GX Infrastructure with Digital x Energy for Carbon Neutral

AS IS → TO BE

{Physical first → Copy first(Digital Twin) → Code/Cyber first}

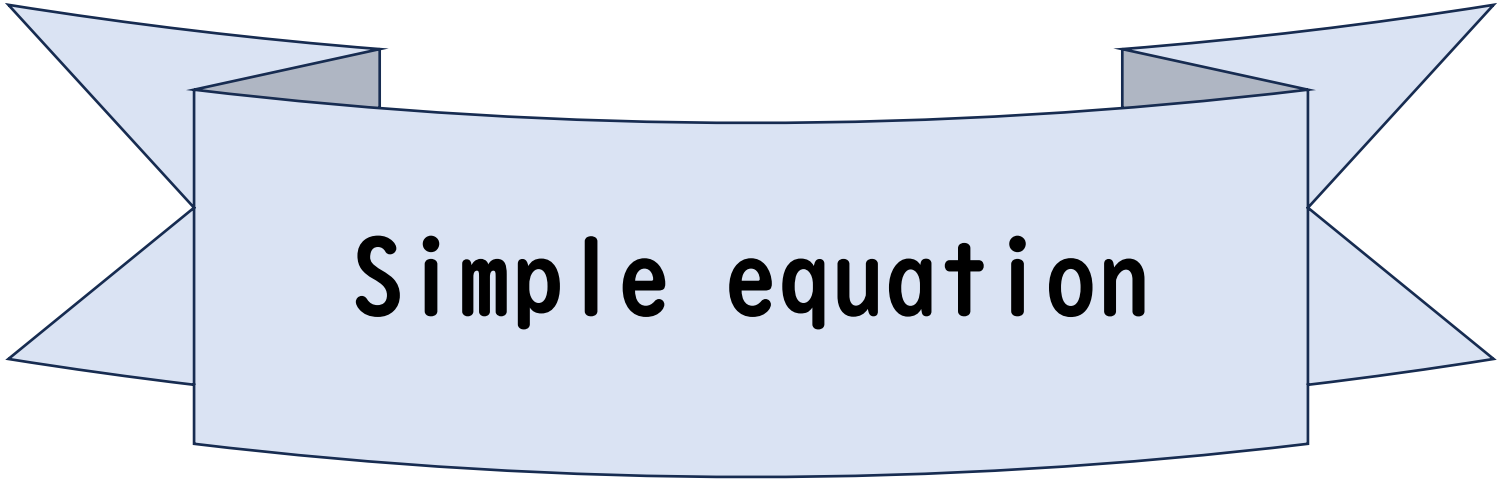
Hiroshi Esaki, Ph.D.,

Professor, The University of Tokyo

Director, WIDE Project

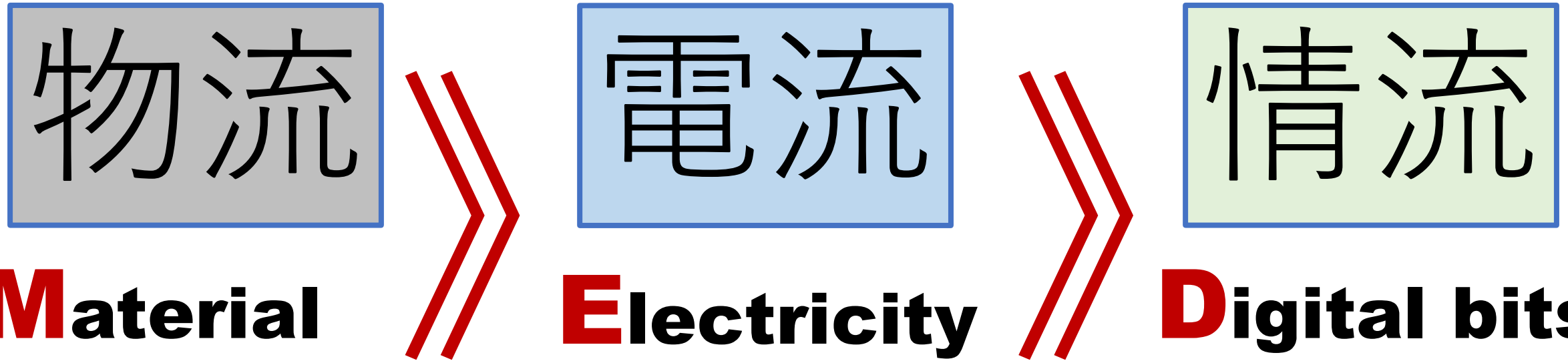
Vice President, Japan Data Center Council (JDCC)

Director, Green Univ. of Tokyo (GUTP).



