



intel[®] VISION

Energy & Sustainability

Industrial Decarbonization



Agenda

- Industry Disruption and Transformation
- Industrial Decarbonization
 - Integrated Energy Services for Energy Optimization and Grid Resiliency
 - Carbon Aware Datacenter Operations
- Session Recap

System Disruption and Transformation

Energy Resilience and Sustainability

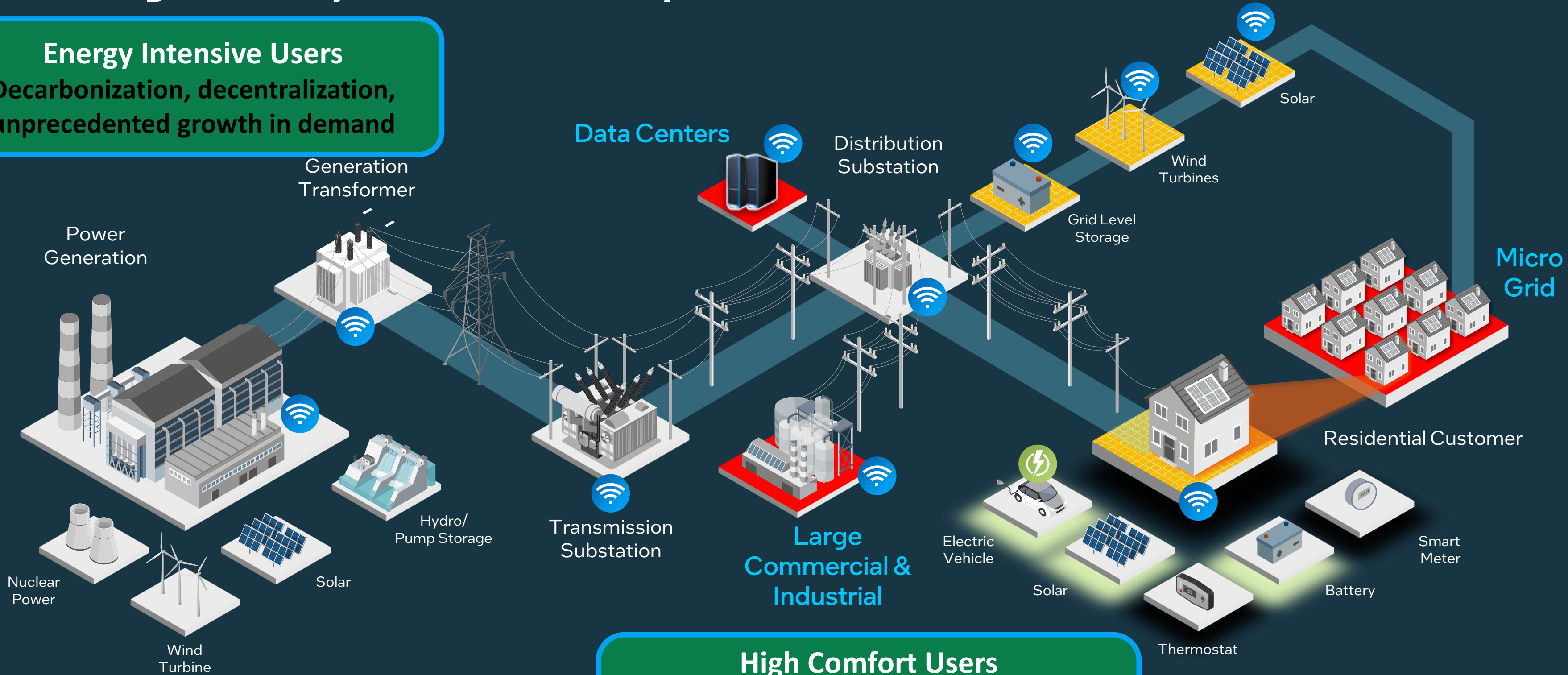


The Energy Grid – A System of Systems

Shifting Industry & Customer Dynamics

High Reliability Users
Ongoing need to maintain grid reliability, amidst aging infrastructure

Energy Intensive Users
Decarbonization, decentralization, unprecedented growth in demand



High Comfort Users
Rise of the energy prosumer, need to deliver innovative products for controllable load



The New Reality

Expectations For Massive Shifts In Supply Mix

85% by 2050



Renewables are expected to become the new baseload, accounting for 50% of the power mix by 2030 and 85% by 2050.

McKinsey Energy Insights Global Energy Perspective 2022

Manage Grid Resiliency –

Managing requirements of electricity adequacy requires new tools and capabilities

Optimize Operations and Assets, With Integrated Intelligence

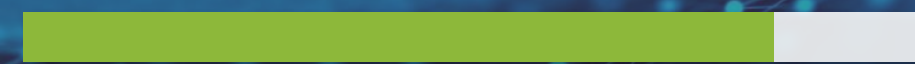
AI and real-time insights, combined with textual and geo-visual data can **de-risk aging assets**, improve grid performance, and enable the build-out of next generation infrastructure to **manage grid disruption**.



Decarbonization Through DERs and EVs

Business and technology strategies that are inseparable

86%



EY research shows that reliability and affordability are critical to consumers with **86% of consumers** (and nearly 100% of millennials) **interested in generating their own electricity.**

2021 EY Research Study



Relevance of the **EDGE** in Energy

Cloud Native



Control & Insights



Edge Native



Edge Computing
and AI are both
critical to
enabling the grid
of the future



Industrial Decarbonization

Integrating Renewables in the Electric Grid to
Enhance Sustainability & Increase Grid
Resilience



System Convergence and Technology Requirements for Transformation

Design, Deploy, and Operate Next Generation Building Platforms



Grid Modernization

Connection to substations to enhance reliability, safety, security, and manageability.

Thermal Optimization

Distributed intelligence to optimize remote, dispatchable grid capacity.

DERMs Integration

Connecting the control room to grid-edge assets.

Circularity/NetZero

Integrated, scalable platforms – where clean energy and technology goals are inseparable

Grid Integrated EVs

Integrated control and energy storage systems for both vehicles and buildings.

Rise of the Prosumer

Flexible and scalable systems to deliver consolidated asset visibility, along with financial and operational tradeoffs.

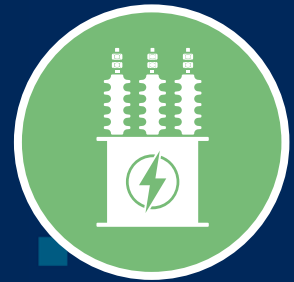
AI & Decision Science

Real-time insights combined with AI to de-risk aging assets, improve building performance.

Value Service Models

Unification of insights across portfolios to deliver innovative XaaS value streams.

