VISION-2050:

a connected-intelligence society

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Fifth Visions for Future Communications Summi
Nov 26, 2025
Lisbon

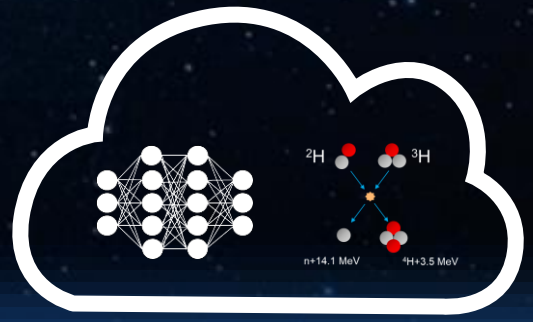
THE NEAR TERM

- The AI Internet

Wireless Network to Deliver Super-Intelligence

To Everyone and Anytime and Anywhere

THIS IS 6G



Neuron Agent (10B)

Neuron Edge (100B)

Neuron Center (100T)

Wireless Network as AI Data Supplier

The Physical World Model Generator

NEXT 10 YEARS

Internet Scale Physical World Twin Repertory

10^{21}

PAST 40 YEARS

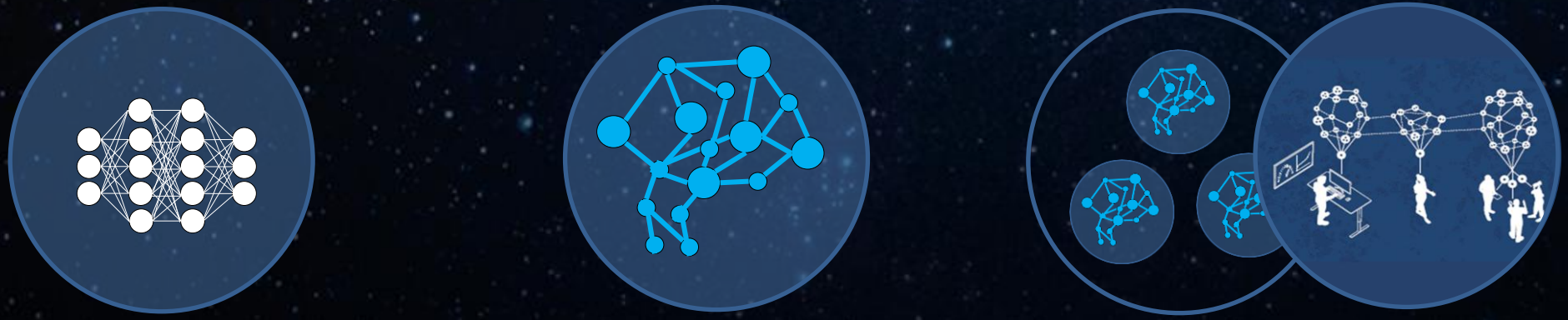
Internet Scale Natural Language Repertory

10^{12}

AI Agent as Wireless Internet “IP Packet”

The Total Diffusion of AI

AGENTS REPRESENT HUMAN TO REPLACE IP



2015-2022

(Building Blocks)
Machine Learning to Foundation Models

Now

(Scale-up)
Simple Assistants & Agents

Next

(Scale-out | internet-scale)
Ensemble (or Composition) of Agentic Apps

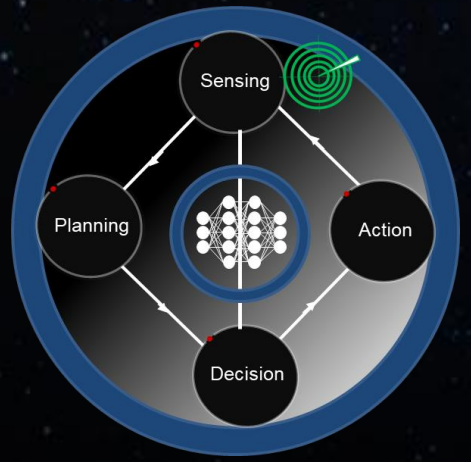
Agentic-AI and AI Agent

From Executor to Thinker

HUAWEI

SYSTEM-1

SYSTEM-2

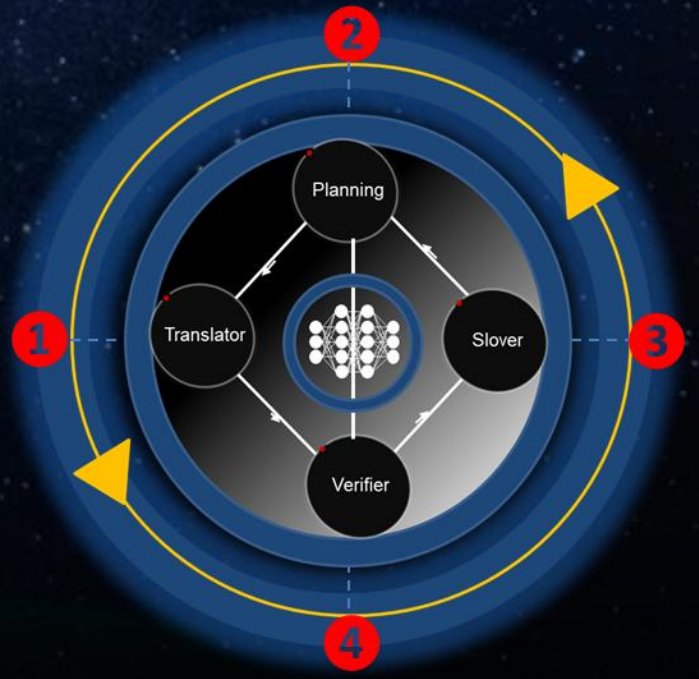


Agentic AI is a continuum

Level of Agent Capabilities

AI Assistants with not full capabilities of Agentic AI

Full capabilities of AI Agents

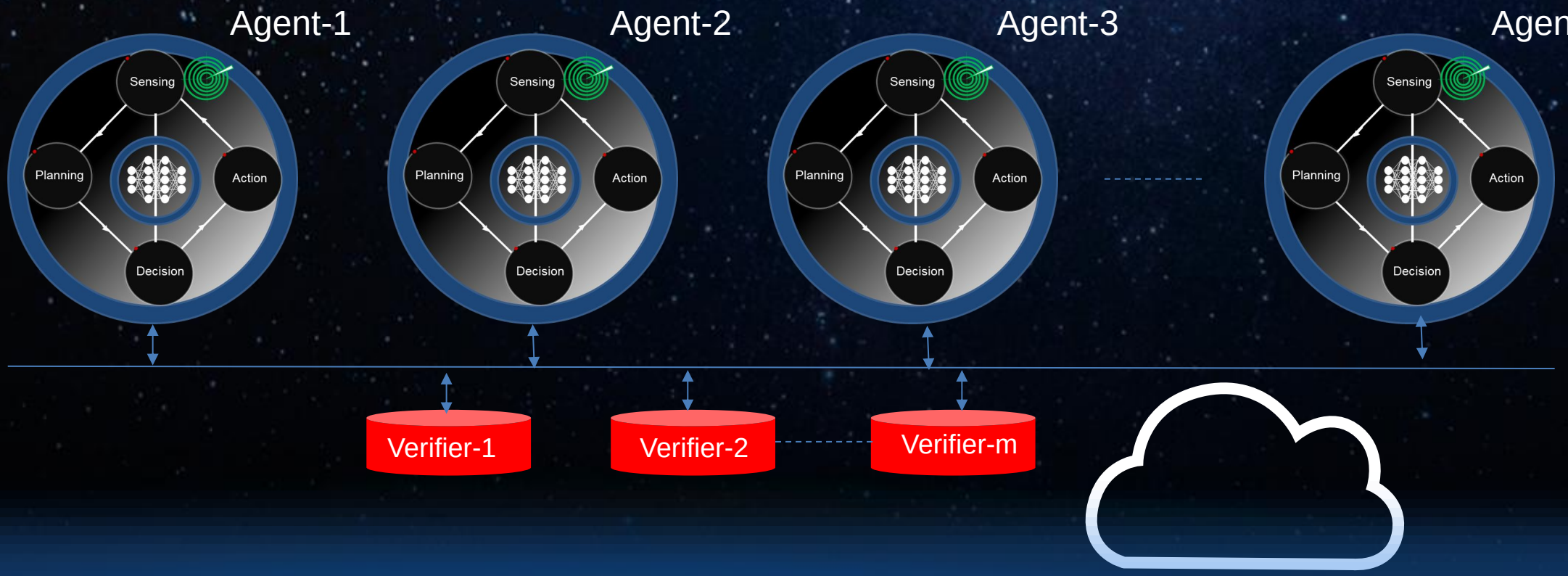


- Reactive
- Static

- Proactive
- Evolving
- Continuously Learning

The Security AI

Ensure AI and Networking Trustworthiness by Distributed Multi-Lateral Verification



