NXP Power Management
Innovation Addressing Emerging Megatrends & Challenges

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The Promise & Challenge of AI Considering Energy Shortage & Sustainability Priorities

- **AI & Machine-Learning** trends enabled by advancement in HPC GPUs & CPU’s and **high-speed networks** continue to drive **smarter systems** that improve our lives, experience, safety and productivity across many spaces.

- **AI-Powered Systems Dramatic Advancements:**
  - Automotive E/E Architecture (Software Define Vehicles),
  - mobile/personal and IoT systems (smart wearables & personal health devices, smart homes/cities),
  - Medical imaging & diagnosis, robotic surgeries,
  - Factory automation, agriculture, warehouse inventory and logistics.

- **AI-induced Unprecedented Energy Demand:**
  - Over 50 billion cloud-connected sensors and IoTs devices in 2020.
  - 700W Nvidia’s GPU H100 was released in 2022, AI servers also run power-hungry CPUs & network cards.
  - In 2022, about 460 TWh were consumed by all data centers (5% of global usage).
  - By 2027, additional 1.5 million AI servers are projected annually.

- **Sustainability & e-waste Reduction:** Governments and industries have been promoting and enforcing new measures and standards, such as adoption of 48V power on data centers, USB-C EPR and BEV’s.

- **Efficient Energy Management Architectures in the PMIC’s** have become **extremely critical** to mitigate the AI HPC SOC technology challenges and extend the ESG priorities, especially with the energy shortage the world is facing.

- Additionally, **Extended Functional Safety & Predictive Maintenance** schemes in the PMIC’s have become more vital and significant components.
Megatrends’ Key Benchmarks Addressed by NXP Power Management Solutions

**COMPUTE PERFORMANCE**
KEEPS INCREASING

- TFLOPS
- 0.2 → 100
- 2015 → 2025

**SOC TECHNOLOGY**
KEEPS SCALING

- 40nm → 28nm → 16nm → 5nm → 3nm

**SDV & BEV E/E ARCHITECTURE**
EVOLUTION

**SUSTAINABILITY**
Energy Efficiency / E-Waste Reduction

- EU: USB-C standardization save 980t/yr on e-waste
- ENERGY STAR certified buildings use 35% fewer greenhouse gas emissions

**INCREASING CORE DOMAIN CURRENTS**

**HIGHER POWER DENSITY & EFFICIENCY**

**HIGHER POWER PROCESS & PACKAGING**

**DISTRIBUTED & SCALABLE ARCHITECTURES**

**HIGHER TEMP & THERMAL MANAGEMENT**

**FASTER INTERFACES & CONNECTIVITY**

**LOWER VOLTAGES & TIGHTER TOLERANCES**

**FASTER TRANSIENT RESPONSE & BOM COST**

**SOC CORE ADAPTIVE VOLTAGE CONTROL**

**SELF-DIAGNOSTICS & PVT/AGING CALIBRATION**

**DIFFERENTIAL SENSING & SMART MONITORING**

**PDN EXTRACTION & SIMPLER PCB DESIGN**

**HV GALVANIC ISOLATION**

**EFFICIENT HV & LV POWER DELIVERY**

**48V LV POWER GRID & CONVERSION**

**EFFICIENT ENERGY MANAGEMENT SCHEME**

**ZONALIZATION & PREDICTIVE MAINTENANCE**

**NEXT GEN FUNCTIONAL SAFETY**

**HIGH EFFICIENCY ENERGY STORAGE SYS**

**USB-C/ PD EPR CONTROLLERS & POWER**

**EXTENDED BATTERY LIFETIME & HEALTH**

**LOWER IQ STANDBY & DEEP SLEEP MODES**

**SMALLER FORM FACTOR SOLUTIONS**

**ENERGY HARVESTING & HARNESSING**
Efficient Energy Management & 48V Bus Adoption to reduce Distribution Losses on AI Servers & BEV’s

PFC & LLC Resonant DC-DC Converters

- Best efficiency across full load range
- Lowest output ripple
- Best transient response

Switched-Cap DC-DC Converters

Enabled Efficient Mobile Fast Charging possible with effective Thermal Management

48V Data Center / AI Server Power Solutions

First Stage

- Multi-Phase DC-DC Converter
- Multi-Phase DC-DC Converter

Second Stage

- Interleaved, Multiphase High-Switching-Freq DC-DC POL
- Interleaved, Multiphase DC-DC Converter

48V Domain (BUS)

- 48V 12V to 5V
- HPC Multi-Phase DC-DC POL
- 0.6 - 1.2V

- CPU
- GPU
- ASIC
- HDD
- PCIe

Adoption of 48V BEV LV Domain (Tesla Cyber Truck was first)

BEV 48V & AI Servers

- USB-C EPR PD
- Safety High-BW with AVP Multi-Phase DC-DC POL

NXP Proprietary
Summary

▪ AI certainly is becoming dominant in our lives and will cover all areas and application.

▪ While AI system improves the quality, productivity and safety of our lives, it introduces dramatic energy demand impact.

▪ The AI-induced energy demand challenge becomes more significant with Energy Shortage and Sustainability efforts across the world.

▪ All of this underscores the importance of efficient power management and energy management architectures solutions.

▪ While during my presentation I focused on examples utilizing High-Performance-Compute Processors on Software Defined Vehicles (SDV) and AI Data Centers Servers, other areas are not less critical and continue to be in focus at NXP, including:
  o USB-C EPR Power Delivery
  o Industrial and IoT systems: (Smart Home, Smart City, Factory Automation, Medical Imaging & Surgery)
  o personal wearables and smart personal health devices.
THANK YOU