GUIDING PRINCIPLES



Confronting the IT and OT Divide – Intelligent Technologies

Digital Transformation Starts at the Edge

Physical and digital
systems **become**
seamless

1

Networks are
software-defined

2

AI at every data point

3

Apps run seamlessly
from cloud to edge

Modernizing the Utility Grid for Renewables Everywhere

intel.
XEON

Utility Grid Modernization



Smart Substation Control and Protection



SW Defined Substations

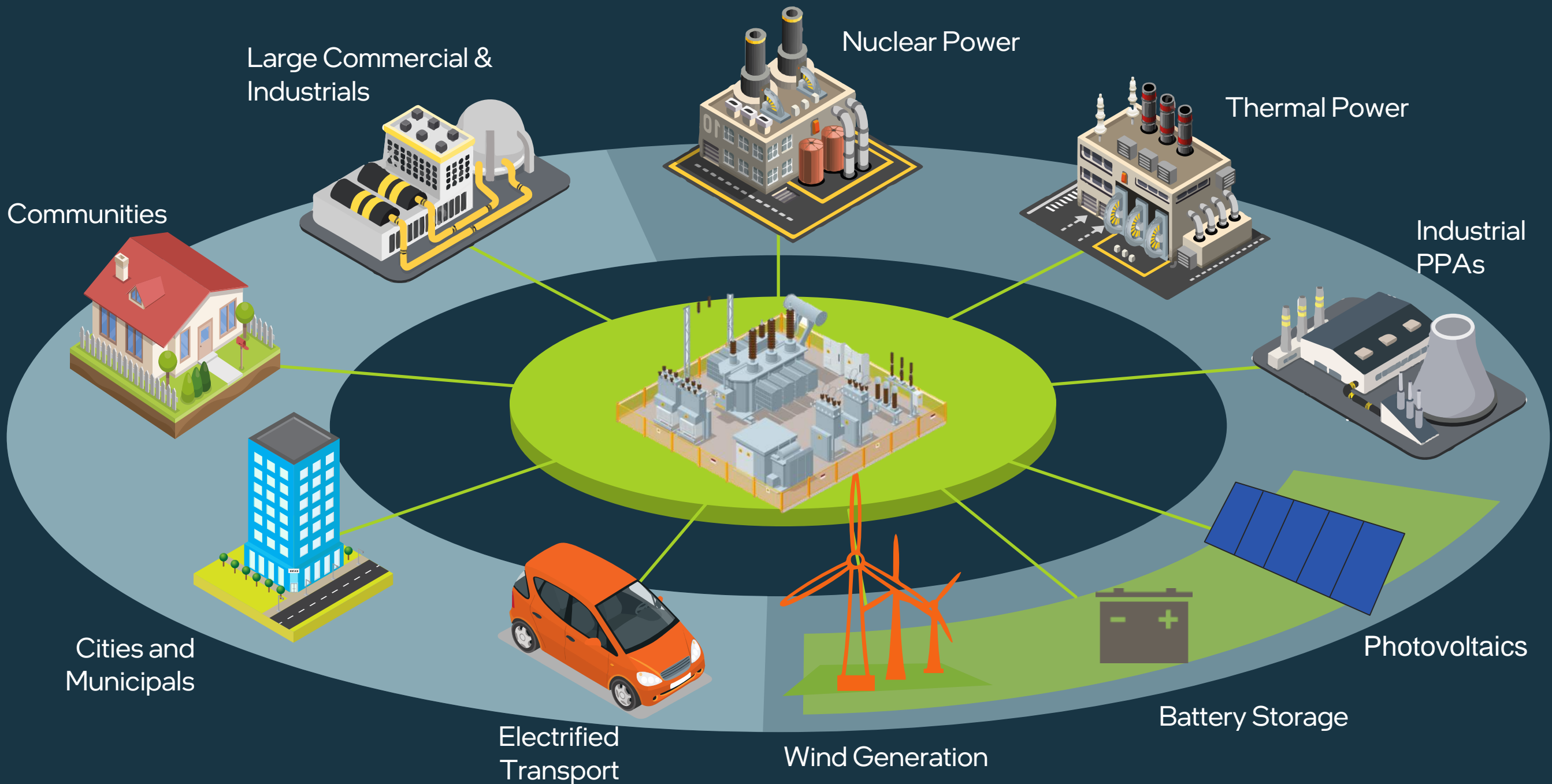


Intel created coalitions in each region of the world to deliver tangible results by collaborating with IT and OT industry leaders.

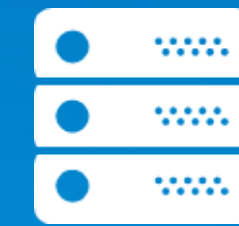
Modernizing the Grid

Central Nervous System Allowing Bi-directional Integration of New, Sustainable Grid Resources

Software-Defined Automation & Control Systems – Enhance Reliability, Safety, Security & Manageability



Modern comms architecture for bi-directional interoperability



Standardized SW-defined HW platform



Virtualization to future-proof IT/OT substation application deployment

Maturing Sustainable Solutions on a Bi-directional Grid



Intel's edge-native software platform enables enterprises to build, deploy, run, manage, and scale edge and AI solutions.

