NXP Power Management Innovation Addressing Emerging Megatrends & Challenges

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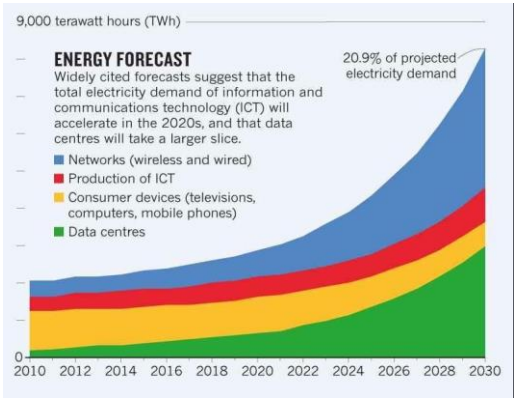
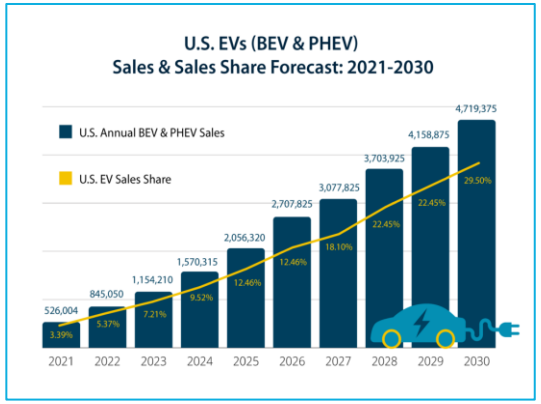
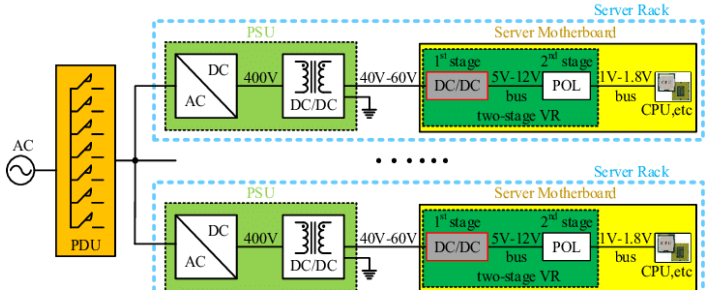
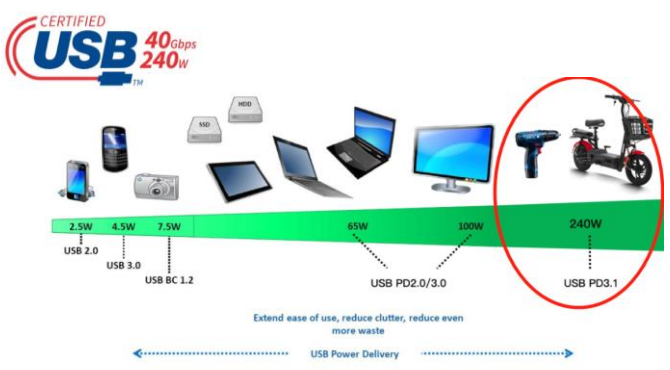
The Promise & Challenge of AI Considering Energy Shortage & Sustainability Priorities

- **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.





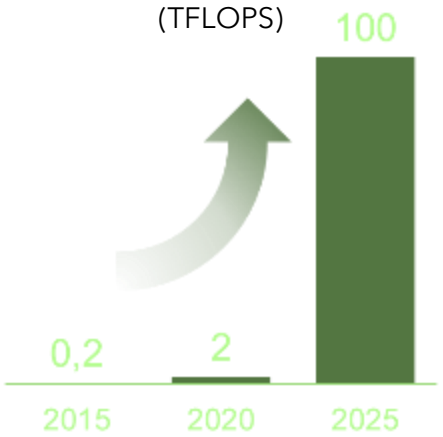




- **Efficient Energy Management Architectures in the PMIC's** have become **extremely critical** to mitigate the AI HPC SOC technology challenges and extend the ESG priorities, especially with the energy shortage the world is facing.
- Additionally, **Extended Functional Safety** & **Predictive Maintenance** schemes in the PMIC's have become more vital and significant components.

