Suddenly so Many Big Trends. Why?

mast.hpc.social/@Shahin

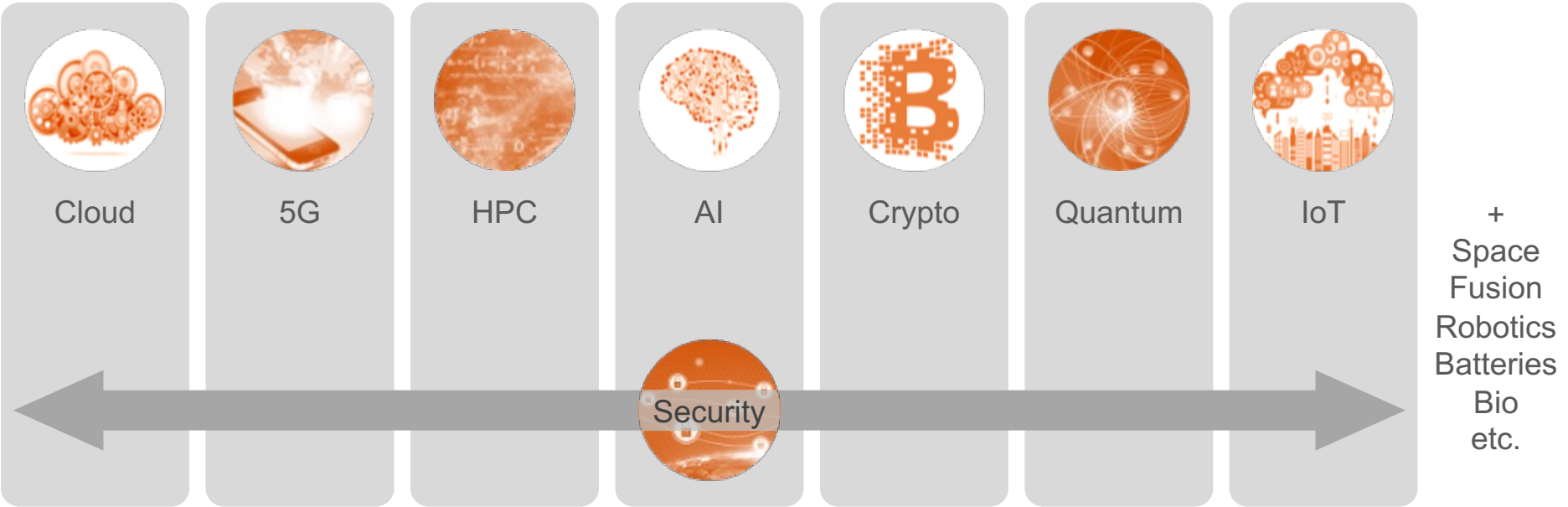April 2025

"When things change, they're not the same anymore"

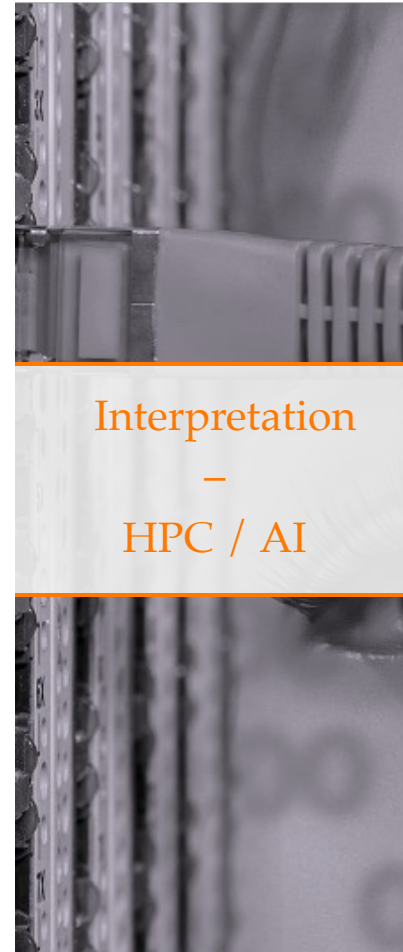– *Anonymous?*
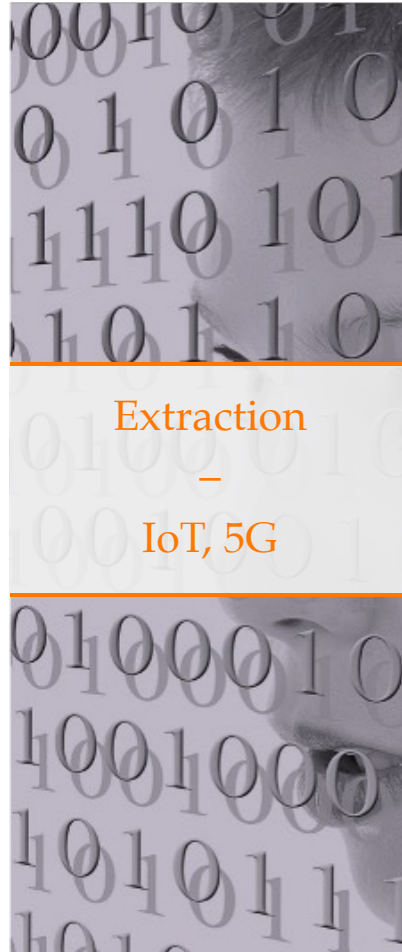
Suddenly so many big trends. Why?