Building Blocks to Delivery New Decarbonization Solutions

1

Edge Native Intelligence

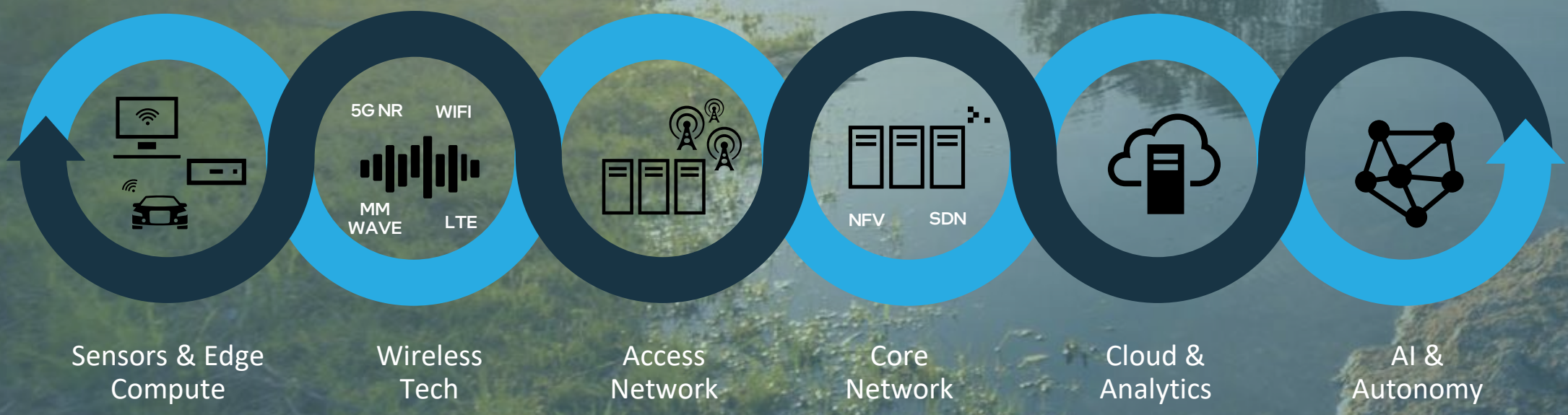
2

Modular AI/SW Deployment

3

Simplified Solutions Management

Intel Technologies

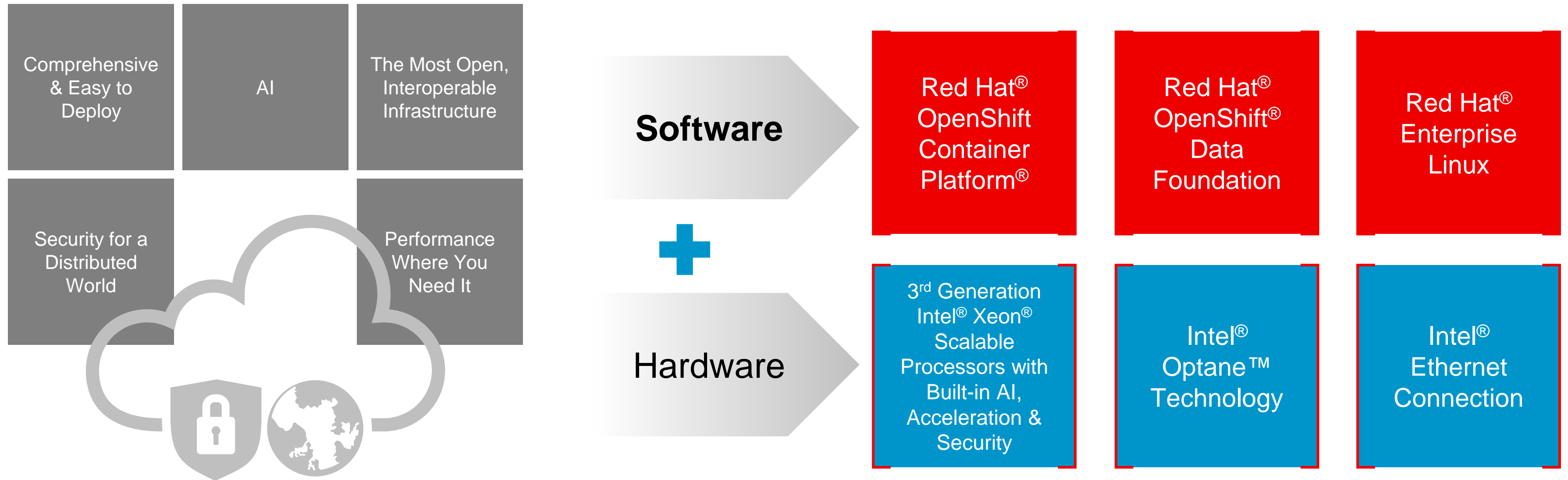


Partner & End User Solutions

Portfolio of cross-industry and industry vertical capabilities

A New Digital Infrastructure

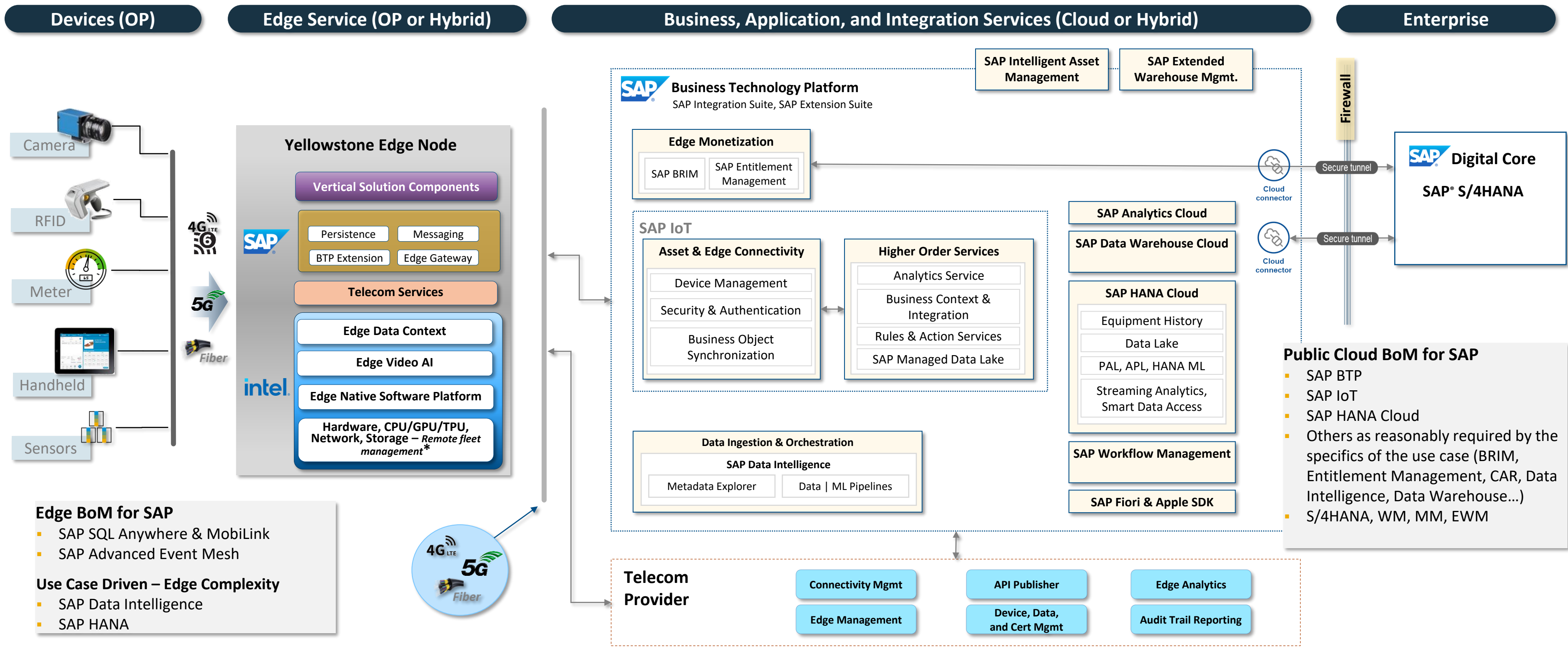
The Intel® solution for Red Hat OpenShift Container Platform scales for today & tomorrow



Hybrid Cloud Benefits

Red Hat & Intel combine industry-leading technologies for a new era of digital everything