Community ledger

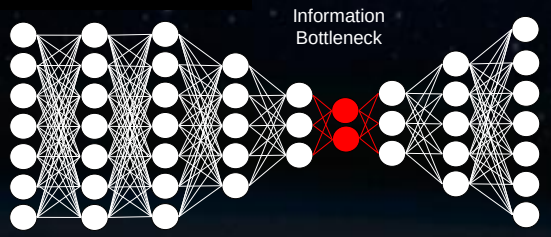
AI Communications Security

Protect Data Privacy and Data Sovereignty

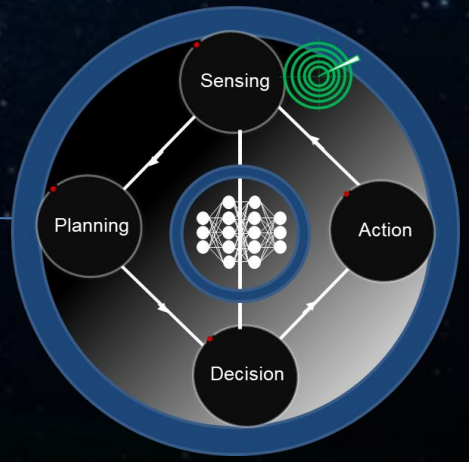
AI INTERNET TRANSMITS INTELIGENCE NOT DATA

① Token Level

② Model Level



③ Agent Level



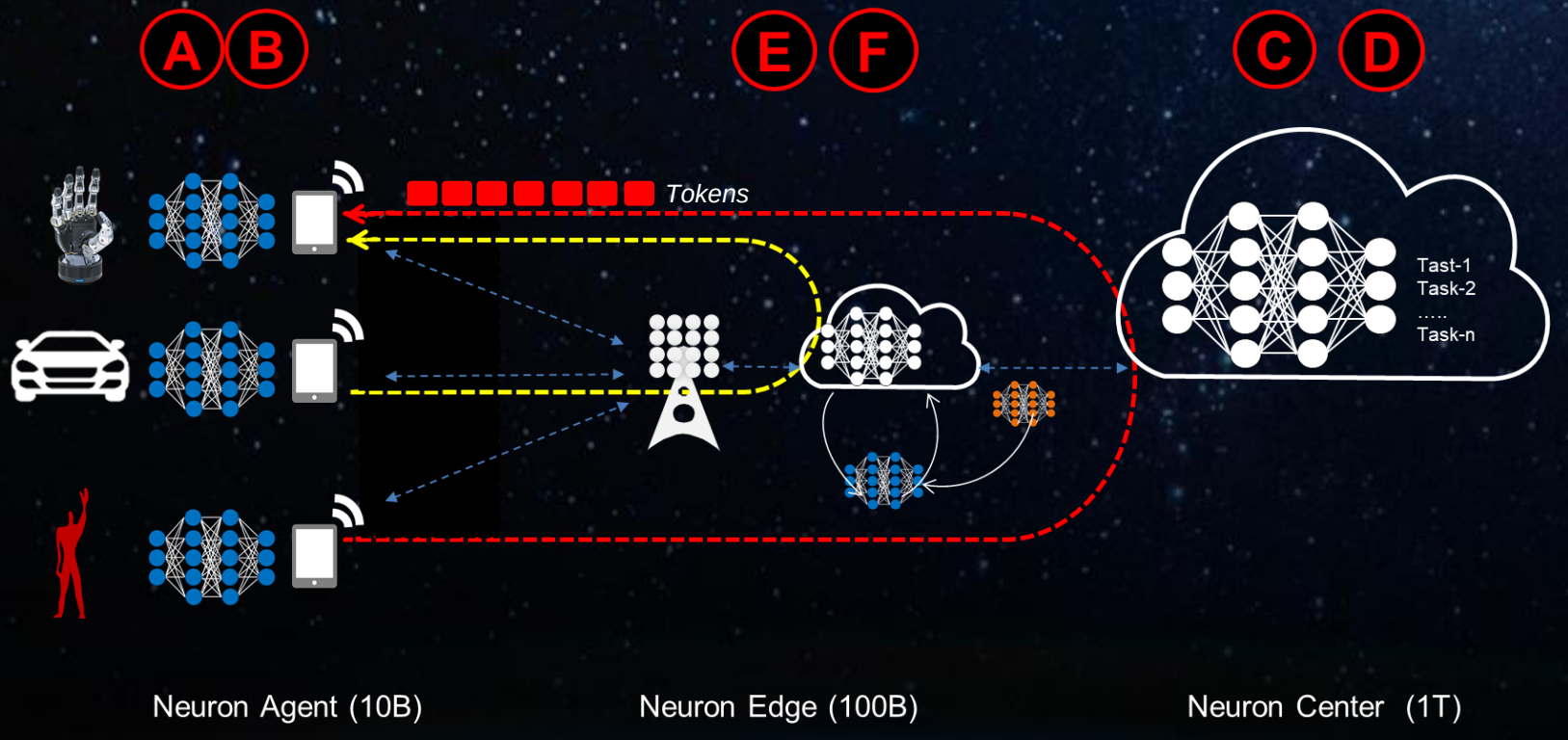
Privacy

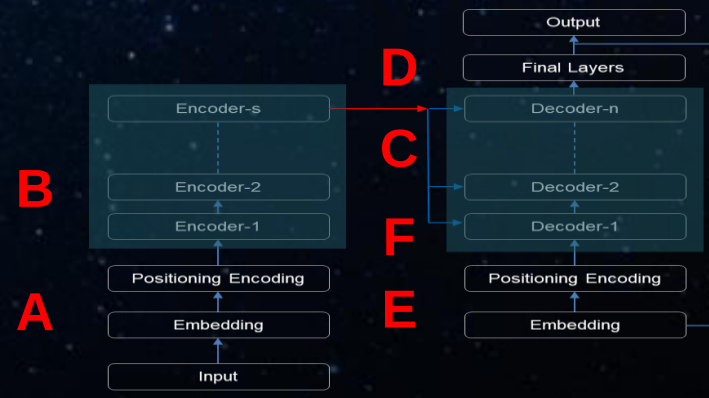
Computational Irreversibility to retrieve training data set or inferencing input

Security

AI Token Communications

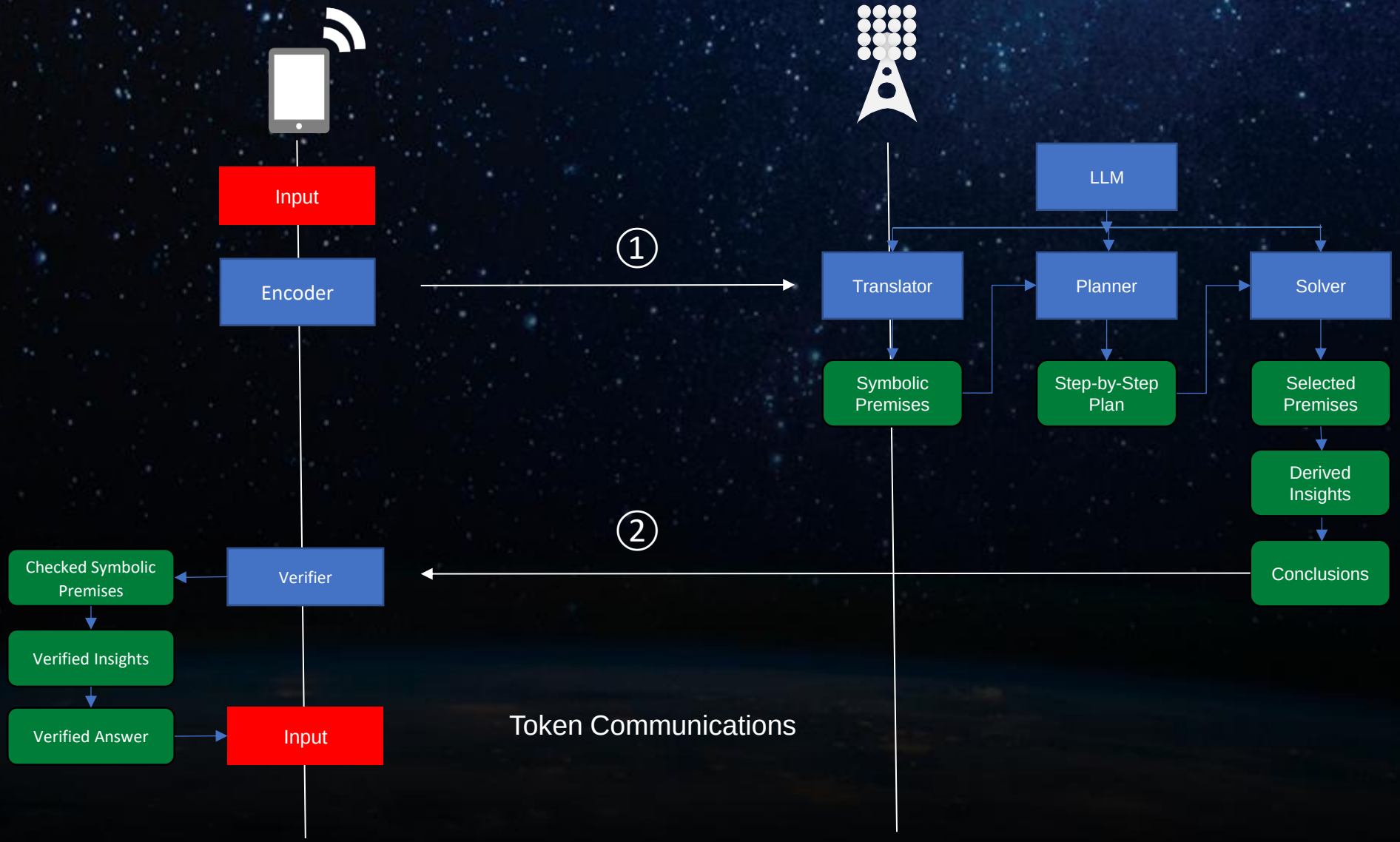
Reliable low Latency Streaming and Always-on Connectivity for AI