| Cloud | 5G | HPC | AI | Crypto | Quantum | IoT | + Space Fusion Robotics Batteries Bio etc. |

Security

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Common thread:

Data

Extraction
–
IoT, 5G

Interpretation
–
HPC / AI

Processing
–
Commerce

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Data supply chain

Data is the new oil

Bits – Information	Digital Twin

Data Economy

Atoms – Things	Physical Twin

⬌ Inception to Edge ⬌ Edge to Cloud ⬌ Cloud to Control ⬌

Data Sources → Data Supplies → Data Product → Data Market

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Sources of data

Organizations → People

Nature → Things

Extracting Information Content

Structured Data

Apps

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IoT (Edge)

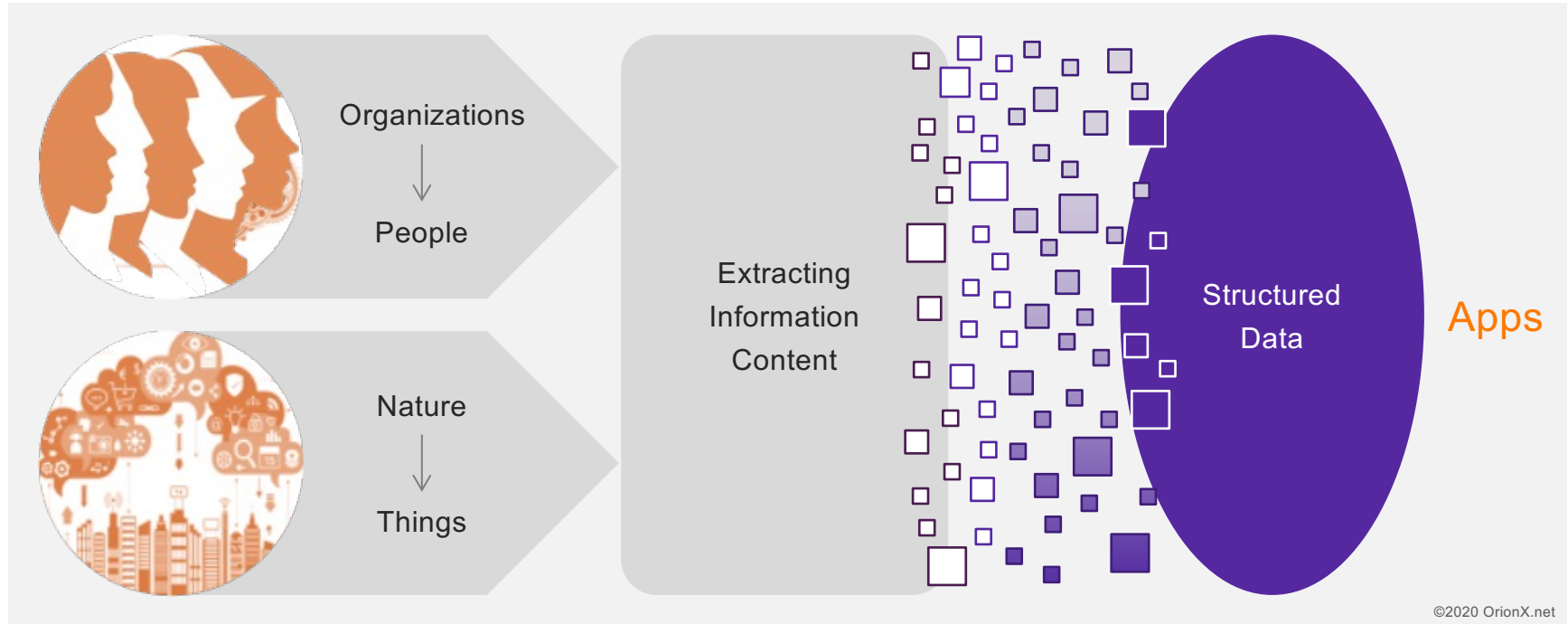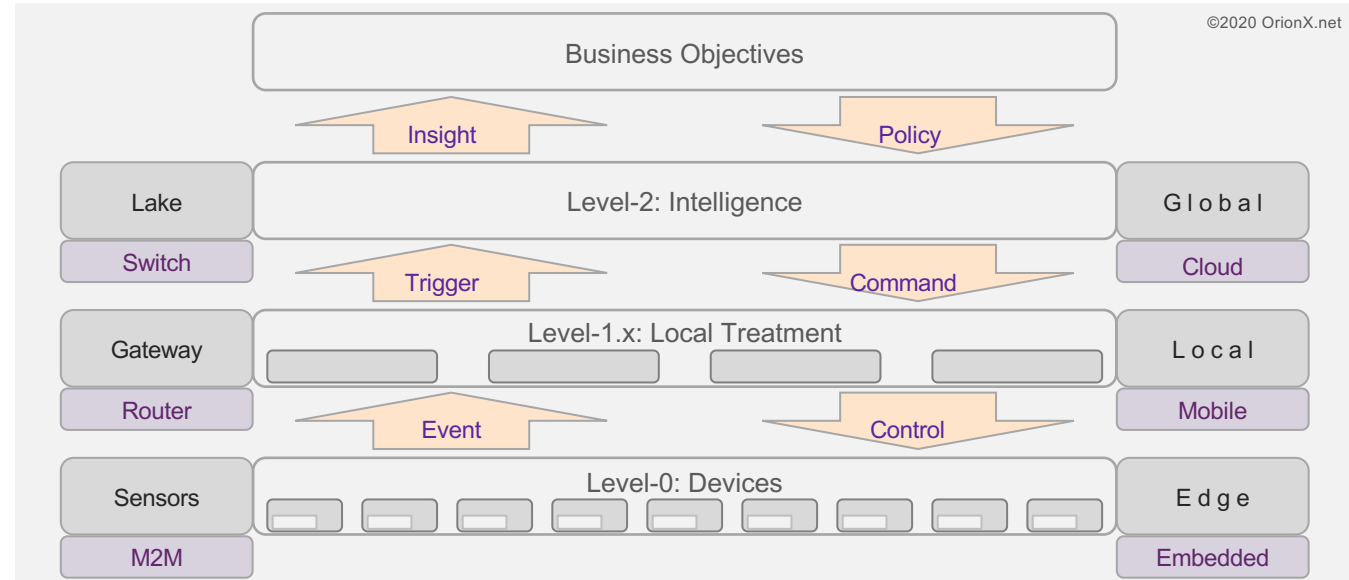## Fountain of data