Yellowstone: Edge to Cloud as-a-Service

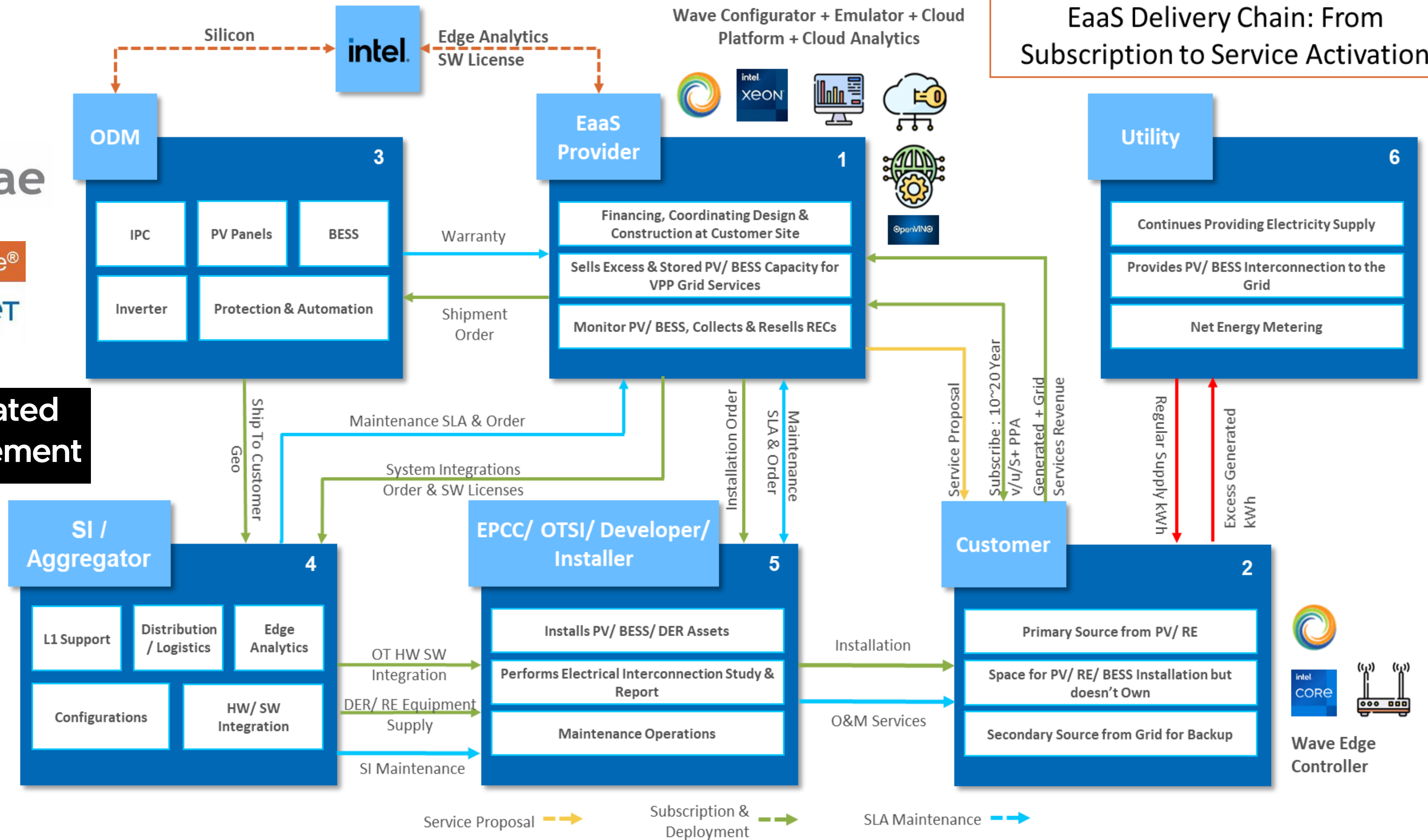


Solution employs secure, high-performance edge computing, AI, data analytics, CV, 5G, and cloud computing

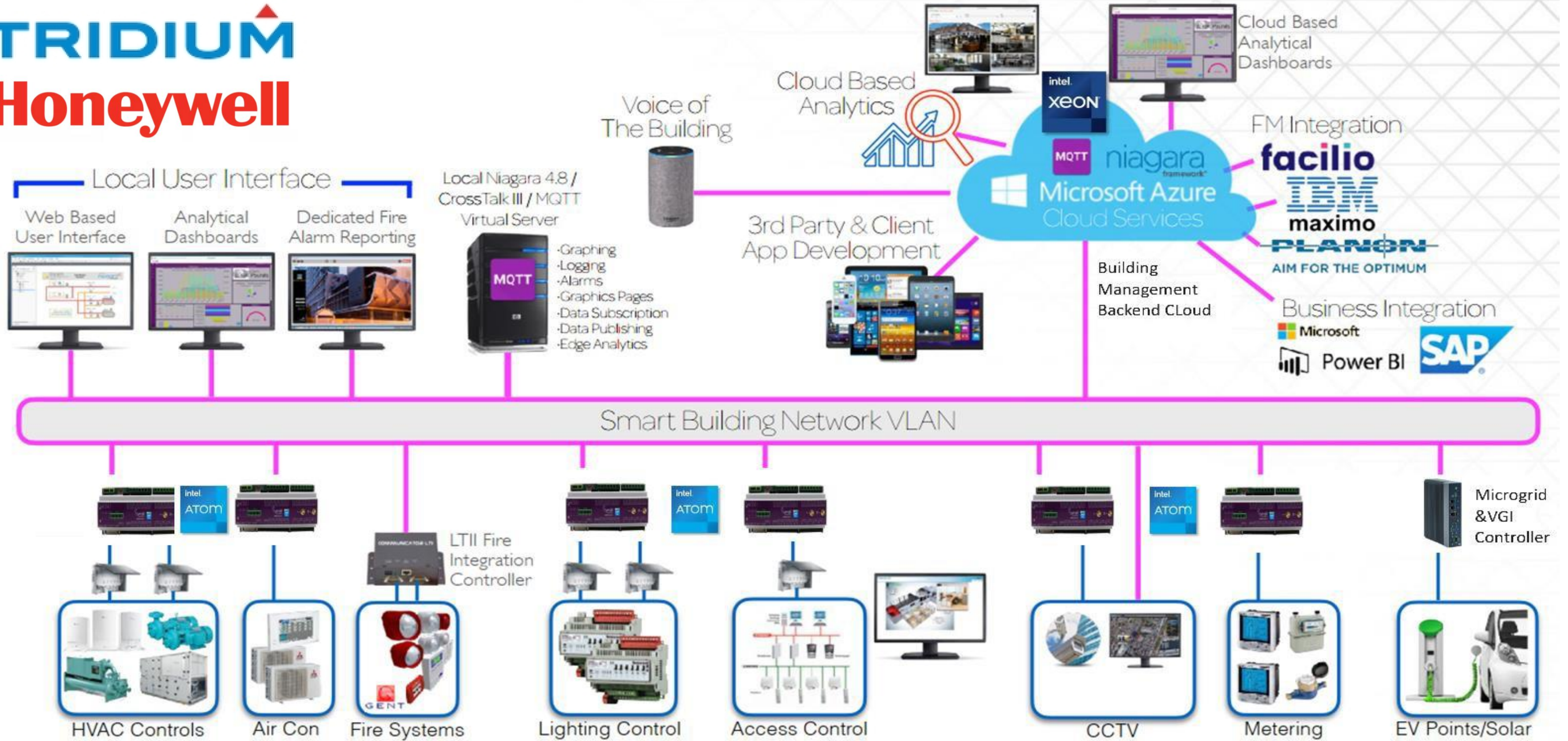
EaaS Delivery Chain: From Subscription to Service Activation