The User Centric Agent Trustworthiness

Use Tools, Memory and Self-Reasoning



AI Internet Bulling Blocks：From MCP, A2A, AGNTCY to NANDA

The Global Internet-Scale Prompting

"billions of AI agents discover each other, verify capabilities, and coordinate tasks"

Component

Foundations of Agentic Web

- Index Infrastructure: Cross-Platform and tools for easy agent deployment
- Interoperability: Standards for agents to work across different platforms
- Communication: Protocol bridges between A2A, MCP, HTTPS
- Agent Onboarding: SDKs

Coordinated

Society of Agents

- Large Population Models (LPMs)
- Collaborative Learning
- Cross-Silo Coordination
- Distributed AI

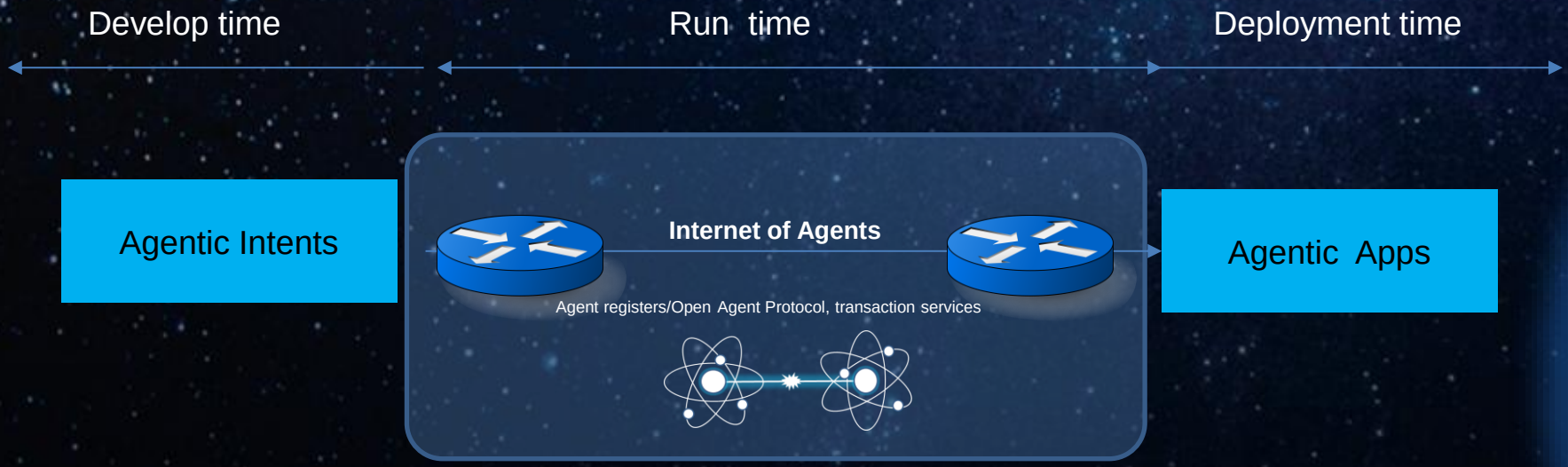
Collective

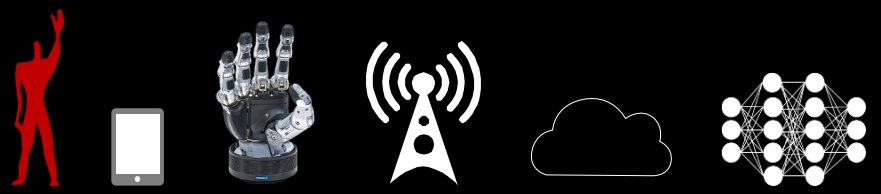
Agentic Commerce

- Knowledge Pricing
- Edge AI Integration
- Economic Protocols
- Resource Markets

Stage-1 Stage-2 Stage-3

Summary: AI Internet Concept





RESOURCES

Research Agenda:

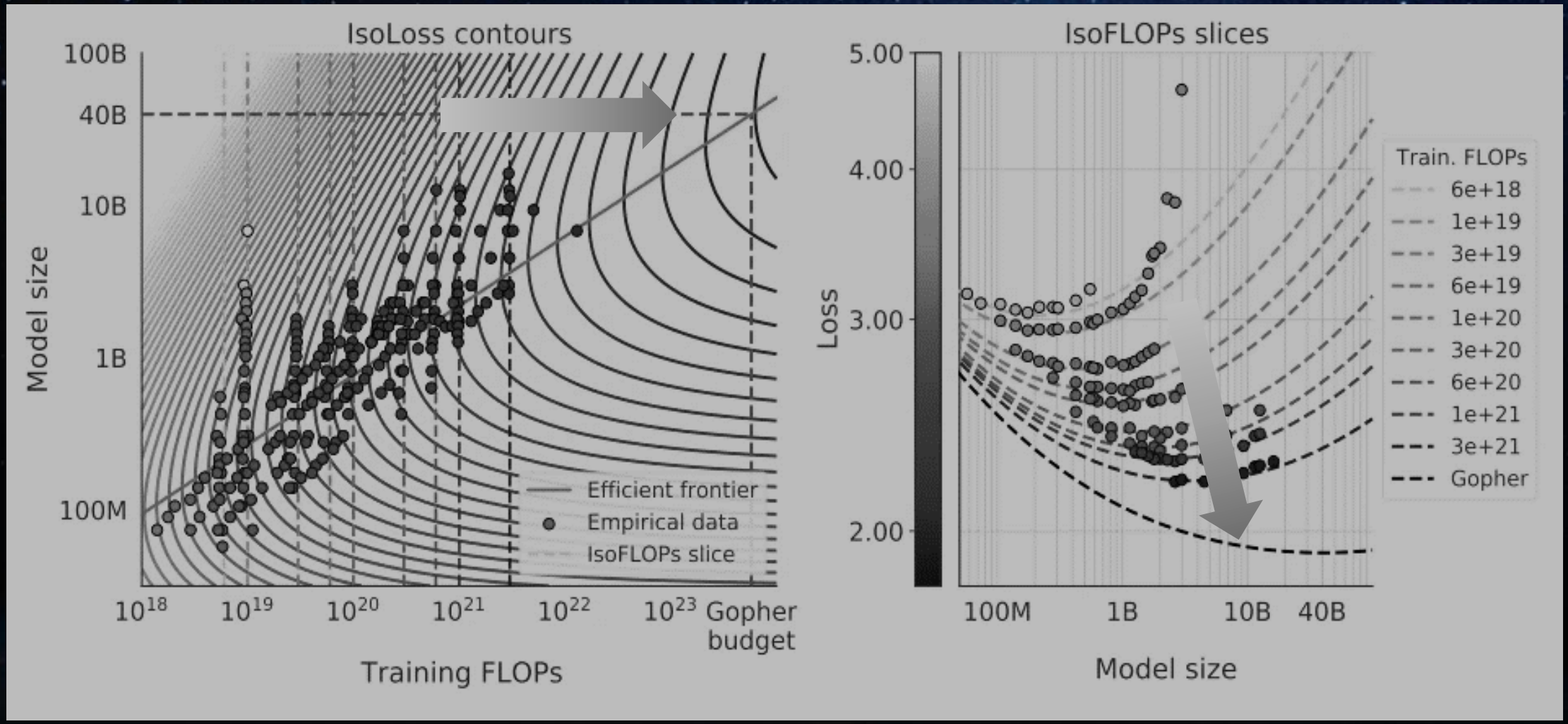
1. Intent driven networks and networking workflow generation with Agentic-AI
2. Natural language based network interface with AI services and applications
3. A2A protocol as AI internet networking fabric and routing protocol
4. Wireless access network optimization for Internet-wide:
   - Token Transmission
   - Model Transfer
   - Distributed Inference
   - Distributed Training
5. Data and model discovery and publishing, with internet-wide prompting
6. Multi-lateral distributed trust and verification guardrail