Everything is Smart

- ✦ Embedded, Mobile, Cloud
- ✦ Scale, Reliability, Speed, Ease of use, Environmental factors, Cost
- ✦ Attack surface
- ✦ Lots of protocols
  - LPWAN, Zigbee, SigFox, LoRa, 3G-4G-5G, BLE, WiFi, OpenRAN, etc.

Business Objectives		
	Insight	Policy
Lake	Level-2: Intelligence	Global
Switch	Trigger — Command	Cloud
Gateway	Level-1.x: Local Treatment	Local
Router	Event — Control	Mobile
Sensors	Level-0: Devices	Edge
M2M		Embedded

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5G → 6G

How data is communicated

Everything is Connected

Bandwidth 20 Gbps	Latency 1ms	Precision <1m	Density 1mil devices/km2	Back-end Robustness	Low Power 90% less	Coverage 100%

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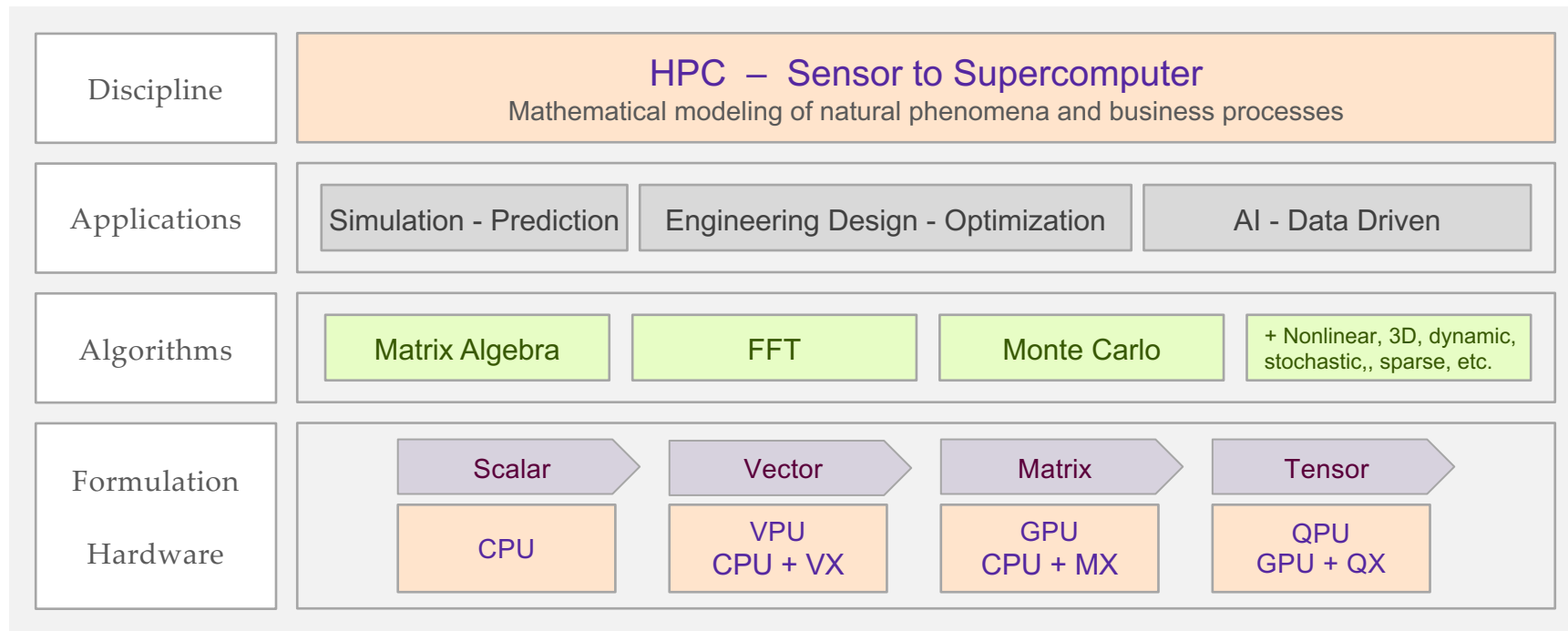
- ✦ Big standard, hot global topic
- ✦ Two different similar 5G standards
  - – 3GPP
  - – IMT-2020
- ✦ Buzzwords (Service Classes)
  - – eMBB (enhanced Mobile BroadBand)
  - – URLLC (Ultra Reliable Low Latency Communications)
  - – mMTC (massive Machine Type Communications)
- ✦ Wide spectrum
  - – Millimeter waves: ~30GHz-300GHz
  - – 200 to 950 MBytes/s have been measured
  - – Spectrum allocation impacts speed, etc.