Grid Integrated DER Management



Intelligent Edge-to-Cloud Building Management System



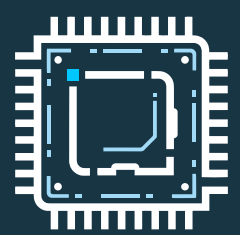
Carbon Aware Datacenters

Accelerating a Sustainable Solutions for
Energy Through Product Innovation and
Circularity



Today's Datacenter Energy Outlook

Dual need for energy resiliency and sustainability



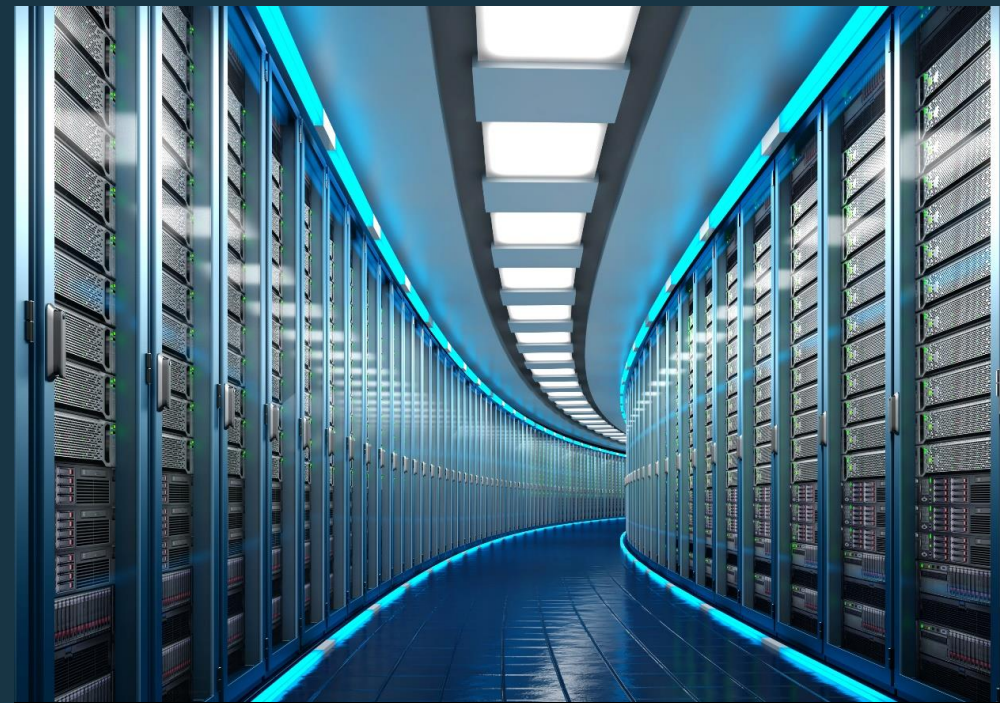
Higher TDP CPU/GPU
up to 350W (CPU)
up to 800W (GPU)



Increased electricity usage
16% CAGR '22 to '27¹



Growth in AI electricity use
85-134 TWh² to power world's
AI Servers



A More Energy Efficient Data Center

- ✓ Increased Density
 - ✓ Lower PUE
 - ✓ Better TCO



Worldwide Electricity Prices
2x wholesale yr / yr³



Environmental regulations
electricity and water use



Lower PUE requirements
leveling at 1.6⁴

Key Focus Areas for Datacenter Use Case Prioritization

1



Gain visibility
into energy
consumption and
demand dynamics

2



Decrease carbon
impact in existing
supply chain and
operations

3



Build a next-gen
infrastructure to
enable grid integrated
renewables

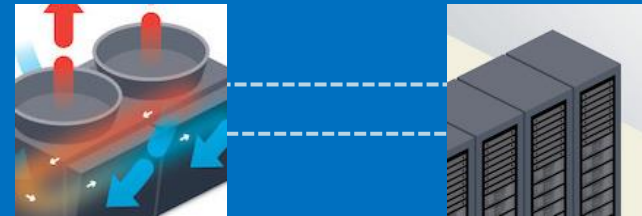
Rethinking How We Build Data Centers

Immersion Cooling & Distributed Energy Resources (Recapturing Heat)

Benefits

- Reduce energy consumption
- Increase computing density per sqm
- Reduce building costs
- Increase deployment speed

Heat Capture Advantage



99%

heat captured in the closed-water cooling loop.
No water consumed.

Ecosystem Partners



Use case

Hospital

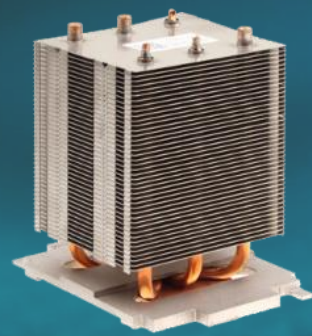


Data Center

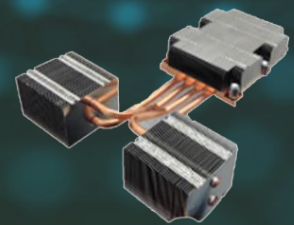
Unprecedented **energy reuse** if Data Centers are close to communities or industry. New DC revenue streams

Data Center Efficiency: Reducing Power Usage Effectiveness (PUE) through Liquid Cooling