THE MID TERM

- The Scaling Law for Computing Technology
- The Scaling-Law for Mobile Communications

The Scaling Law of Computing Technology

More intelligence "for free" by Scaling



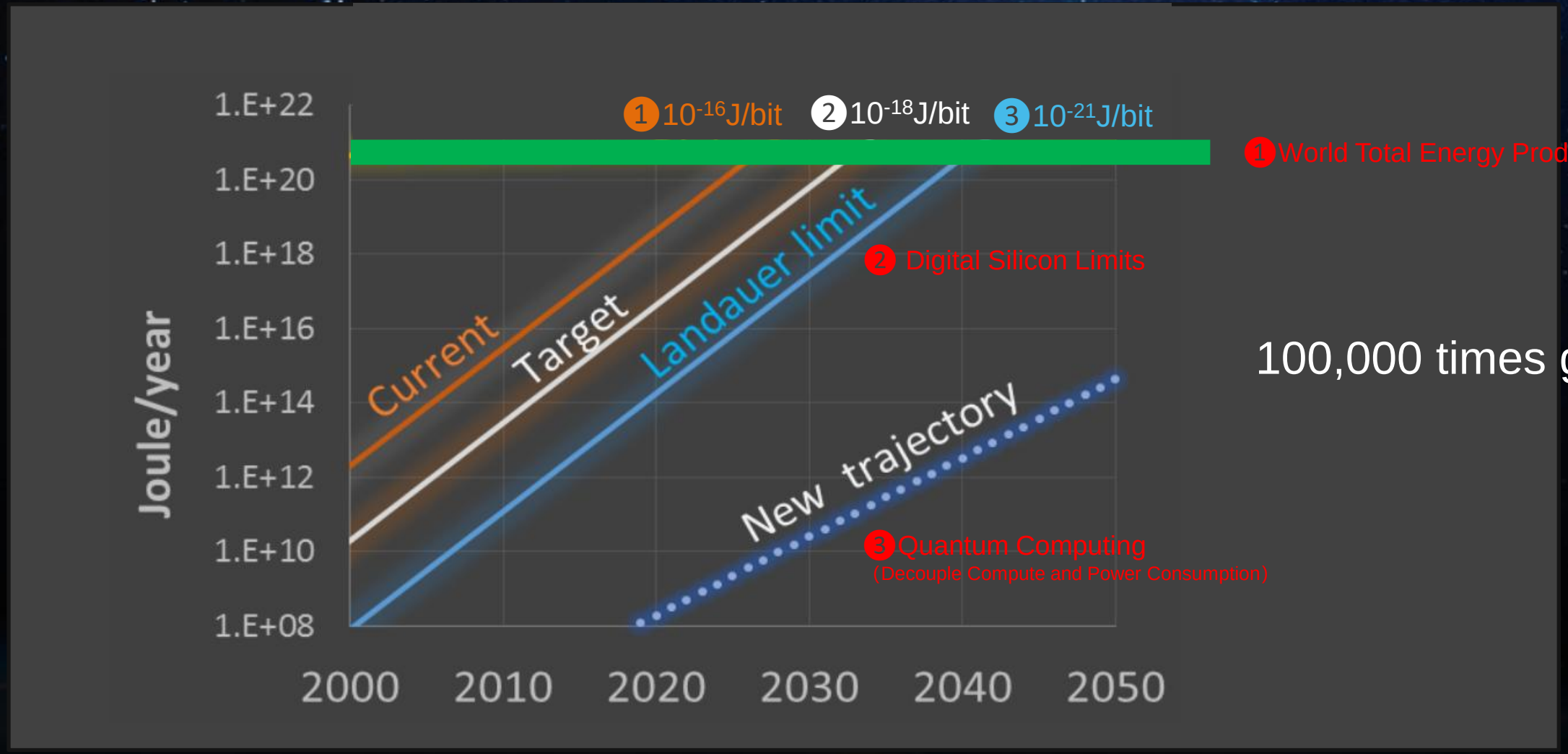
The Scaling of Silicon

Sustainability Crisis

A 5TB MODEL REQUIRES ZETA FLOPS TRAINING COMPUTING

Landauer limit for digital computing

Landauer Limit: the minimum power consumption to alter one bit at room temperature



100,000 times gap

1 Brain-Inspired Dynamics Computing

AI Circuits for Energy-Efficient Scaling approaching Human Brain (100TB)

NEXT ONE MILLION TIMES IMPROVEMENT

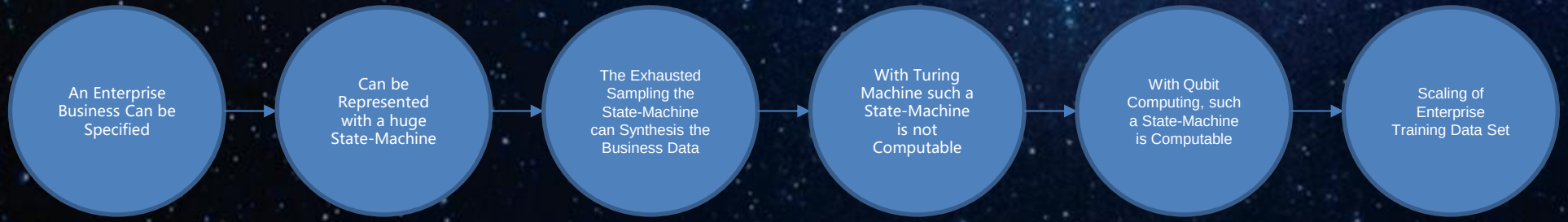
- Human Brian-like new computing architecture, which is
  - 1 million times efficient than the transformer based LLM model and,
  - 100 million times efficiency compared to the world model

- Biological learning and decision making mechanism
  - Multi-scale spatiotemporal processing with heterogeny cell structure
  - Dynamical heterogeneous efficiency mechanism
  - Neuroethologies study with small, median and large scale characteristics

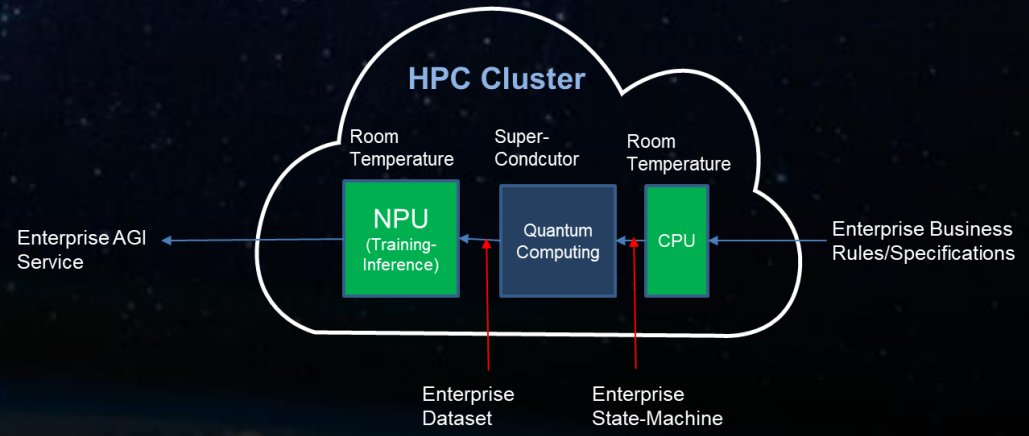
- Create new brain-inspired algorithms, circuits, network
  - Create new learning and inferencing function and architecture
  - Memristor for Spike Neural Networks
    - Low power (<1/1000th of GPU),
    - High density (~10^{12} per cm^2),
    - Compute analogy neuro algorithm