- ✦ Issues
  - – Suburban and rural coverage
  - – Line of sight, inside buildings or in snow/rain
  - – Lingering health concerns
- ✦ Classes of technologies
  - – Handset, Tower, Picocells, Back-end Switches
  - – Software: Serverization, Network Function Virtualization (NFV), Open Cellular, SDN, etc.
- ✦ Real-looking use cases
  - – Device-dense environments: sports, etc.
  - – Urban driverless cars: Vehicle-to-Everything (V2X), V2V, V2I (Infrastructure)
  - – Edge Data Centers
  - – Less so:
    - • Tele-surgery
    - • VR/AR

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HPC = Performance First, Early Adopter, Openness, Technical Depth
How data is made sense of

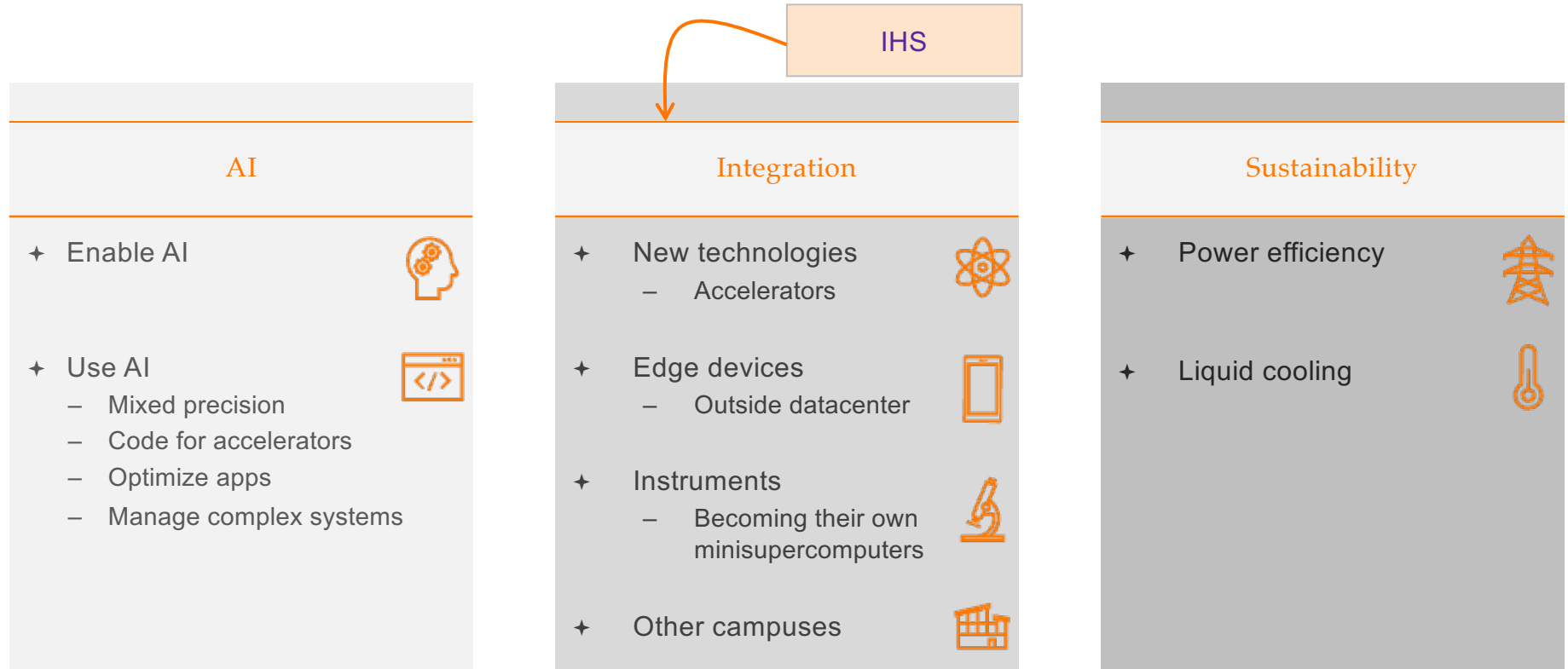|			
Discipline	**HPC – Sensor to Supercomputer** Mathematical modeling of natural phenomena and business processes		
Applications	Simulation - Prediction	Engineering Design - Optimization	AI - Data Driven
Algorithms	Matrix Algebra	FFT	Monte Carlo	+ Nonlinear, 3D, dynamic, stochastic,, sparse, etc.
Formulation	Scalar	Vector	Matrix	Tensor
Hardware	CPU	VPU CPU + VX	GPU CPU + MX	QPU GPU + QX

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"If you have 200 rows, it's a spreadsheet, but if you have 2 billion rows, it's HPC."

