Qualcomm

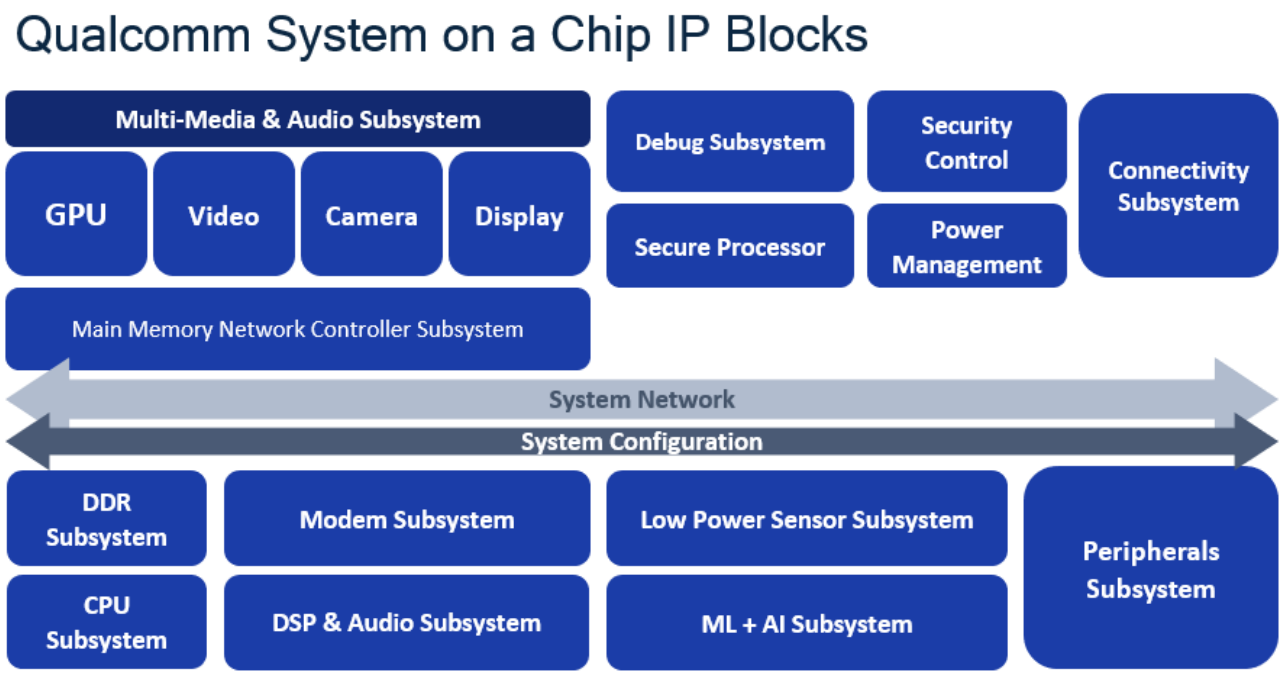
Introduction

Qualcomm Technologies, Inc. (QTI) is a global technology company headquartered in San Diego, CA. Founded in 1985 on satellite communications technology, QTI led the digital transformation of cellular. Since then, QTI has grown into adjacent SWAP-sensitive (Size, Weight, And Power) markets including automotive and the Internet of Things (IOT) markets which now make up 40% of Qualcomm's annual revenue, including $30B in industry leading technology contracts Advanced Driver Assistance Systems (ADAS).

Qualcomm Technologies Snapdragon®* (Snapdragon is a product of Qualcomm Technologies, Inc. and/or its subsidiaries) chipset technology is a *heterogenous solution* representing a leap in capabilities well beyond traditional space processors. The drive to increase performance faster than battery capacity has led to efficiencies of >1TOPS/Watt using 5nm and below FinFET (field-effect transistor) technology. This allows a board's worth of processing on a single, monolithic die. Meanwhile, adjacent terrestrial markets such as IOT, robotics, and automotive are demanding reliability such that NASA SMTD should consider including Snapdragon in future terrestrial and space applications. The groundwork for future work was laid with JPL's first major success of including Snapdragon technology inside Mars Ingenuity and Perseverance has survived the flight to Mars and been operational over 1.5 years on Mars surface. Moreover, the commercial ecosystem is rich with companies providing specialized boards and software libraries for multiple markets, allowing NASA mission teams to focus more on rapid application development through leveraging commercial technology.