2 Quantum Computing for LLM Training

***S**uper Exponential fast Qubit Computing to remove the dataset bottleneck*

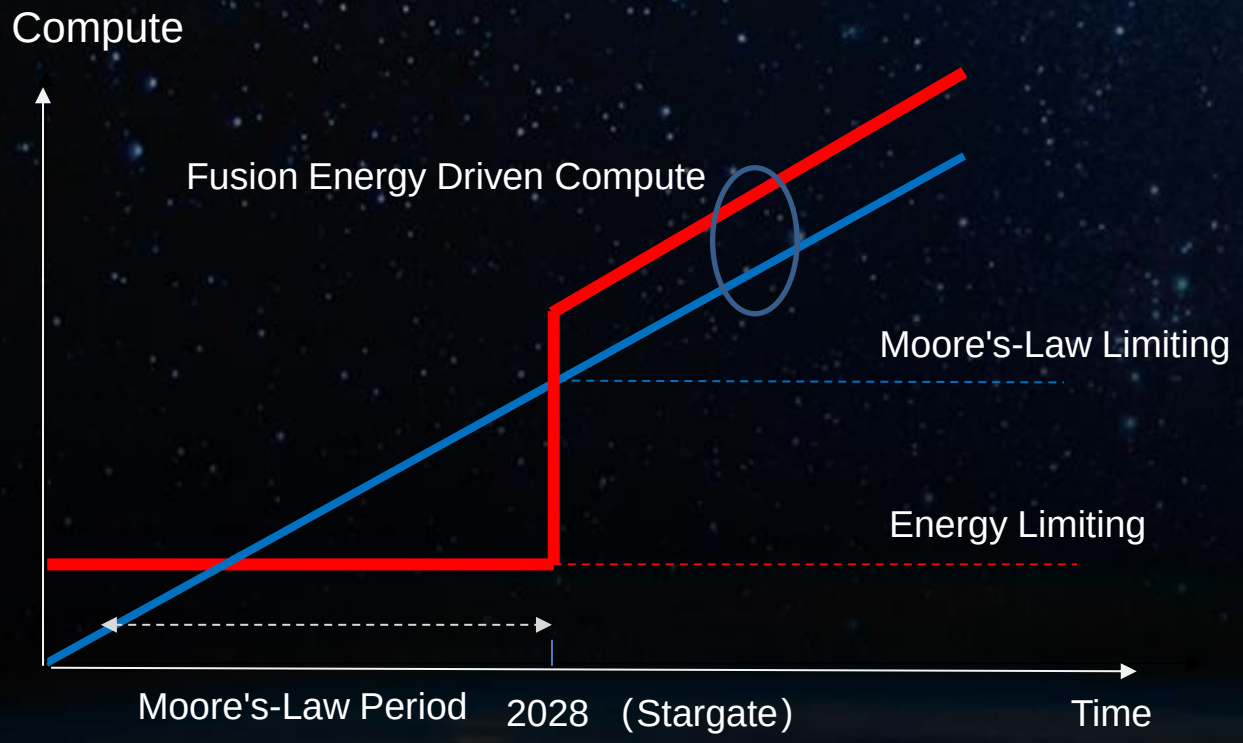


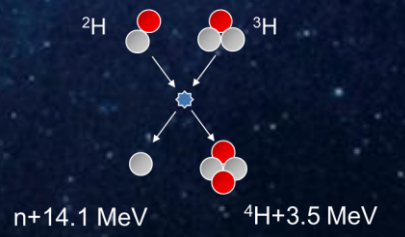
1. Dataset Scaling
   - Synthetic Dataset
   - Dataset Wheel
2. For AGI
   - Enterprise Dataset
3. For SAI
   - Larger Dataset and Larger Model
4. For Physical-AI
   - Physical World Simulation Dataset

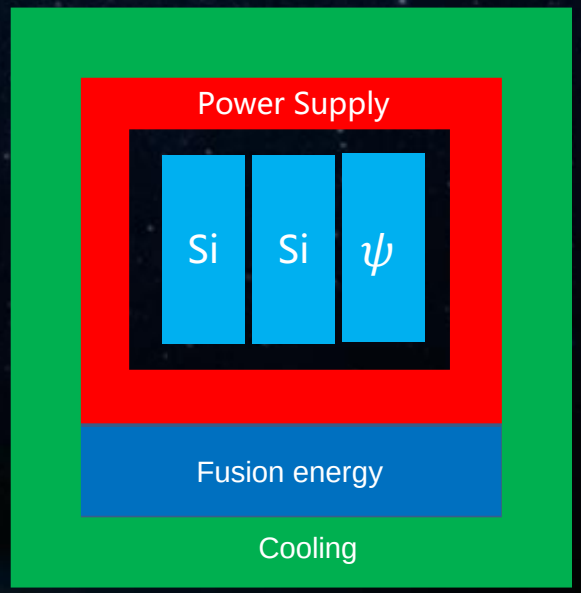


Power Scaling for Computing

Moore's-Law Stops around 2035, the Scaling of Computing requires Power Scaling







Compute Cube Concept
(indoor)

Dyson Sphere Power for Space DataCenter

To Resolve 3 Bottlenecks for Distributed Training: ❶Power Consumption ❷Cooling ❸Communications

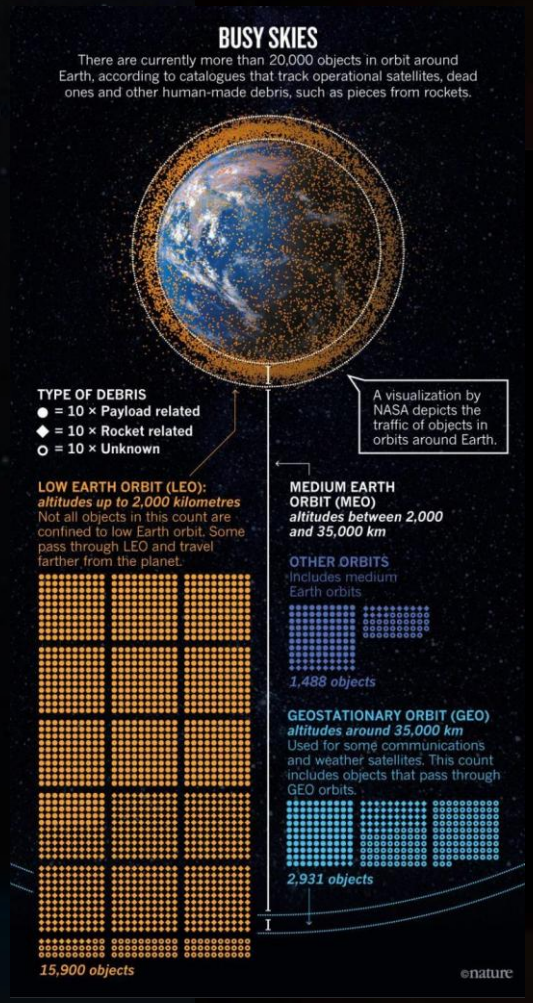
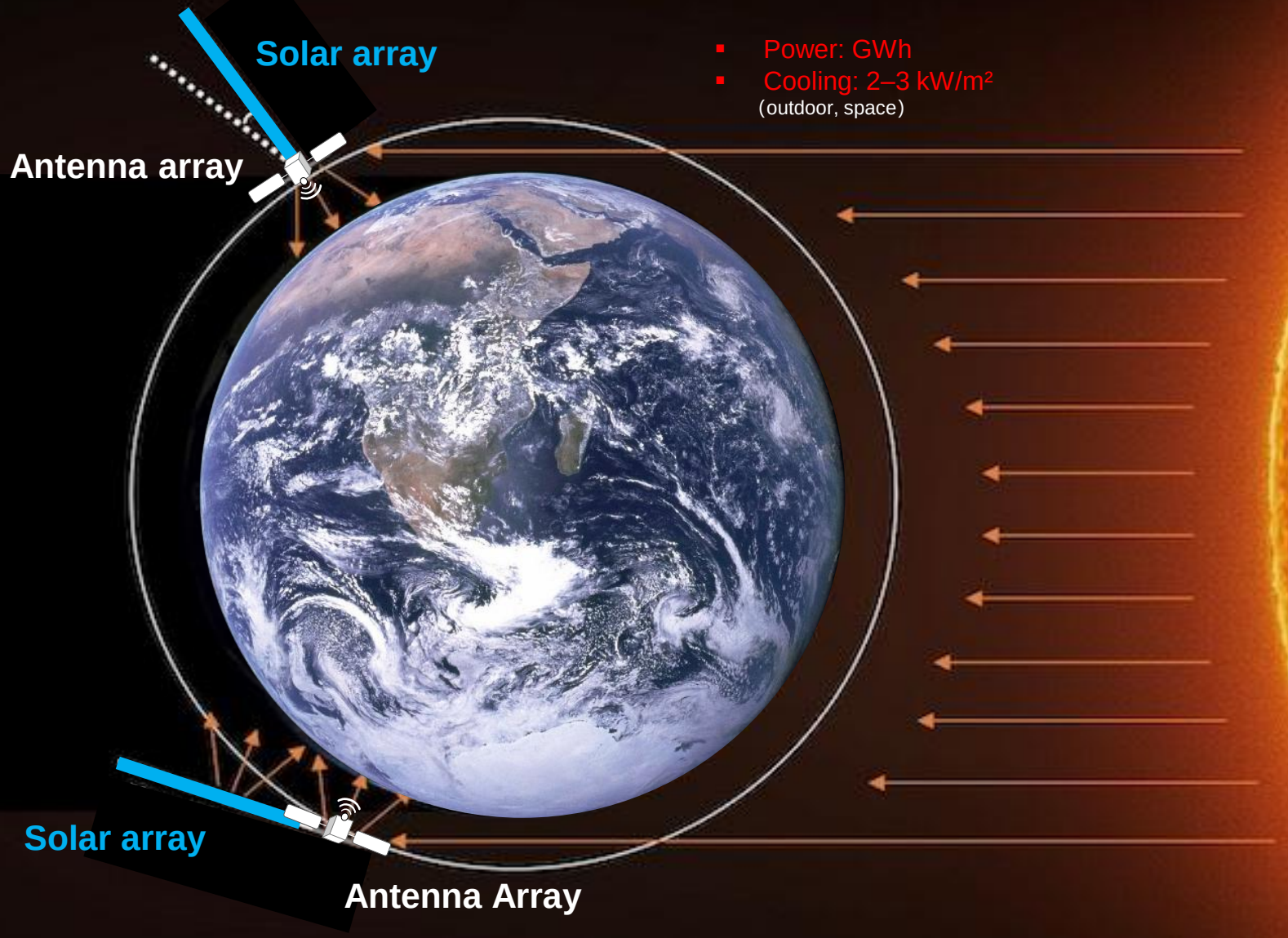