2002

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Trends I see in HPC
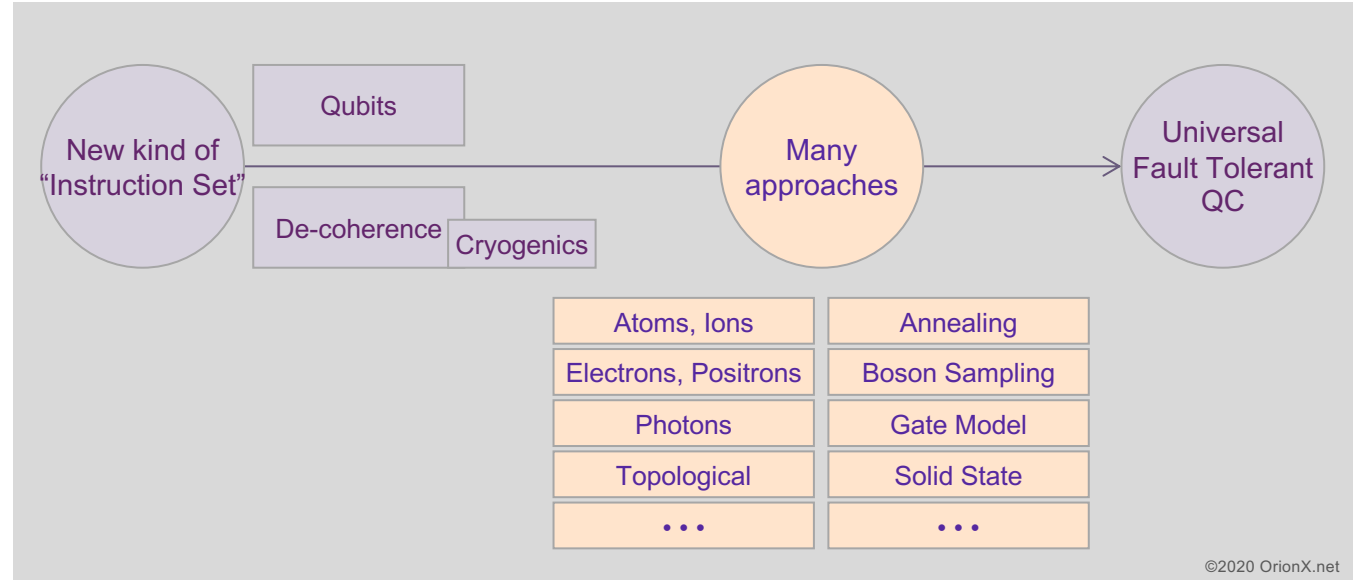## AI is an HPC app, Quantum is an HPC subroutine call

IHS

AI

✦ Enable AI

✦ Use AI
  – Mixed precision
  – Code for accelerators
  – Optimize apps
  – Manage complex systems

Integration

✦ New technologies
  – Accelerators

✦ Edge devices
  – Outside datacenter

✦ Instruments
  – Becoming their own minisupercomputers

✦ Other campuses

Sustainability

✦ Power efficiency
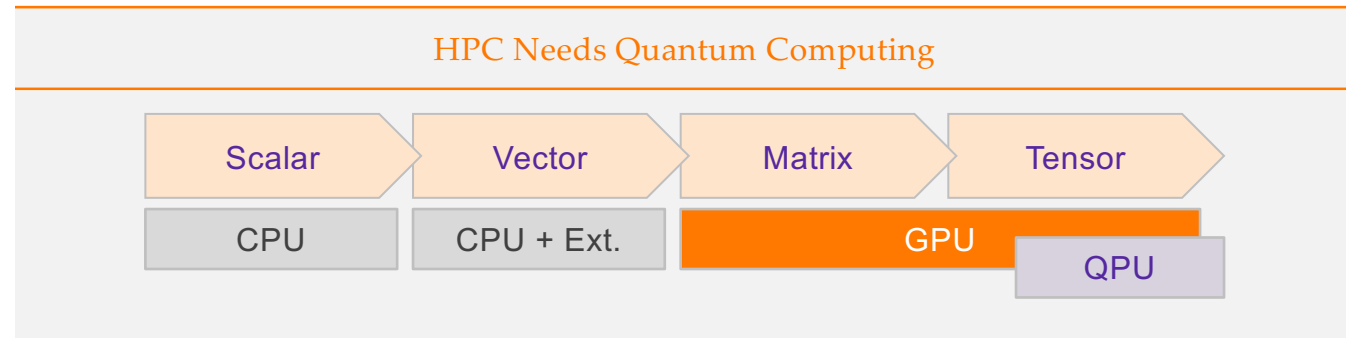
✦ Liquid cooling

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Quantum *Computing*

How data is accelerated

Everything is a Probability Function

- ✦ Quantum Sensing, Quantum Communications, Quantum Computing (least real)
- ✦ "Overhyped and Underestimated", Hot, and will remain hot for the next decade
- ✦ Current state: NISQ: Noisy Intermediate Scale
- ✦ Global push: tens of serious efforts in multiple applications
- ✦ Used as an accelerator to classical computing
- ✦ Buzzwords: QIS, Supremacy/Advantage, Y2Q, post-quantum or quantum-safe cryptography, QML, QEC, QKD, …

New kind of "Instruction Set"

Qubits

De-coherence   Cryogenics

Many approaches

Universal Fault Tolerant QC

Atoms, Ions	Annealing
Electrons, Positrons	Boson Sampling
Photons	Gate Model
Topological	Solid State
. . .	. . .