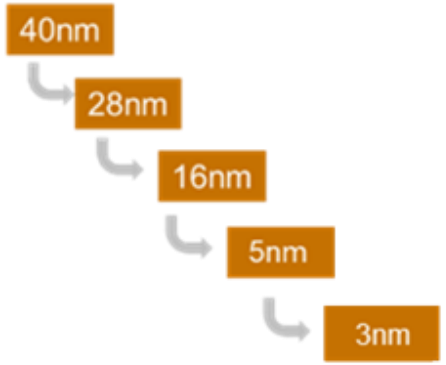
Megatrends' Key Benchmarks Addressed by NXP Power Management Solutions

COMPUTE PERFORMANCE KEEPS INCREASING



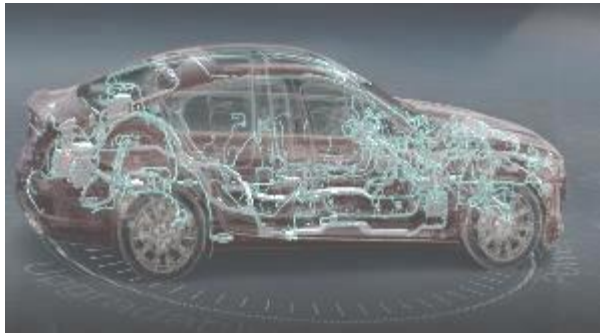
- INCREASING CORE DOMAIN CURRENTS
- HIGHER POWER DENSITY & EFFICIENCY
- HIGHER POWER PROCESS & PACKAGING
- DISTRIBUTED & SCALABLE ARCHITECTURES
- HIGHER TEMP & THERMAL MANAGEMENT
- FASTER INTERFACES & CONNECTIVITY

SOC TECHNOLOGY KEEPS SCALING



- 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

SDV & BEV E/E ARCHITECTURE EVOLUTION



- HV GALVANIC ISOLATION
- EFFICIENT HV & LV POWER DELIVERY
- 48V LV POWER GRID & CONVERSION
- EFFICIENT ENERGY MANAGEMENT SCHEME
- ZONALIZATION & PREDICTIVE MAINTENANCE
- NEXT GEN FUNCTIONAL SAFETY

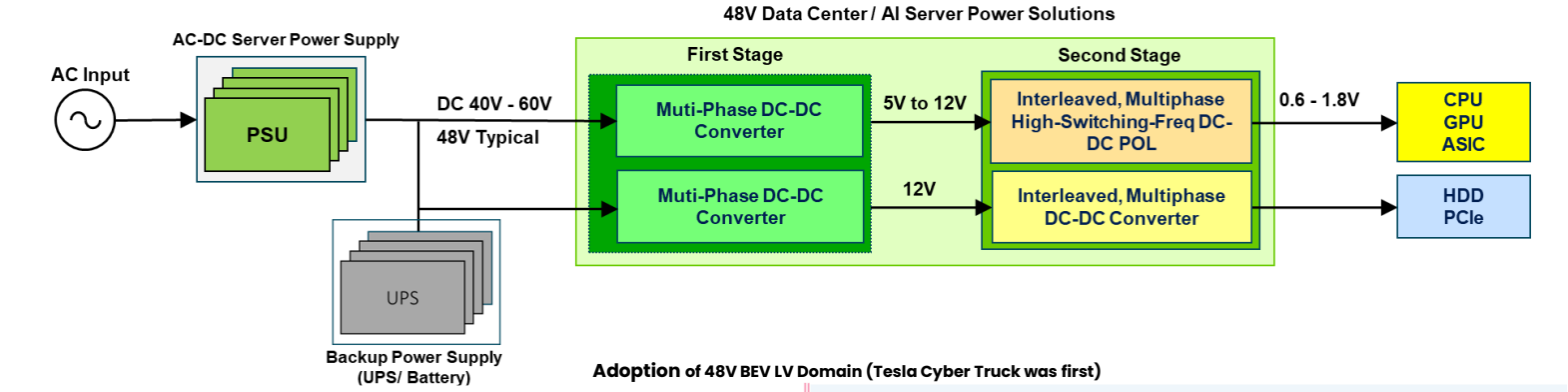
SUSTAINABILITY
Energy Efficiency / E-Waste Reduction