Image: NASA Goddard Space Flight Center/JSC



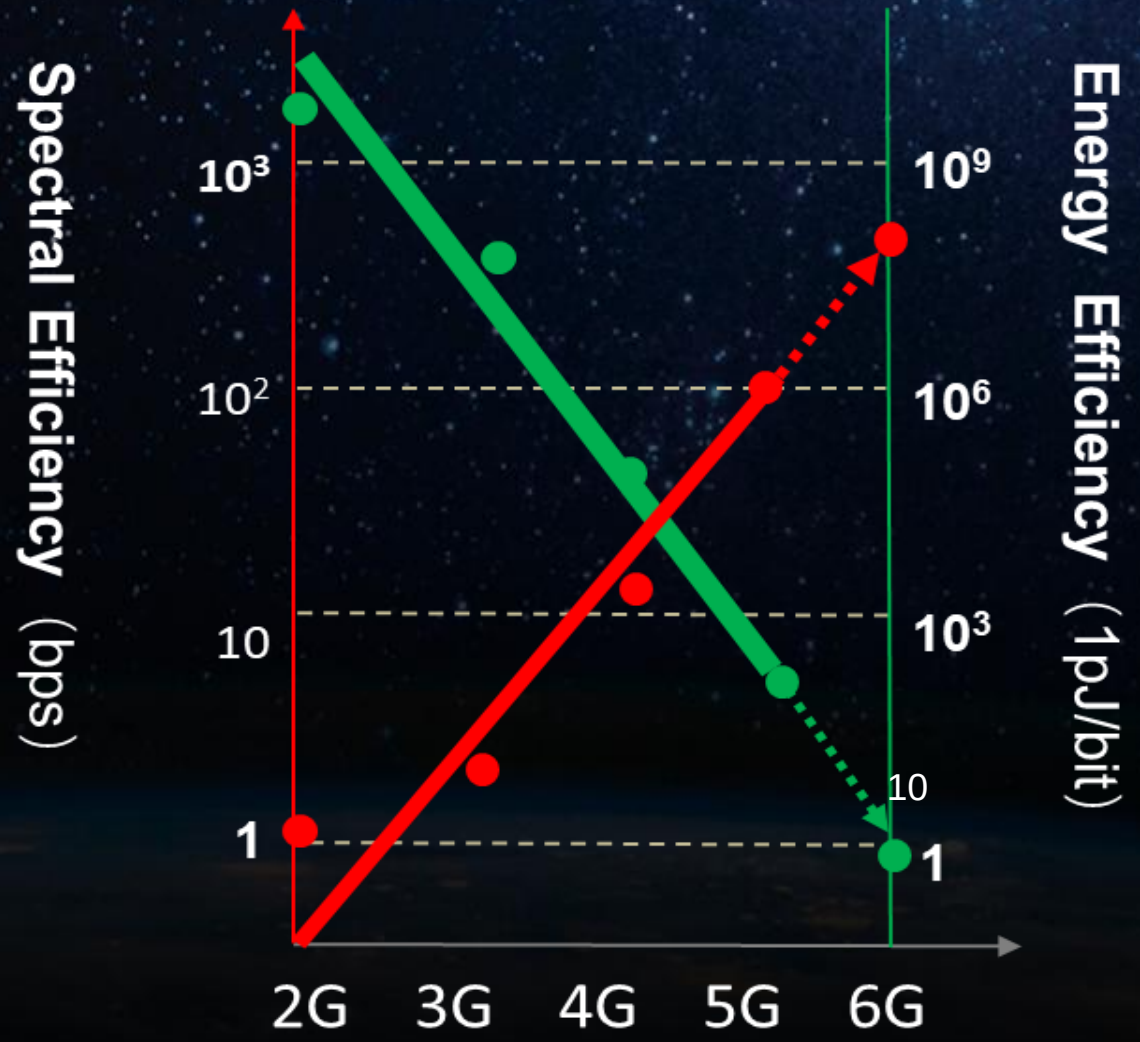
- Power: GWh
- Cooling: 2–3 kW/m² (outdoor, space)

THE MID TERM

- The Scaling Law for Computing Technology
- The Scaling-Law for Mobile Communications

The Scaling-Law for Mobile Communications

The Sustainability Challenge



cmWave Tera-MIMO for 6G

Evolution of MIMO Technology for 30 Years

4G

MIMO-1.0

400MHz – 2GHz

Classical MIMO

- Single transmit antenna
- Transmit diversity
- Open loop spatial multiplexing with cyclic delay diversity (CDD)
- Closed loop spatial multiplexing 2
- Multi-user MIMO
- Closed loop spatial multiplexing using a single transmission layer
- Beamforming
- Dual-layer beamforming
- 8 layer transmission

5G

MIMO-2.0

2.6GHz – 5GHz

Massive MIMO

- Spatial division to further scale MIMO
- SVD based MIMO pre-coding
- More accurate UE MIMO modes feedback
- Uplink limited with # of UE streams