Liquid Cooling Enables Lower PUE



Traditional Heat Sink



Enhanced Volume Air Cooling



Immersion



Cold Plate

Down to
1.3-1.2

PUE

Down to
1.03

Intel Support for Liquid Cooling

Available immersion cooling warranty rider

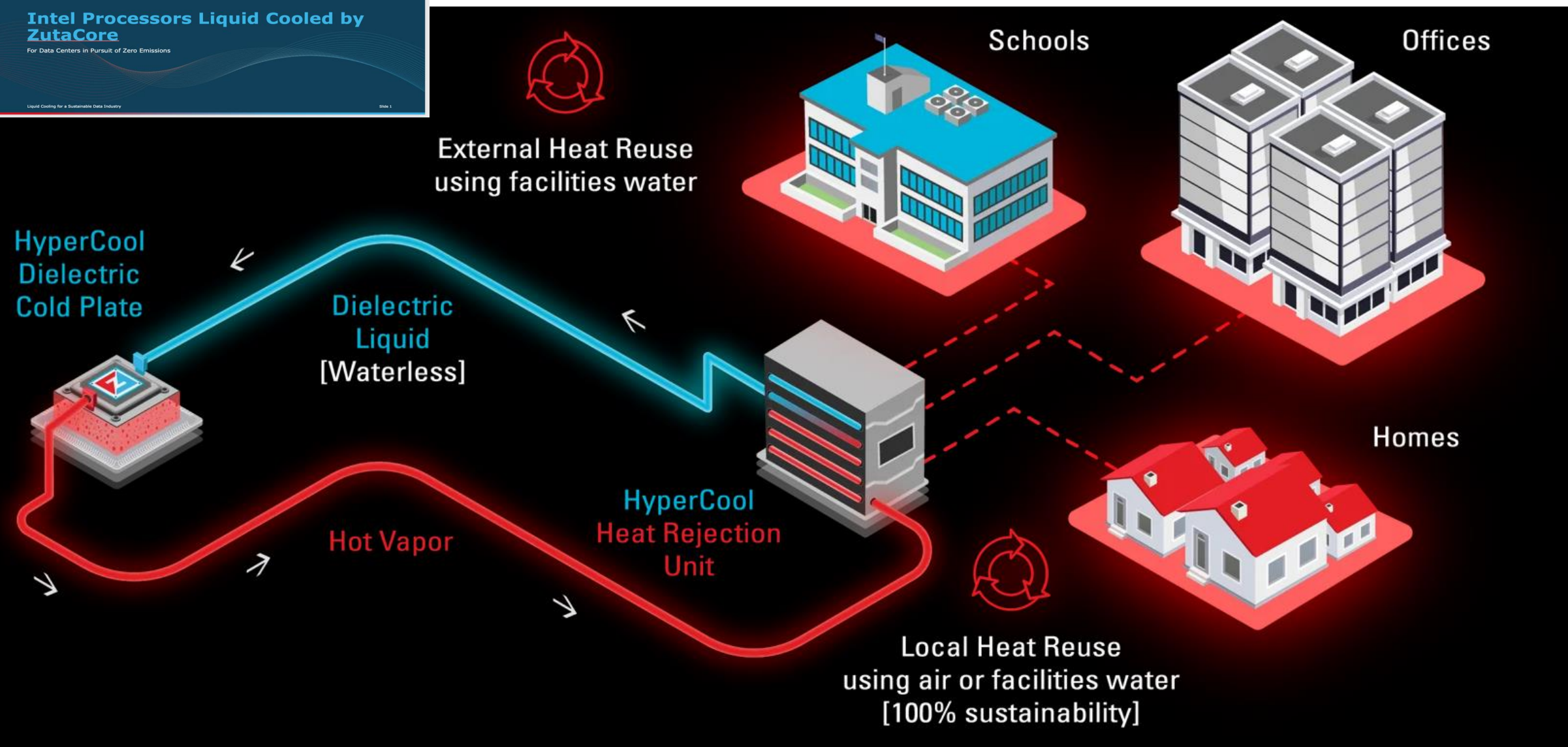
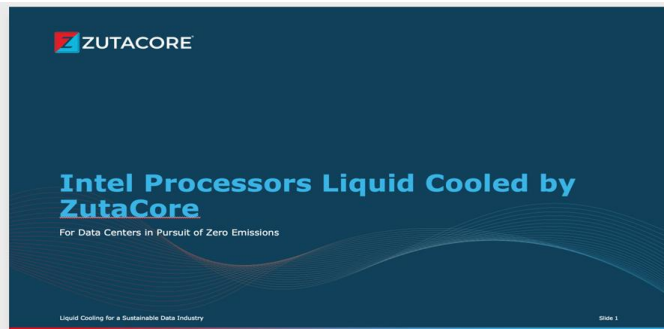
Liquid validation

Reference documents

Qualified DLC/CP partners

Learn more: https://www.youtube.com/watch?v=yBVO_YQBYjc

Reducing Friction for Intel Platforms



Making Enterprise AI More Energy Efficient & Sustainable

ZUTACORE
ZutaCore* HyperCool*

Target Verticals: All verticals
Geo Availability: United States, EMEA, Asia Pacific, and Japan

Solution Overview
ZutaCore is leading the transformation to a zero emissions data industry with ZutaCore HyperCool, a direct-on-chip, waterless, dielectric liquid cooling solution. ZutaCore HyperCool delivers improved compute, TCO reduction, 100% heat reuse, and reduced CO₂ emissions for a sustainable data center. Part of Intel's thermal server system design guide, ZutaCore HyperCool is tested and certified for 4th Gen Intel Xeon Scalable processors, supporting 136 Xeon processors at full TDP of 350W with facility water up to 38° Celsius. Another step forward to bringing zero-emissions to the data industry through the reduction of power, footprint, and TCO.

Value Props

- Enable sustainable digital infrastructure: On-demand, self-regulated cooling improves energy efficiency of the data center with a partial PUE (power usage effectiveness) as low as a constant 1.02
- Reduce risk of equipment deterioration: Direct-on-chip method applies coolants (stored in an external unit) directly to the chips to extract and disperse heat without water, protecting equipment from corrosion and other water-related threats
- Deploy and scale operations quickly: Snap-on simplicity delivers scalability from one server to the entire data center and easy retrofitting allows for deployment in new or existing datacenters

Case Study: Equinix shows liquid cooling in action on their own production servers

- The situation:** Large data center operators are continuously looking for new technology to increase performance and reduce their ecological footprint. Equinix, a digital infrastructure enterprise, was looking for a solution that could upgrade their current liquid cooling system to improve performance and achieve their sustainability goals.
- The solution:** Equinix worked closely with ZutaCore to implement the ZutaCore HyperCool solution in one of their New York Metro data centers. They used this smaller scale deployment to educate their teams and learn by doing with the hope of eventually scaling the solution to their entire operations.
- The results:** Since the installation in June of 2022, the liquid cooling solution has been stable and operational without any issues, keeping processor casing temperatures at or below 52°C.

Solution Components

Intel Components	ZutaCore HyperCool Components
• Intel® Xeon® Scalable Processors	• HyperCool Dielectric Cold Plate
	• HyperCool Manifold
	• HyperCool Heat Rejection Unit (HRU)
	• HyperCool Software Defined Cooling (SDC)

Learn More

- [ZutaCore Company Website](#)
- [ZutaCore Solution Video](#)
- [Press Release](#)
- [Equinix Case Study Video](#)

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Sustainable Consumption

Partnerships That Make A Difference

Intel Innovation Conference 2023

I'm thrilled to share that Intel and Shell are joining forces to revolutionize data center cooling. The Shell team will be working with Intel's Advanced Data Center Development Labs to put Shell's Immersion Cooling Fluids to the test.