Watt・Bit and Shell(Molecule)

Energy to build, operate and to maintain



x0000 : x00 : 1

Energy to build, operate and to maintain

Embodied Carbon

Operational Carbon

物流 》 電流 》 情流

Material **E**lectricity **D**igital bits

(**M**olecule) (**P**ower/**W**att) (**D**igital **F**unction)

x0000 : x00 : 1

		mass(g)	Normalized by electron
Phy. Material	Proton/Neutron	1.673×10^{-24}	1,840 ($=1.8 \times 10^{-3}$)
Power grid	Electron	9.109×10^{-28}	1
Bit(Telecom)	Photon	$0 < m < 2 \times 10^{-51}$	$> 2.198 \times 10^{-24}$

	(Km/h)	(m/sec)	Normalized by material
Physical matetrial	**36**	**10**	**1**
Electric currency	3×10^{5}	3×10^{8}	30 million
(electron)	0.0075 mm/sec	7.5×10^{-5}	1/7.5M
Radio wave(in air)	3×10^{5}	3×10^{8}	30 million
(in fiber glass)	2×10^{5}	2×10^{8}	20 million

Phy. Material

Power grid

Bit(Telecom)

Physical material
is extremely heavy…
☞
①extremely slow ☹
②extremely expensive ☹

			Normalized by material
Physical matetrial	**36**	**10**	**1**
Electric currency	$3x10^5$	$3x10^8$	30 million
(electron)	0.0075 mm/sec	$7.5x10^{-5}$	1/7.5M
Radio wave(in air)	$3x10^5$	$3x10^8$	30 million
(in fiber glass)	$2x10^5$	$2x10^8$	20 million

【Revolution of Infrastructure】

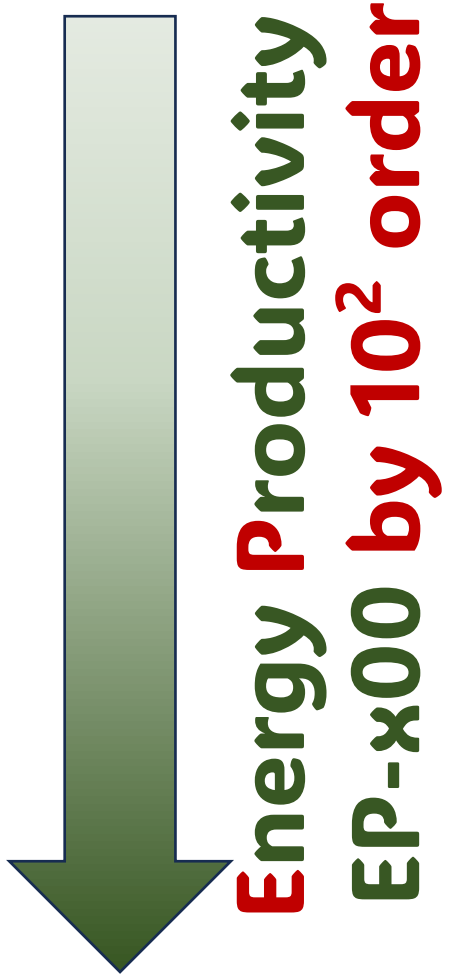
① Molecule flow (by Container)

👇

② Energy flow (by Electron)
(Watt)

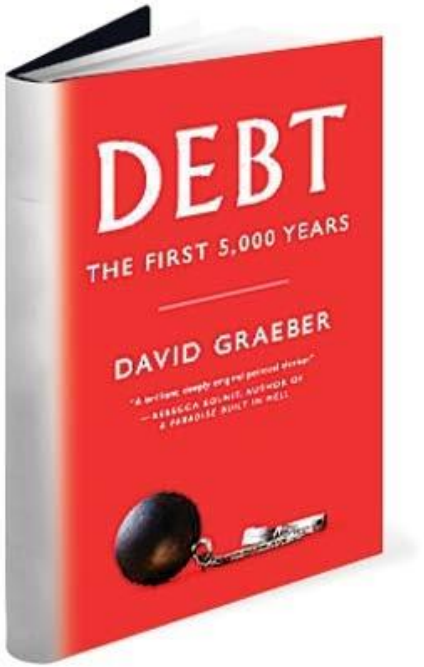
👇

③Information flow (by Photon)
(Bits)



History of debt(money):

Ledger ➔ Currency ➔ Digital Cash



1. Molecule transport (no alternative)
2. Valuable alternative molecule (e.g., gold/silver cash)
3. Trustable paper/coin

Analogue world

4. Trustable bits
   - 4-1. Batch & Off-line bits tra
   - 4-2. Realtime On-line bits tra

Digital world

Innovation in Logistics

2020s =Cyber-First Sharing Economy

19th century = exclusive separated system

Bits

Molecule

20th century
(1) Physical Sharing Economy

General printer
e.g., 3D printer

Late 20th century
(2) Sharing Economy
in cyber space

Container
Parrett
(1956)

Digital package
(=IP Packet)