6G

MIMO-3.0

6GHz – 15GHz

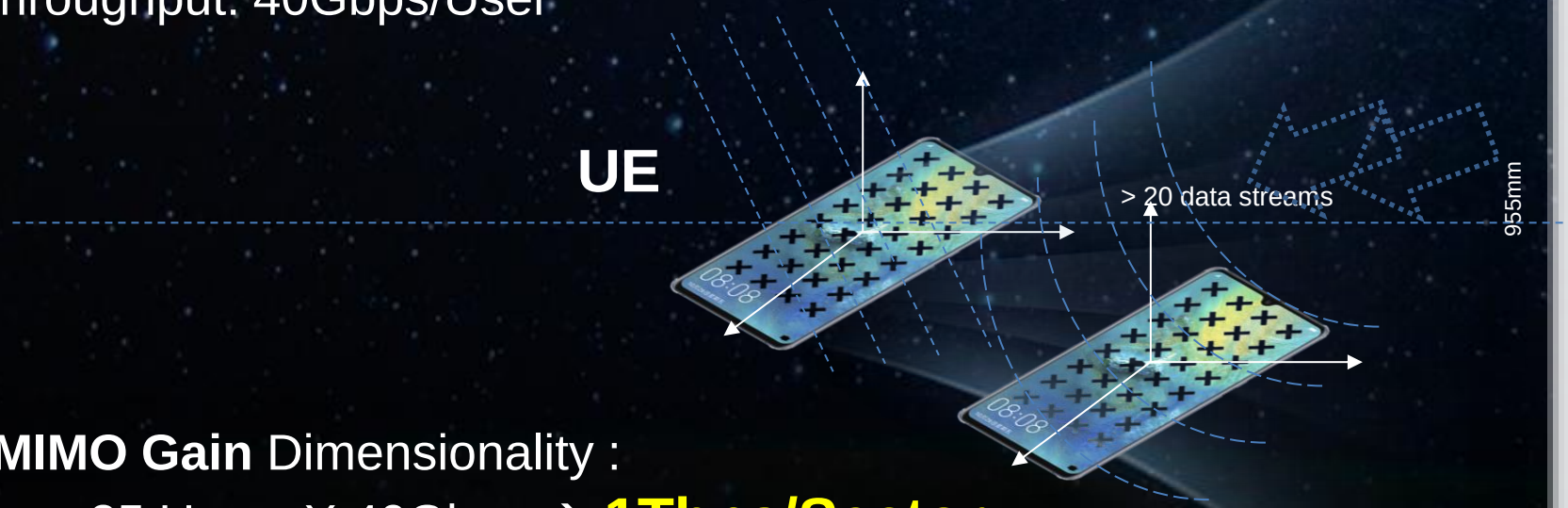
cmWave MIMO

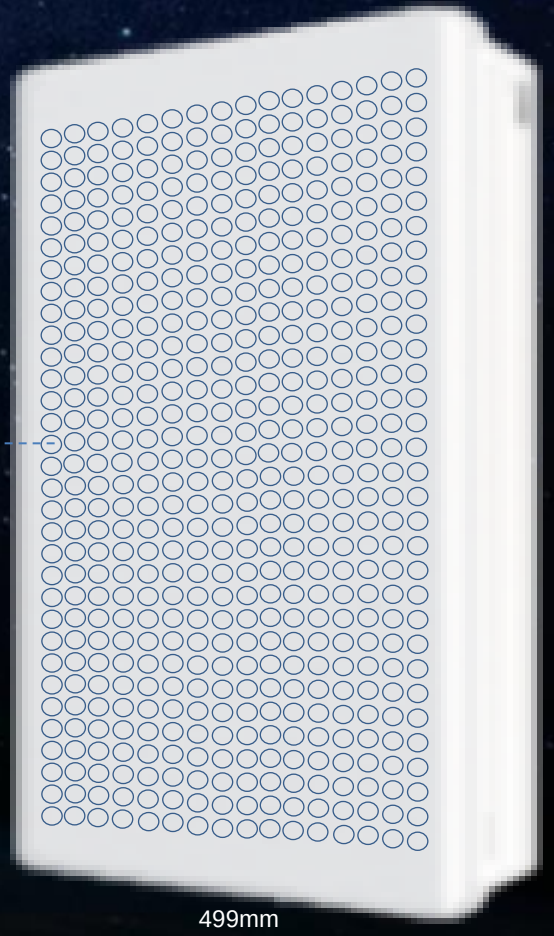
- Rich Scattering and multi-bounce
- Rician channel hardening effect
- Environment object centric
- New algorithm

cmWave UE Massive-MIMO (7GHz~15GHz)

cmWave MIMO System (7GHz~15GHz)

- Frequency: 10GHz
- Bandwidth: 0.4GHz
- Modulation 64QAM (R=5/6)
- MIMO: 20 Streams
- Throughput: 40Gbps/User





1. **MIMO Gain** Dimensionality :
   - 25 Users X 40Gbps → **1Tbps/Sector**
2. **Array Gain** Dimensionality
   - 1024-500=524→ $20*\log_{10}(525)=27.2$dB
   - To overcome additional pathloss
   -

cmWave-MIMO UE Antenna Architecture

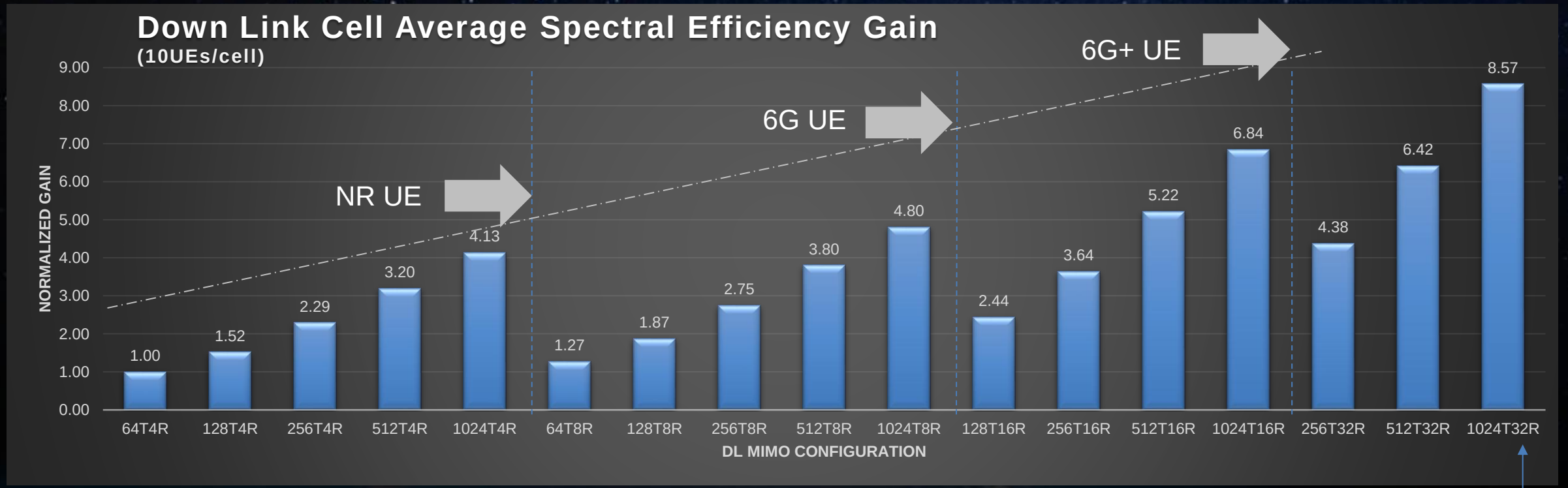
1. **Main Band Antenna A Tx/Rx**
   - CDMA/EVDO BC0/1T1R
   - GSM/GPRS/EDGE/850/2900 Tx/Rx
   - UMTS B2/4/5 Tx/Rx
   - LTE B2/4/512/13//14/25/66/Tx/Rx
   - LTE B30 Tx/Rx
   - LTE B29 Rx only
2. **Main Band Antenna B Tx/Rx**
   - LTEB7/30/38/41/48 TxRx
3. **Sub Antenna C Rx**
   - LTEB30 Rx Only DL 4x4MIMO
4. **Sub Antenna D Rx**
   - LTEB2/44/66 Rx Only (4x4 DL MIMO)
5. **Sub Antenna E Rx**
   - CDMA/EVDO/ BC0 Rx Only
   - GSM/GPRS/EDGE 850 Rx Only
   - UMTS B5 Rx Only
   - LTE B1/12/13/14/26/29 Rx Only
6. **Sub Antenna F Rx**
   - CDMA/EVDO/ BC1 Rx Only
   - GSM/GPRS/EDGE 1900 Rx Only
   - UMTS B2/4 Rx Only
   - LTE B2/4/7/30/38/41/66 Rx Only (4x4 DL MIMO)
   - GPS Rx Only
7. **Sub Antenna G Rx**
   1. LTE B2/20/30/66 Rx Only (4x4 DL MIMO)
8. **Sub Antenna H Rx**
   1. LTE B48 Rx Only
9. **WiFi Antenna #1**
   - 2.4/5GHz WiFi Ant.-#1 TxRx
   - LTE B46 Rx
   - BT/Atenna + Tx/Rx
10. **WiFi Antenna #2**
    - WiFi Antenna 2 (2.4/5GHz) TxRx
    - LTEB48 Rx
11. **Antenna J**
    - NR n261
12. **Antenna K**
    - NR n261
13. **Antenna L**
    - NRn261

NR UE

cmWave UE

The Capacity Scaling Law for cmWave MIMO

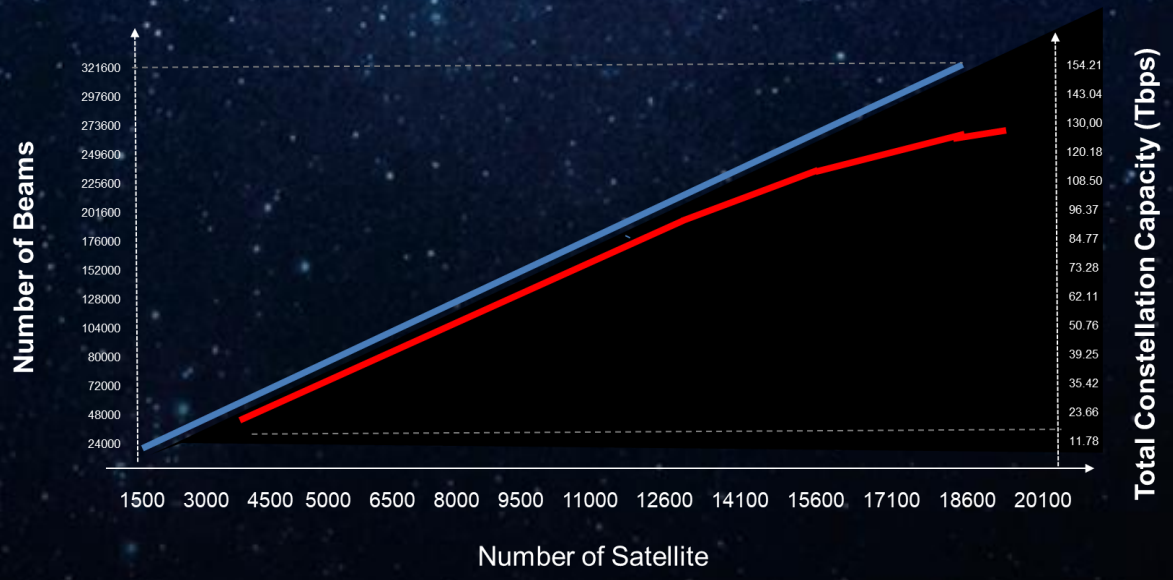
cmWave MIMO can deliver spectrum efficiency for 2030-2040