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Quantum Computing

HPC Needs Quantum Computing

Scalar	Vector	Matrix	Tensor
CPU	CPU + Ext.	GPU	
			QPU

✦ HPC Grand Challenge Apps
- Climate Modeling
- Nuclear Stockpile Management
- Precision Medicine
- Cognitive Science
- National Security
- Condensed Matter and New Materials
- Geo Science, Astrophysics, etc.

+ growing AI infusion, mixed precision

✦ Quantum Advantage
- ☑ Accuracy
- ☑ Energy
- Speed

✦ Quantum-inspired classical algorithms
- ☑ Several examples

✦ Expected Quantum Advantage Apps
- ☑ Quantum Chemistry/Physics
- ☑ Optimization
  - Parameter, input data
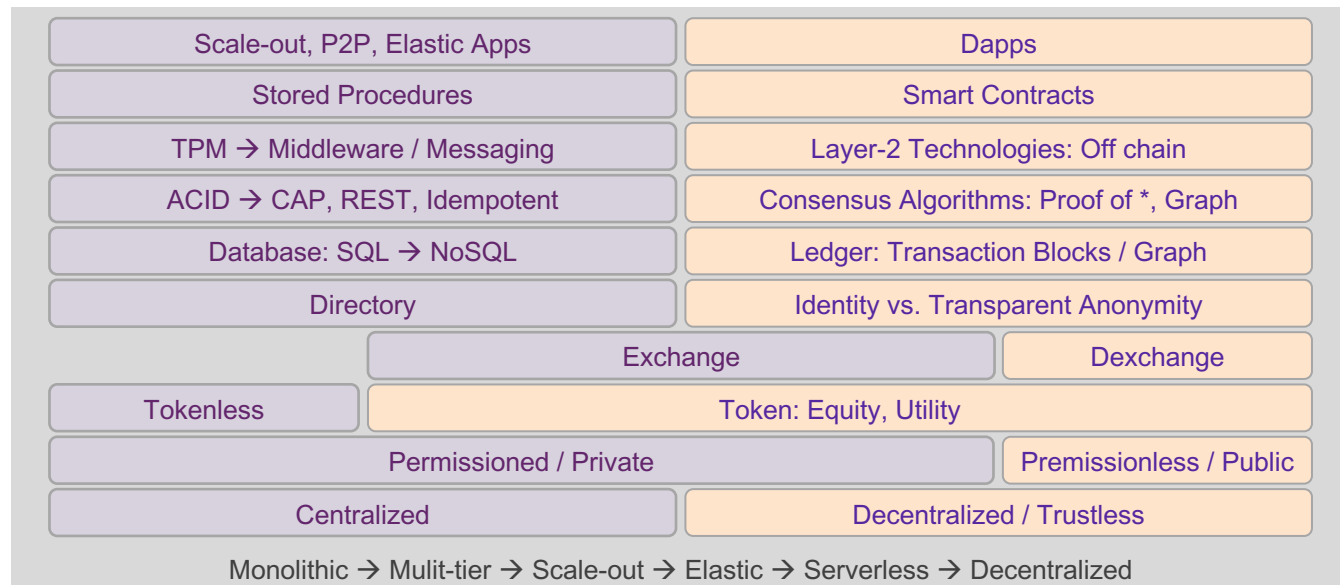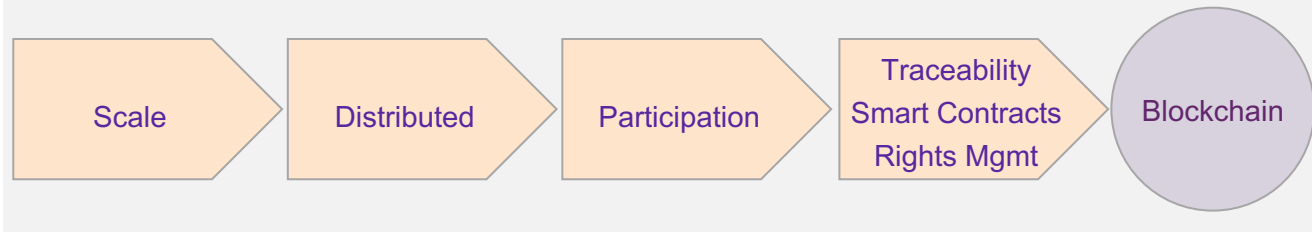 - Portfolio, cargo, traffic, etc.
- QML
- Cybersecurity
  - "Un-quantum"

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Cryptocurrency
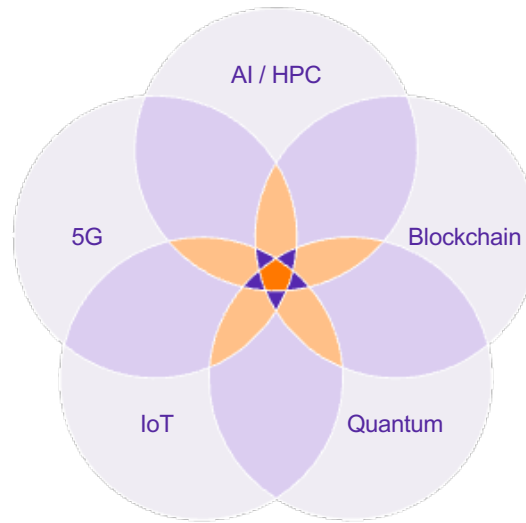
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Blockchain

