Distributed Technology for Smart Manufacturing: an Incrementalist Approach

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Who Are We – About Wanxiang Group

- Founded: 1969
- Headcount: 40,000+
- Wanxiang Group: Hangzhou
- Wanxiang Holdings: Shanghai
- Wanxiang US: Chicago
- Revenue: USD2.8B
- Average growth rate: 25.89%
- 22+ Holding/Invested listed companies
- Among China’s Fortune 500
  - Top 1 in Automotive Components
  - Top 8 in Automotive Manufacturing 100 WW
- Industry
  - Electric Vehicle
  - Lithium-ion Battery
  - Renewable Energy
  - Automotive Component
  - Natural Resources
- Technology
  - Wanxiang Blockchain Co.
  - DataYes (AI Fintech)
- Financial Sector
  - Bank, Futures, Trust, Insurance, Fund, FinTech
WHY Distributed – Digital Factory vs Brownfield

Greenfield factory
• Sophistication: built with sensors; controllers; networks & computers required to meet the end user’s desires for information.
• Niche: Time: a digital production line takes 6 months to build; longer than many industries’ typical turnaround from prototype to production.

Reality: Brownfield Plant
• Legacy equipment. Absence of data collection and data format consistency.
• Connectivity. Islands of production, with little connectedness.
• Business model. Lack of a viable IT infrastructure to reap the benefits of digital factory.
WHY Distributed – Digital Factory vs Brownfield

The Billion-Dollar Question: how to bring traditional manufacturing into the fold

Brownfield Smartness Imperatives

- Synergy factor: connecting to the dumb parts of the world
- Humans are here to stay. A smart factory is not only looking for better ways for components to communicate and interact, but also human operators.
- An unbroken data and logical chain for each order that can be executed optimally, start to finish.
- Automation is the means not the end.
- Change management. Incremental at scale is better than revolutionary in niche.
- Integration through incremental linking of smart modules
- Data silo, just when data integration becomes compelling not only within the enterprise, but throughout the value chain
- Business Model: distinguish supply chain vs. Value chain.
- OT is nothing but a pushdown of new technology: “技术下沉”
WHY Distributed – OT + IT Integration

Key Objectives
• Modular development: to avoid clunky team
• Incremental, horizontal scalability, to match return to investment
• Rapid deployment: to demo benefits
• Facilitate new business model.

- Smart factory insights: generated through cloud-based big data analytics (IT) fueled by real-time data collection on the factory floor (OT).
- Vertical → Horizontal: inflicted OT/IT interactions of the past are giving way to collaborative OT/IT alliances
- IT penetration into OT; but not like OT adopting the IT architecture. OT vs. IT compared to Edge vs. Cloud, and Distributed vs. Centralized.
- OT gains its own footing, by orienting toward location and distributed processing for low-latency and real-time processing.
WHY Distributed – OT + IT Integration

Tech Measures

- Adding sensors and monitors;
- Low-cost reference designs of edge devices;
- Connectivity to a local edge platform;
- Develop manageable and self-contained app modules;
- Machine learning on the edge;
- Build self-organized local networks, with DLT + IIoT;
- Discovery of, and smart access to, cloud-based services: AI at the edge; data security assurance via blockchain.
Wanxiang’s Challenges & Opportunities

**Wanxiang shares the difficulties** to create an OT context for digital innovation:

**ROI Challenge:** high investment (data acquisition and analytics, edge-cloud computing infrastructure) vs. insufficient demonstrable success

**Resources:** hard for manufacturers to retain IT/data system domain experts

**Behavioral barrier:** lacking discipline to convert production domain knowledge into models and apps – broad OT/IT gap

**Ecosystem:** the gaps in the space between High and Low - industrial app developers collaborate closely and productively

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**Vision and Aspiration**

- **Internal Market:** more than 40 factories globally with a revenue over $19B – substantial scalability platform. An 1% efficiency improvement would amount to close to $200M of saving per year.