The Capacity Scaling Law for Satellite Communications

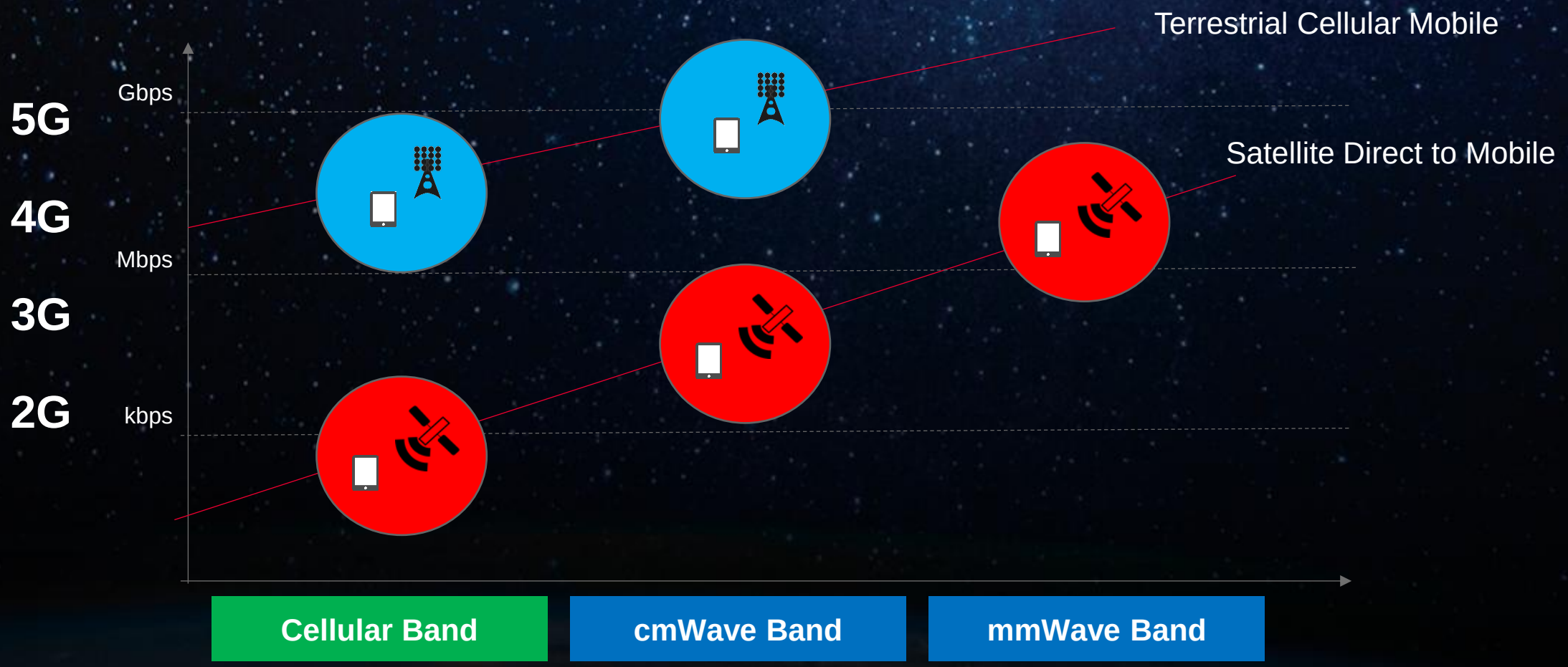
The Mega LEOS Constellation can Deliver NTN Capacity for 2030-2040

- The satellite capacity for 250km-1000km LEO is from several hundred thousands to 1 millions
- To minimize the interference, the satellite capacity for S-band 14 thousands, 70 thousands for Ka band



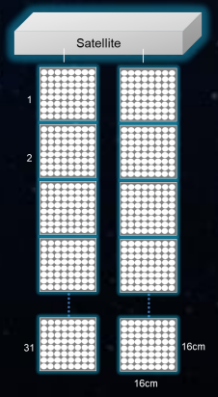
Frequency	Beamwidth (°)	Hight (km)	Satellite (#)	Throughput per Beam (Mbps)	Beam Throughput Density (Mbps/km²)	Average Throughput Density (Mbps/km²)
Ka	0.94	250-600	72794	404.50	6.43-37.01	1.29-7.47
Ku	1.04	250-600	59478	404.50	5.25-30.24	0.79-4.55
C	1.48	250-600	29368	80.90	0.52-2.99	0.09-0.52
S	2.08	250-600	14865	18.96	0.06-0.35	0.01-0.04

Comparison of Terrestrial and Non-Territorial Access



Summary

To-C Market

	cmWave **MIMO**	**mmWave** Terrestrial Massive Beams	**mmWave** Satellite Massive Beams
			
			
Market size	10^7	10^6	10^4

THE LONG TERM

- The Molecular Communications

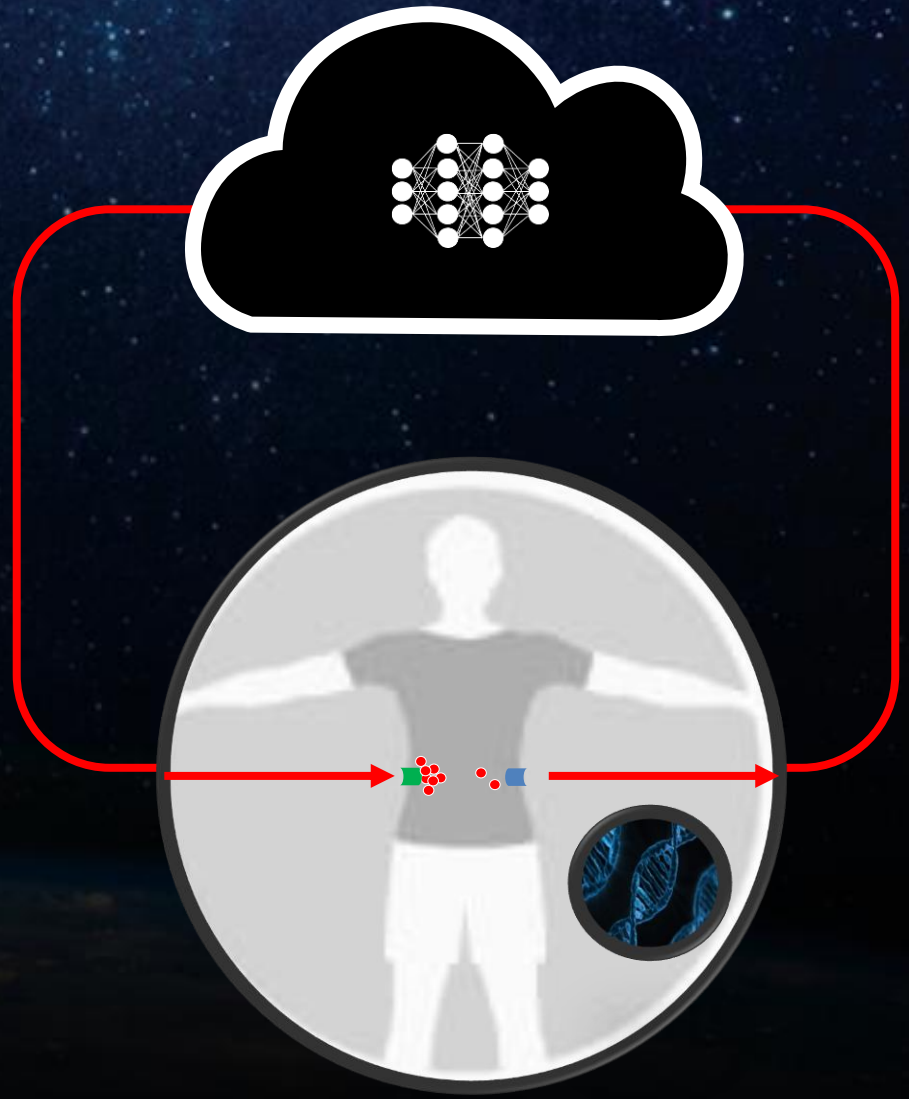
Molecules as Carriers Transmit for Point A to Point B

Biology Communications and Actuation with AI

- Non EM communications
- Molecules properties
- Exchange molecules
- Nano scale

Transmitter Channel Receiver

- Health monitoring
- Targeted drag delivery



Summary

1. Capacity Scaling Law for Wireless Networks works for 2050 (NTN as well)
2. Digital Computing Scaling becomes Power Scaling
3. Brian-Inspired Computing yet to develop
4. In addition to IoT, The Molecular Communications is new area worth study

Thank You.