How data is transacted

Trust is computable

| Scale | Distributed | Participation | Traceability Smart Contracts Rights Mgmt | Blockchain |

Scale-out, P2P, Elastic Apps	Dapps
Stored Procedures	Smart Contracts
TPM → Middleware / Messaging	Layer-2 Technologies: Off chain
ACID → CAP, REST, Idempotent	Consensus Algorithms: Proof of *, Graph
Database: SQL → NoSQL	Ledger: Transaction Blocks / Graph
Directory	Identity vs. Transparent Anonymity
	Exchange	Dexchange
Tokenless	Token: Equity, Utility
Permissioned / Private	Premissionless / Public
Centralized	Decentralized / Trustless

Monolithic → Mulit-tier → Scale-out → Elastic → Serverless → Decentralized
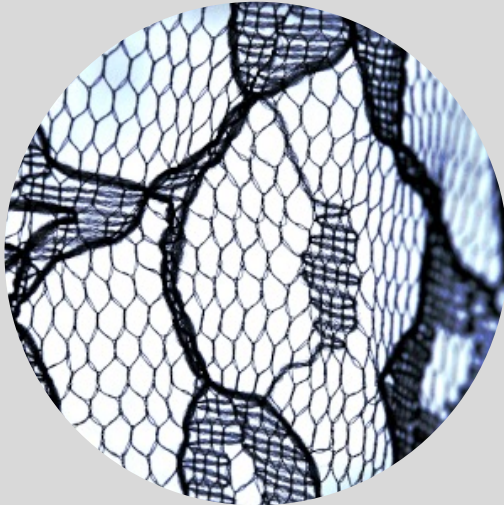
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Trust is expensive

The Future

Digital Transformation

Enterprise as a System

AI / HPC

5G

Blockchain

IoT

Quantum
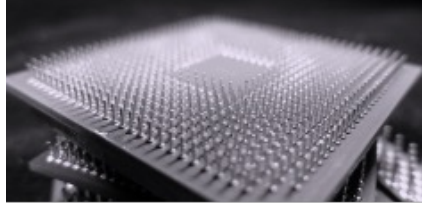
Computability – Data Economy

Opportunity and Threat

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IoT — Everything is smart.

5G — Everything is connected.

Blockchain — Trust is computable.

AI — Intelligence is computable.

Quantum — Everything is a probability.

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Revolutions

	Agricultural	Industrial	Information
Enabler			
Revolution	Agricultural	Industrial	Information
Focus	Land Livestock	Mechanization Oil	Digitization Data
Economy	Agricultural Economy Single Entry Accounting	Manufacturing Economy Mechanized Agriculture Double Entry Accounting	Data Economy Digital Manufacturing Digital Farming Triple Entry Accounting
Impact	Hunting → Farming Muscle Augmentation - planning Structure: Family Issues: Health, Governance	Rural → Cities Muscle Automation - action Structure: Company Issues: + Climate, Jobs, Money	Regional → Global Brain Automation - decision Structure: Community Issues: + Mistrust, Work

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What will it change?

War	→
Work	→
Money	→
Laws	→
Health	→
Art	→
Spirituality	→

Complexity

Need

Capability
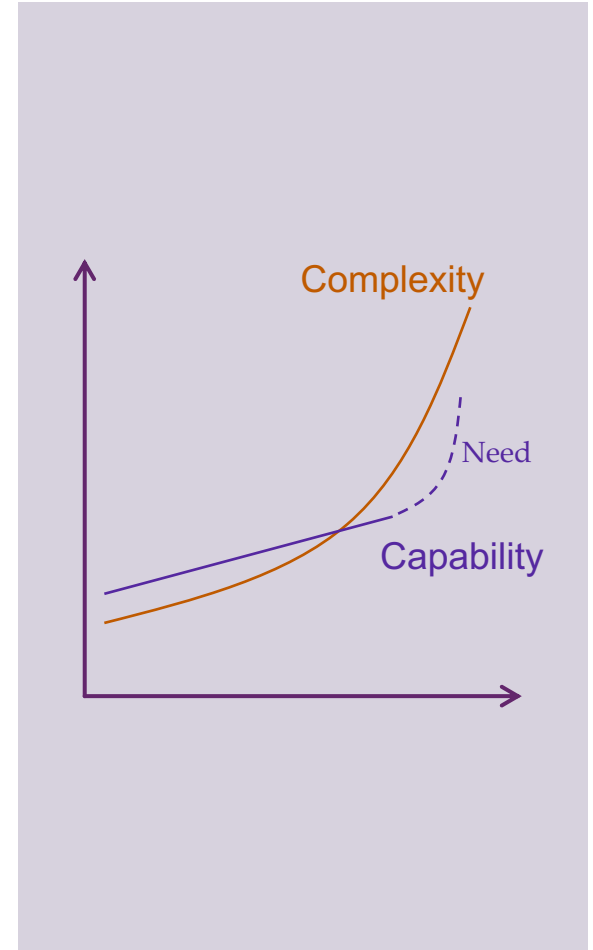
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Change is easiest when it's your own idea!