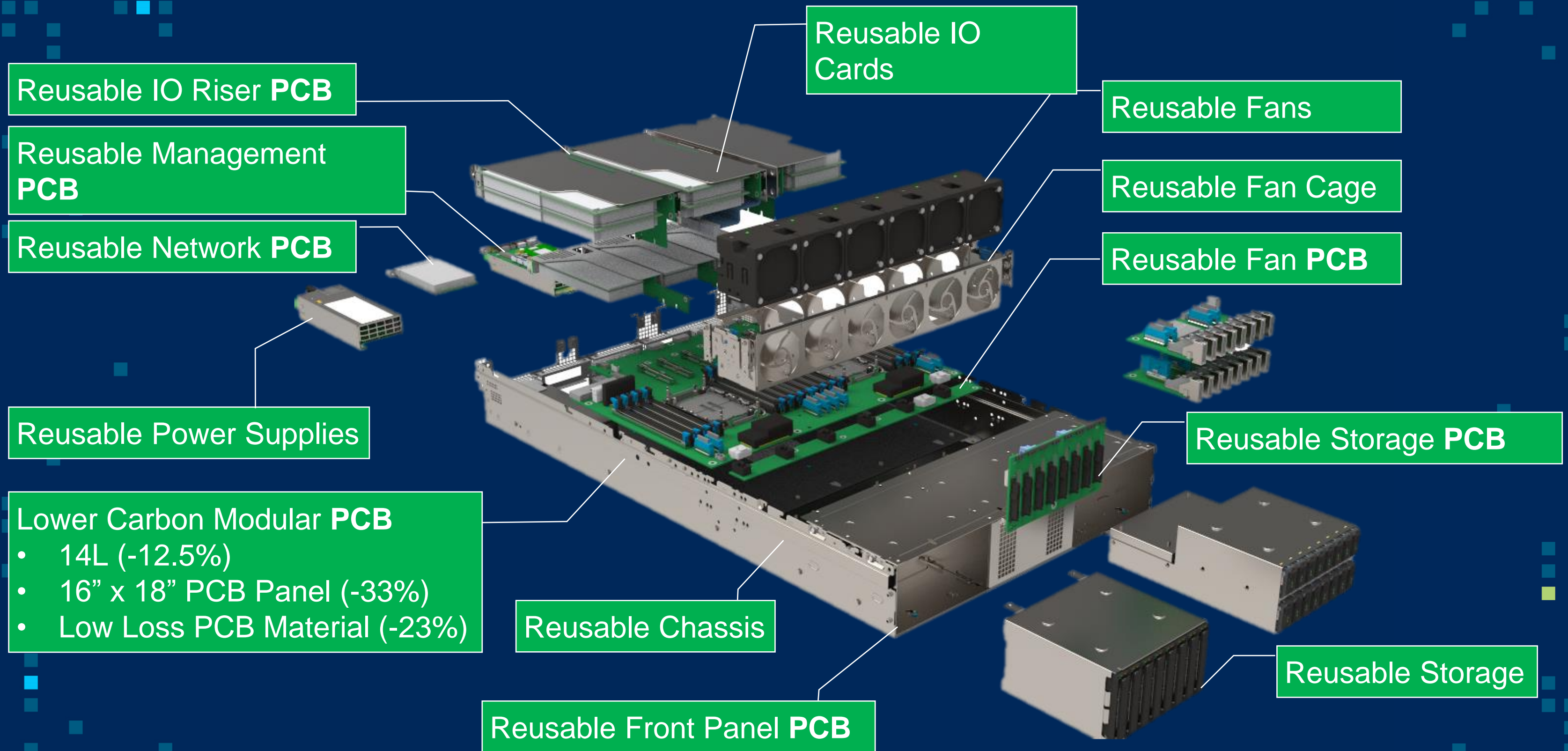
The joint teams' goal is to accelerate the adoption of immersion cooling as one of the solutions to help tackle the challenges of data center cooling and energy reduction.

Selda Gonsel
President, Shell Global Solutions US



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Delivering Modular Platforms for the Circular Economy



Data Center Modular Hardware System (DC-MHS):
See [specs](#) developed with Dell, HPE, Google, Meta, Microsoft



Anomaly & Defect Detection in Green Energy Operations

Intel at Mobile World Congress – 2024

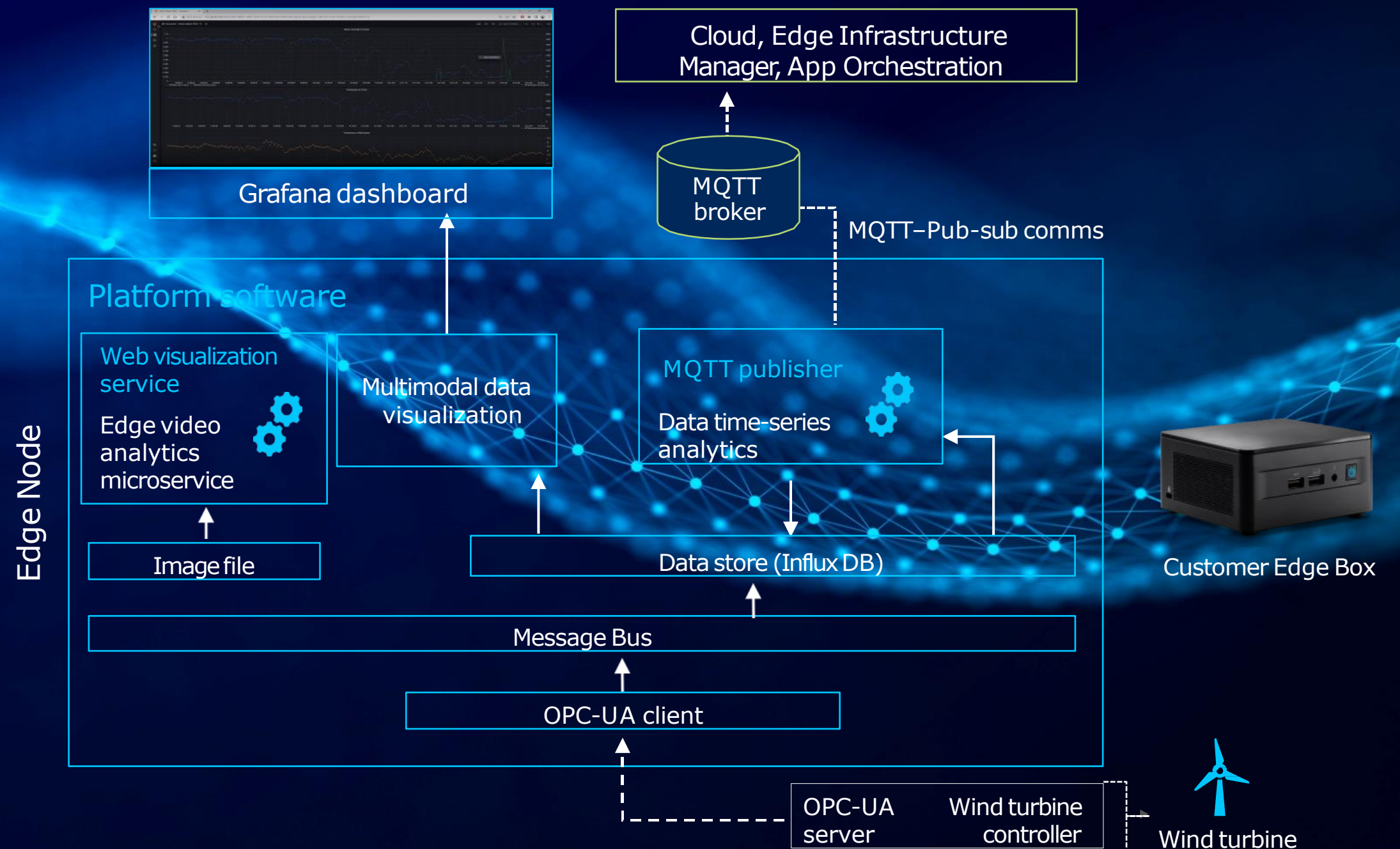
This proof of concept (PoC) improves operational efficiency through anomaly and defect detection of green energy assets.

