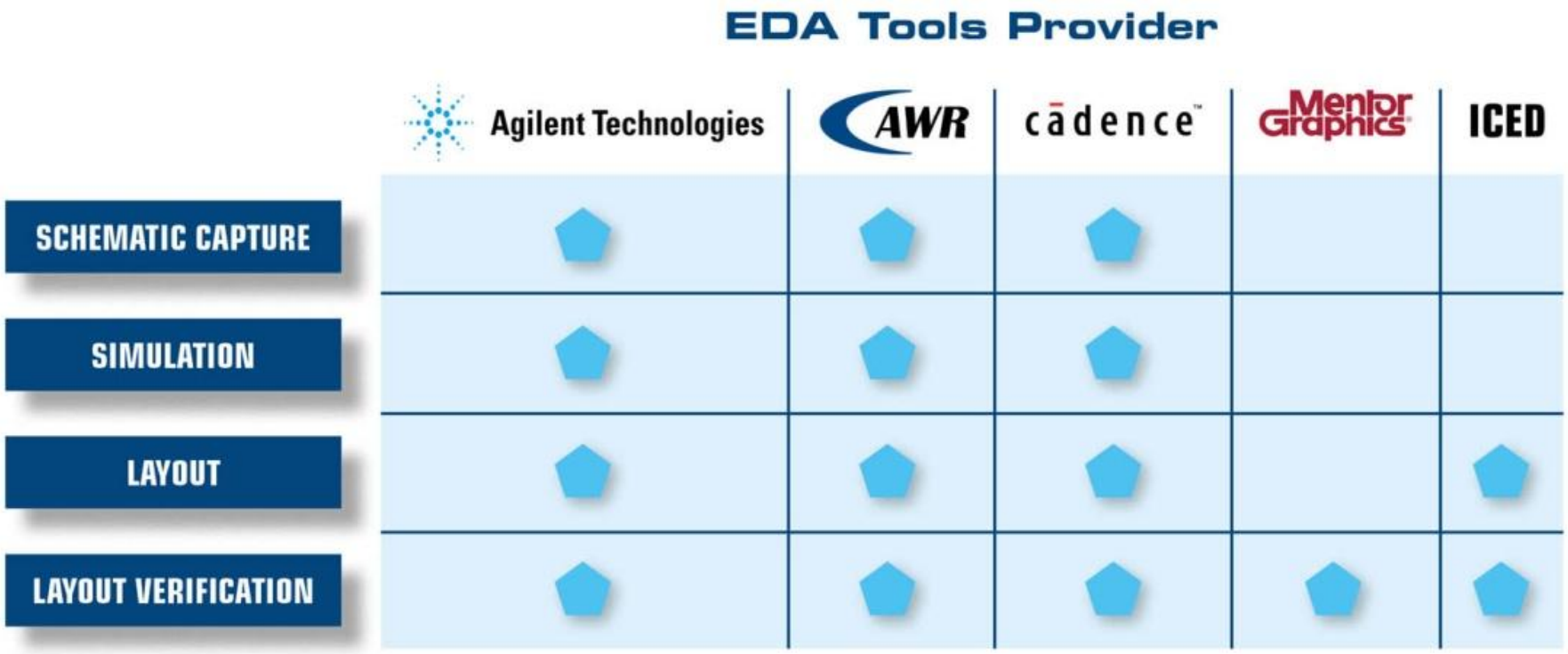
TGA2572; 20W Ku-band GaN HPA

GaN R&D Programs

- DARPA WBS (Wide Bandgap Semiconductor) - $32.3M
  - Develop GaN highest power wideband amplifiers
  - Advance GaN materials, processing and MMIC design technologies
  - Deliver PA modules to DoD
- DARPA NeXt (Advanced Nitride Electronics) - $16.2M
  - Develop 500GHz Nitride based transistors using sub 0.1µm GaN process
  - Monolithically integrated E&D mode transistors
- Defense Production Act Title III - $17.5M
  - GaN manufacturing development contract
  - Increase yield, lower costs and improve time-to-market cycles for defense and commercial GaN integrated circuits.

Design – Tools and Applications Support

- Industry standard for pHEMT models
- Senior applications staff
  - Design Reviews, circuit consulting, apps support