- **External Market:** 300+ suppliers, total revenue exceeding $40B. Assuming 30% upstream supply chain adoption rate, a 1% efficiency gain would amount to a value greater than $100Ms.

- The scale is sizable enough for an ecosystem of industrial app developers.
Tapping the IIC Ecosystem: Testbeds & Beyond

Ref Architecture. Standards. Partners

IIRA, IISF, AI & Edge Whitepapers

- A Network for Partner Discovery
- A Source of Inspirations
- And a Platform for Tech Engagement with Existing Network
Solution Overview – Edge to Cloud Solution

- Establishing standard edge computing platform, incubate hardware development ecosystem
- Establish distributed trusted value exchange network of intelligent machines using blockchain technology
- Incubating micro-service analysis and application development ecosystem
  - SDK and API for ecosystem developers to create industrial apps at the edge and in the cloud
  - Interface (with methodology and technologies) to securely expose data to the developers
  - Interface (with processes and technologies) to qualify developers and validate the apps
  - Interface for factory engineers choose apps and deploy them to edge and cloud as appropriate
Implementation View – Architecture & Ecosystem

Edge Tier
- Edge Platform
  - Fieldbus & Device Connectivity
  - Edge Analytics Apps
  - Data Mgmt
  - Device/Security Mgmt
- Cloud Connectivity
- EdgeX Platform

Platform Tier
- Cloud Platform
  - Development Tools
  - App Store
  - μService App Runtime
  - Analytics Platform (Streaming & Big Data)
  - Data Platform (Collection, Storage & Mgmt)
  - Device Mgmt
  - User Mgmt & Authn
- Developer Network
- Operation Network

Enterprise Tier
- Enterprise Systems
  - HTTPS over Ethernet

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AI at the Edge – Vision & Key Objectives

Vision of an Intelligent Edge
• Continually expanding set of connected systems
• Close to end users and the data that is generated
• Ability to create a new class of distributed, connected applications that enable breakthrough business outcomes.

Why AI at the Edge Matters
➢ Latency. 30 images/sec; 200ms latency.
➢ Availability. 50% of world at less than 8mbps. Only 73% 3G/4G access WW.
➢ Pragmatic. Allows implemental mapping of development costs to benefits

Feasibility of running sophisticated on the edge
➢ Model compression techniques (Google’s Learn2Compress) that enables squeezing large AI models into small hardware form factors
➢ Ready HW platform (ARM’s Project Trillium)
➢ Federated learning and blockchain-based decentralized AI
AI at the Edge – OMPAI Testbed, on IIC Platform

Published in May, 2018: IIC Q2 Member Meeting, Helsinki

This testbed optimizes manufacturing production processes by deploying distributed AI and industrial APPs strategically at multiple levels of a brown-field manufacturing environment.

- To test technologies, algorithms and technical frameworks for applying AI and analytics to solve specific production quality, cost & efficiency problems in automotive manufacturing environment

Sponsors: Wanxiang Group

Participants: Thingswise, Xilinx, Dell EMC, China Unicom, CAICT

- Explores AI algorithms to solve real world, underdeveloped manufacturing problems
- Demonstrates a manufacturing company’s approach to enable IT ecosystem to solve OT problems
- Showcases edge computing for the Industrial Internet

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AI at the Edge – Usage Scenarios

Tech Scalability:

- An edge platform to connect to various brownfield production equipment and to provide necessary computation capability to enable edge analytics
- An analytic platform to collect, process, analyze large amount of machine, product and process data
- A machine learning model building and execute framework to build models deployable in the system for real-time pattern recognition and analytics

Usage Scenario 1
Machine Vision On-line Quality Assurance

Usage Scenario 2
Battery Cell Welding Quality Control

Usage Scenario 3
Wheel Bearing Production Line Optimization

Usage Scenario 4
Predictive Maintenance of Grinding Machines
AI at the Edge

Wanxiang’s Key Objectives
1. Evaluate AI analytics algorithms and technologies to solve specific production quality, cost & efficiency problems in automotive manufacturing environment
2. Determine optimal distribution of AI and analytics across multiple level from edge to cloud
3. Enable an open industrial app framework for incubating a developer ecosystem for agilely creating AI and analytic models, and industrial apps enabled by microservice.