Celebrate | Reinvent

Appreciate | Recalibrate

Unexpected

Expected

Good Change | Bad Change
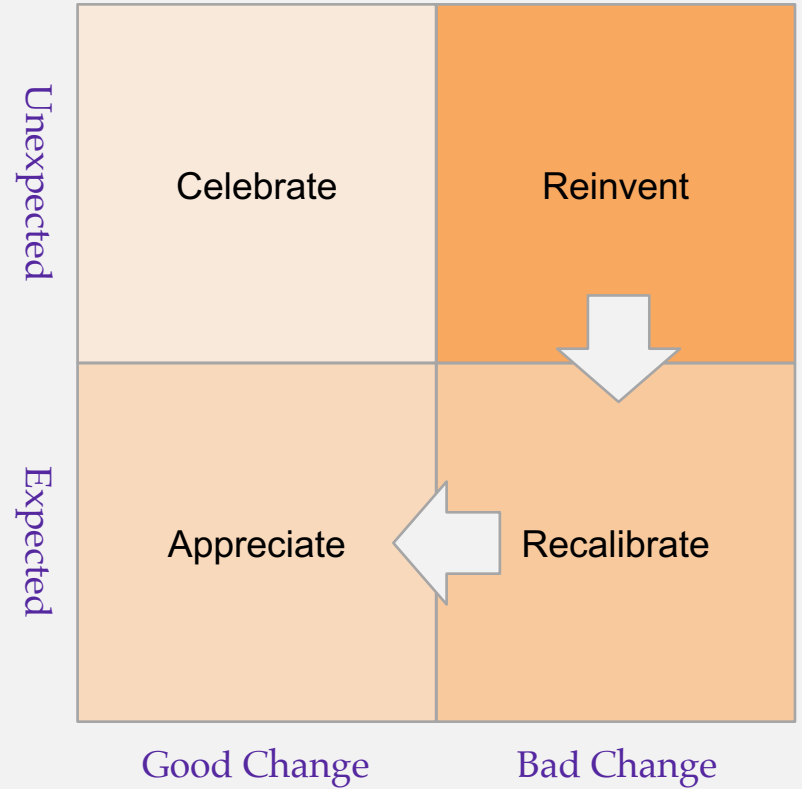
"The FUTURE is
IoT Blockchain Quantum AI
where Machines/Bots/DAOs/Dapps
do most of the Creating-Consuming-Paying"

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Thank you!

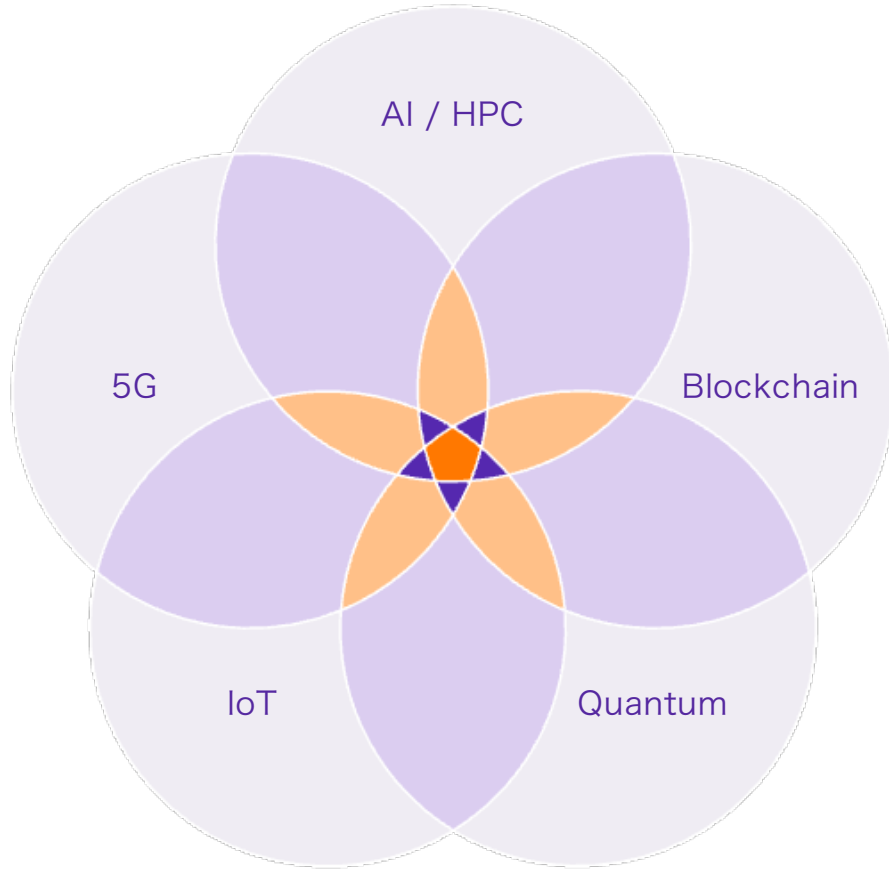Shahin.Khan@OrionX.net

April 2025

AI / HPC

5G

Blockchain

IoT

Quantum

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