Summary

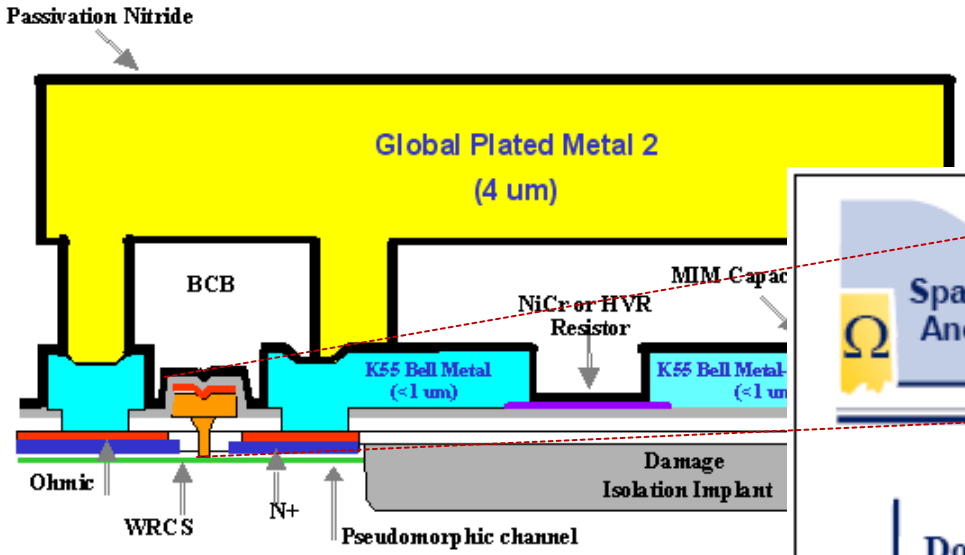
- GaAs and GaN best technologies for RF applications
- Broad technology portfolio required to address various RF markets
- Optimized design tools and experienced applications support required to meet demanding RF specifications

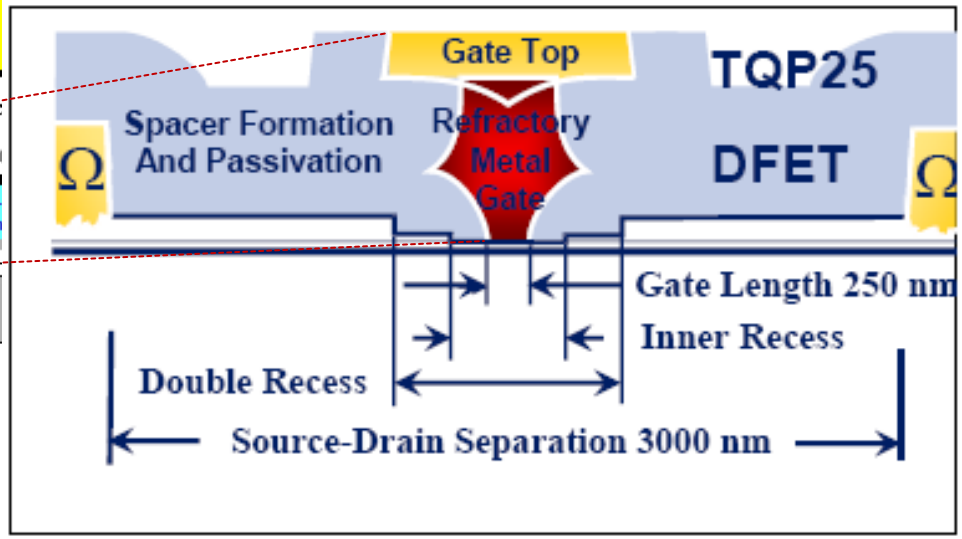
Backup Slides

Process Portfolio Overview

Technology	Attributes	TriQuint Process Name	Wafer Size
pHEMT	0.5µm E/D Mode FETs – Mixers, LNAs, Switches	TQPED	150mm
	0.25µm E/D Mode FETs – Switches & Amplifiers	TQP25	150mm
	0.15µm D-Mode – mmW Amplifiers	TQP15	150mm
	0.13µm Low Noise	TQP13-N	150mm
	Highest Power pHEMT Density	0.35µm PWR pHEMT 3MI	100mm
	High Power Through 50 GHz	0.25µm mmW pHEMT 3MI	100mm
	High Power Through 20 GHz	0.25µm XKu pHEMT 3MI	100mm
	Higher Power Density Through 80 GHz	0.15µm PWR pHEMT 3MI	100mm
MESFET	E/D Mode FETs – Mixers, LNAs, Switches	TQTRx	150mm
	D-Mode FETs – Higher Power	TQHiP / HA2	150mm
Heterostructure FET	High Linearity	0.5µm HFET 2MI	100mm
InGaP HBT	InGaP HBT 3 Metal Interconnect	TQHBT3	150mm
BiHEMT	Integrated E/D pHEMT & HBT	TQBiHEMT	150mm
GaN	Highest Power Density	0.25µm GaN 3MI	100mm
Vertical PIN Diode	Low Loss Switches	VPIN 2MI	100mm
Passives	Integrated Passives	TQRLC	150mm
Flip Chip	Copper Bump	CuFlip™	150mm

Reducing the Cost of mmWave with Optical Gates





- **Gate length drives Ft**
- **Ft drives frequency capability**

	E-Beam	DUV Optical	Spacer-Based Optical
Cost	🟡	🔴	🟢
Throughput	🔴	🟢	🟢
Performance	🟢	🟡	🟡

HBT Process Overview