Applications and development

From the video accelerators in camera phones of 2002 to today's sensor fusion on the QTI automotive architecture with seven cameras and six radars, Qualcomm provides leading platforms for machine vision processing driving the pace of massive Edge-based processing. This is where heterogenous compute has an advantage because the data pipeline never goes off-chip from the pre-processing imager data in the DSP before running machine learning on the Network Processor Unit (NPU),



leaving the CPU cores free to make decisions based on the results.

Snapdragon® advantages

- Fast, small autonomous air vehicles are one of the most SWAP-C and performance challenged markets. QTI has a dedicated team developing foundational capabilities for air and ground, including end applications like power grid inspection drones. In addition, Snapdragon® has a range of radio options, from earbud-sized Bluetooth transceivers capable of time-sensitive data cable replacement to NB-IOT (Narrowband Internet of Things) for long range asset tracking on a AAA QTI to cellular radios moving 5Gbps to 4G LTE and 5G-NR functionality. Snapdragon® also has extensive GNSS capabilities for position, timing, and navigation.
- Snapdragon® supports multiple operating systems. While QTI's handset offerings are dominated by Android, IOT uses Ubuntu Linux, and Automotive uses QNX, Linux Automotive and hypervisors.
- Material costs are low, which allows for both the flight and development Snapdragon® variants to be plugged into a test chassis for economical software development and test. Using available development platforms enables the entire team to get an early start and work in parallel, skipping the transition from emulators, as well as enabling automation with hardware in the loop at scale.

Peripheral and network interfaces

A typical Snapdragon® SOC (System on Chip) has 1000 solder balls, with many that can be used as GPIO (General Purpose Input Output) or configured for medium (<1Gbps) or high bandwidth (10Gbps/lane) serial interfaces including:

- UART/SPI/I2C/I3C
- SPI, QSPI, SDIO
- ADC (Analog to Digital Converter)
- MIPI CPHY (MIPI Alliance Physical Layer standard - camera)
- MIPI DPHY (display)
- PCIe
- RGMII/Ethernet
- USB

Reliability and security

To meet the stringent requirements of markets such as automotive, Qualcomm designs Safety Rated systems with mixed criticality and layered fault tolerance to achieve fail-degraded operation without substantially sacrificing performance. Key SOC caches, subsystems and busses are protected by Error Detection And Correction (EDAC), Error Correcting Code (ECC), and Triple Modular Redundancy (TMR), but there is also an independent Double Modular Redundancy (DMR) processor on die with extensive access to health metrics for hardware and software. Per ISO-26262 JESD-89, and ASIL-D, systems must include terrestrial neutron radiation in their failure rate budgets, which has led to developing capabilities to characterize radiation upset rates and degradation or potential damage from latch-up. Typical automotive specifications require operation at temperatures between -40C and +105C to +125C, and a service life of 10 years, which overlaps well with space needs. In addition to proving AEC-Q100 environmental reliability, Qualcomm continuously collects extensive data on millions of parts per day to minimize yield loss, well beyond GOTS ASIC data collection.

Metric	ASIL B	ASIL C	ASIL D
Probabilistic Metric for Random Hardware Faults (PMHF)	$10^{-7}h^{-1}$ (100 FIT)	$10^{-7}h^{-1}$ (100 FIT)	$10^{-8}h^{-1}$ (10 FIT)
Single Point Fault Metric (SPFM)	≥90%	≥97%	≥99%
Latent Fault Metric (LFM)	≥60%	≥80%	≥90%

To address the security needs of enterprise, DoD, and commercial, QTI has added robust mechanisms including secure boot, an independent secure processing engine for key management, file, and

whole-disk encrypted Dynamic Random-Access Memory (DDR), and AES-256 hardware acceleration.

Conclusion

QTI welcomes the opportunity to attend the NASA Planetary Technology Showcase to share more information about our products with the science community. The NASA SMTD mission could be enhanced by Qualcomm's advanced technology to improve the processing, communications, and autonomy functions required by these exciting exploration concepts. Our unique system on a chip, semiconductor technology nodes offer resiliency, low power, and reduced size and weight while simultaneously providing more capability and showing viability in space applications. QTI is available to partner with these teams to leverage our commercial capabilities into their missions.

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