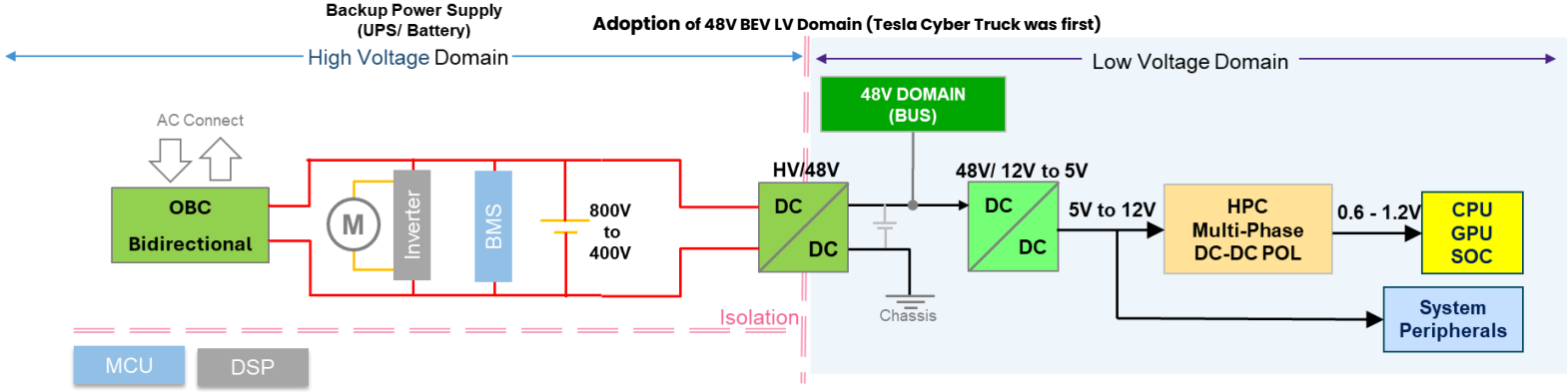
EU: USB-C standardization save 980t/yr on e-waste

ENERGY STAR certified buildings use 35% fewer greenhouse gas emissions

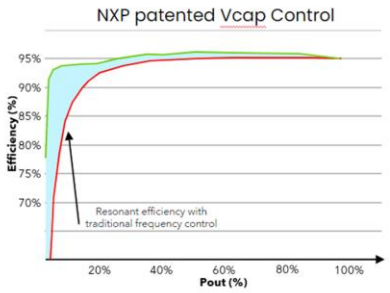
- HIGH EFFICIENCY ENERGY STORAGE SYS
- USB-C/ PD EPR CONTROLLERS & POWER
- EXTENDED BATTERY LIFETIME & HEALTH
- LOWER IQ STANDBY & DEEP SLEEP MODES
- SMALLER FORM FACTOR SOLUTIONS
- ENERGY HARVESTING & HARNESSING

Efficient Energy Management & 48V Bus Adoption to reduce Distribution Losses on AI Servers & BEV's



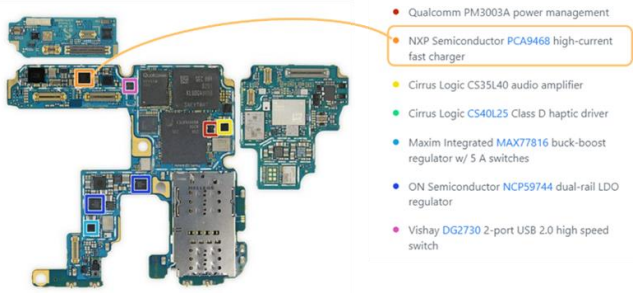


PFC & LLC Resonant DC-DC Converters



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

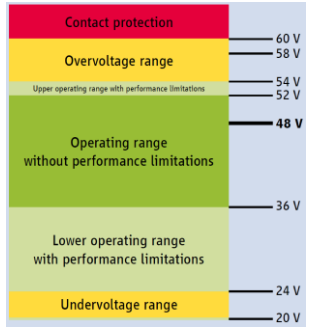
Switched-Cap DC-DC Converters



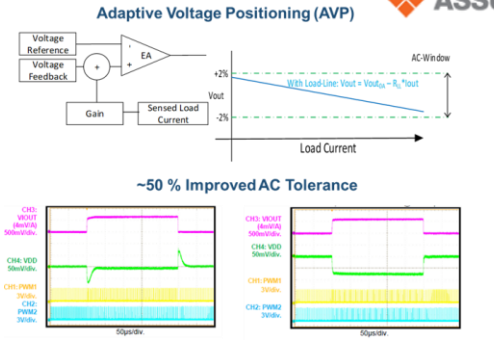
Enabled Efficient Mobile Fast Charging possible with effective Thermal Management

USB-C EPR PD

BEV 48V & AI Servers



Safety High-BW with AVP Multi-Phase DC-DC POL



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:
  - USB-C EPR Power Delivery
  - Industrial and IoT systems: (Smart Home, Smart City, Factory Automation, Medical Imaging & Surgery)
  - personal wearables and smart personal health devices.


THANK YOU