Next: AI Architecture Trends
• Moving up: Edge to Cloud
• Moving down: better algorithms allow shorter learning cycles.
• Moving out: natural user interfaces
• Staying Put: blockchain ensures data integrity and local resourcing
The Case for Blockchain:
- Distributed Ledger: permanent tamper-free data records
- Smart contract: establish automated execution of prior agreement with set conditions; data accessible but not replicable
- Cryptography: data protection across domains
- Consensus: easily establish network of the willing without heavy IT and legal costs.

Particularly relevant to the industrial space:
- Curated data sharing: addresses one of industrial internet’s biggest challenges – why surrender your data
- Seamless and real-time brokering of value exchange: from supply chain to value chain, cross-domain data utilization business model
- Beyond data: could be used to allocate compute resources, in addition to running and training A.I. on mobile devices.
Blockchain – Distributed Data Network for Industrial

- How to increase the collaboration between machines, beyond the bottleneck of machine communications
- How to protect the safety of manufacturing process, material parameters, business security, in the era of big data and cloud computing
- How to monetize industrial big data, so that new value can be mined from big data
- How to guarantee data safety for enterprises and customer, and hold it accountable
- How to pinpoint the quality issue, with trusted, tamper-free records
- How to create new finance services to manufacturers, in real time, and risk-mitigated

Example: Product Quality Tracking on blockchain

- Acquisition of industrial data via smart sensors.
- Data storage over an alliance blockchain solution deployed across suppliers, factories and clients.
- Data tracking with immutable blockchain records.
- Use the trackability of blockchain records for quality analysis, procedure optimization, manufacturing tracking etc.
**Problem:** data collection across data silos, owned by enterprises in different industries.

**Solution:**
- Blockchain is used to track battery spec, recharge time, performance measurement and risk assessment. Tamper-free, permanent record of data.
- Assetize battery: calibrate remaining value of battery via charge time and max capacity
Let’s talk business models: what can be the value of lifetime data cycle for battery?
- Where is the money: killing cost structure for EV
- Where is the money: precision recalls.
- Where is the money: smart storage arrays, based on aging history of each cell.

Challenge: Precision Recall
- 40-50% of an EV’s BoM is the traction battery
- Average viable life for EV battery is 2-3 years
- And they sometimes have high-visibility fire hazard

**EV recalls are massively expensive**
Solution: by accessing the complete data history based on blockchain’s distributed ledger, with the right analytics, OEM can work with battery vendors to pinpoint problem lot with precision, hence reduce the scale of recalls and restore consumer confidence.
Tamper-free battery data allows precision evaluation of every battery cell’s make-and-use history.

Algorithm analyzes data and helps design the optimal array matrix with said cells.

Continual monitoring of performance alerts operators to re-arrange and recycle when necessary.

Improved safety. Maximized commercial value.
Demand → Order Management: a factory gateway can process orders via its own blockchain account; this account then assigns tasks as blockchain transactions to individual machines via sub-orders; transactions can be settled token-based and through smart contracts within and outside the factory.

Smart Diagnostics and Maintenance: through AI-on-Edge, equipment as a blockchain network node monitors its own work status, detects abnormality, assesses pending impact on the overall production factory capability and availability of resources, and initiates repair order through smart contracts.

Industrial Provenance: blockchain’s distributed ledger enables tamper-free data tracking from production to usage, and ensures AI’s data analytics be applied quickly and reliably. Creates economic value by reducing recall volume with surgical precision (a pending testbed from WXIIIP).

Device Collaboration: when executing an order, blockchain’s trusted communication enables an automated machine data exchange network, on which AI can optimize resources use and productivity.

COMMUNITY OUTREACH:
- Collaboration with IIC members, and members’ own app ecosystem
- Facilitate adoption of IIC members’ products and solutions via data synergy
Open Collaboration Converges Innovation
开放共享•创新聚能