The PoC successfully showed anomaly detection of wind turbine operations (power generated vs. wind speed) with local visualization, enabling the site operations team to take immediate actions without delay.

Ingredients:

- Edge Node Software
- Edge Infrastructure Manager
- App Orchestration
- Intel® Edge Insights System
- Intel® Geti™ Platform

The solution is a showcase of data collection, analytics, visualization, and integration



Intel Working in Collaboration With Industry Groups



Creating a More Sustainable Datacenter



Data Center

- Building, Water, Power, Waste, Ecosystem

Grid
Integrated



Rack & Edge

- Space, Power, Cooling

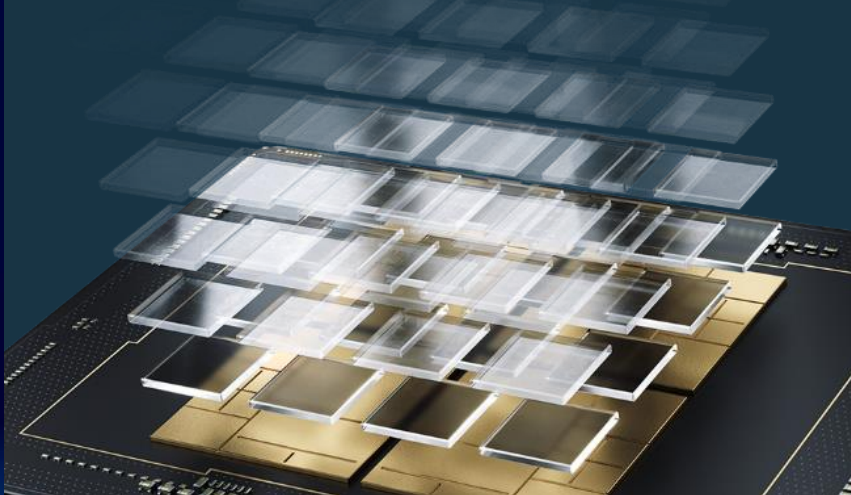
Efficient
HW/SW



Platform

- Embodied CO2, Waste, Power

Efficient
Hardware



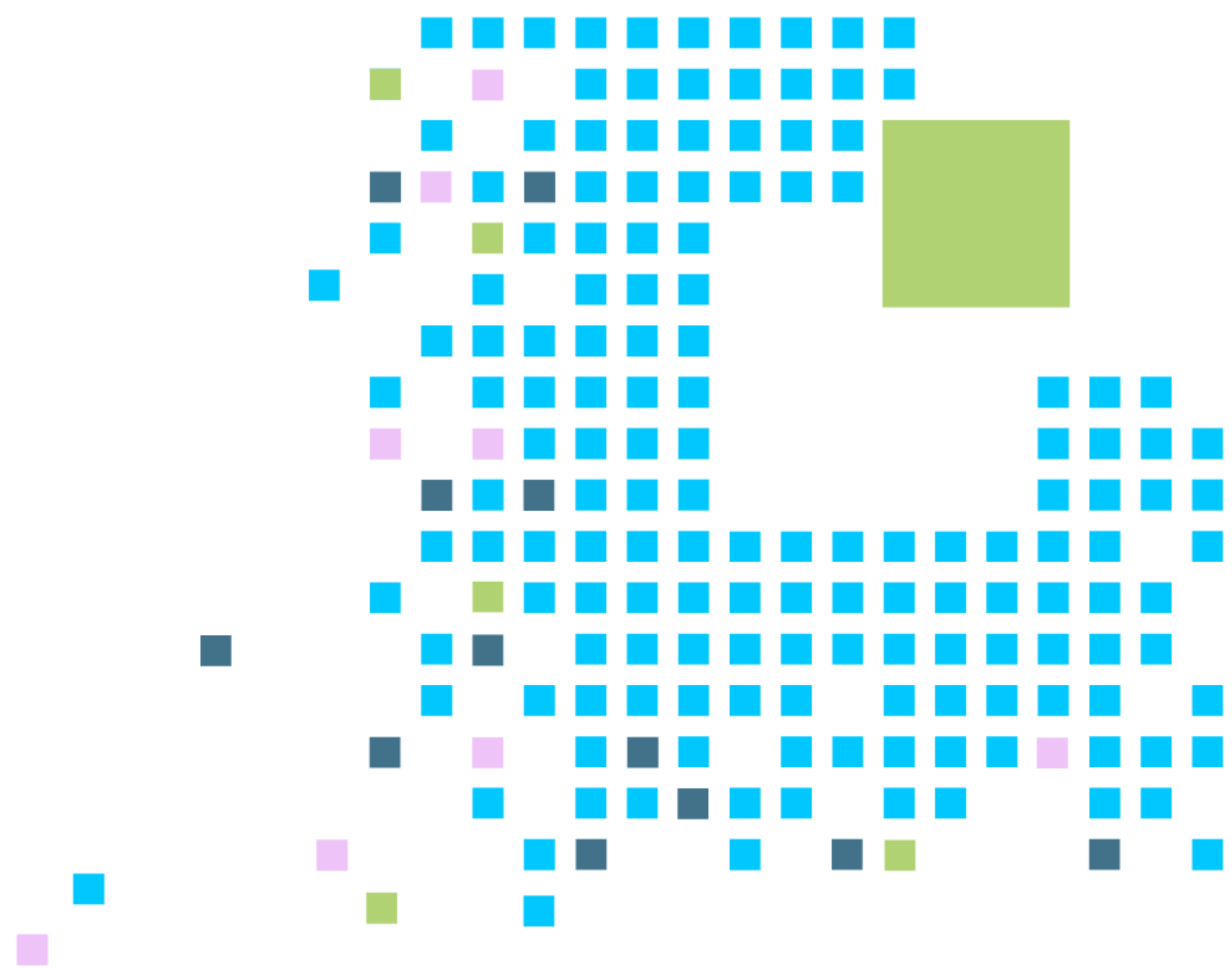
Silicon

- Embodied CO2, Utilization, Waste

Reuse/
Reduce

Recap

Delivering Value Across the Industrial
Decarbonization Landscape



Industrial Decarbonization: Decarbonizing Industry for a Sustainable Energy Future



Renewables

Accelerating the integration of renewables and DERs to the grid and built space

Edge Optimization

Network optimization and grid edge digital innovation

Grid Resiliency

Electric supply adequacy and AI enabled asset optimization services

Sustainability & Circularity

Balanced decarbonization strategies, reuse and recyclability

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The background features a dark blue field with a grid of small squares in various colors (cyan, light blue, green, pink, grey) that form a stylized shape. To the right, there are large blocks of cyan and a white square in the top right corner.

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Thank You!

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