Innovation in Logistics

=Cyber-First Sharing Economy

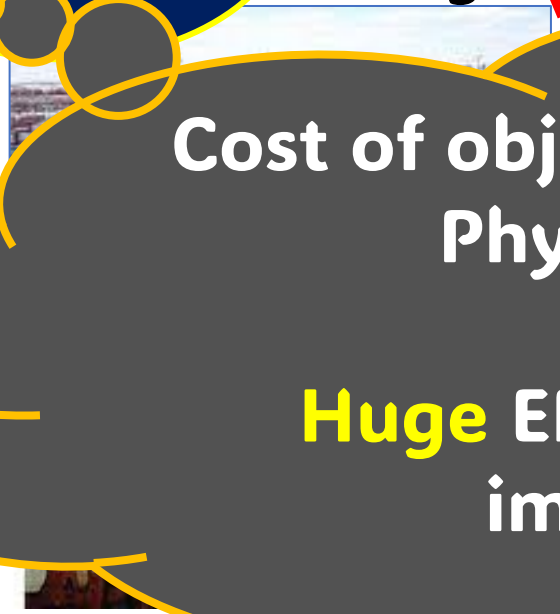
19th century =

Object transfer/mobility over sharing platform !!

1. Physical object

2. Digital object

Sharing Economy



Cost of object transfer/mobility ?

Physical >> Digital

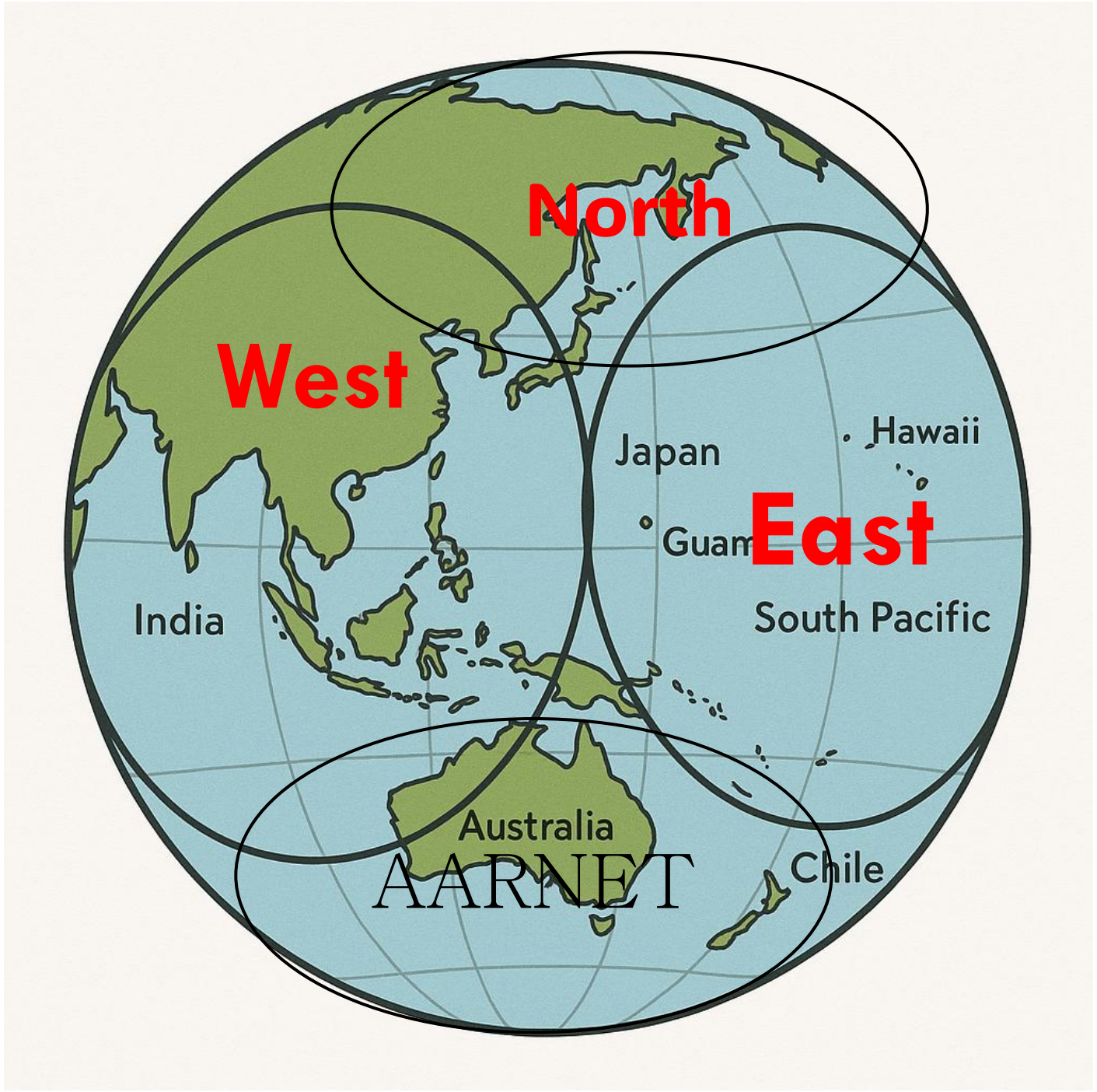
Huge EP(Energy Productivity) improvement !!!

Container Parrett (1956)

Toward globally shared testbed/platform, (i.e., Global Commons) with NRENs, e.g., Work Load Sift of computing processes/power for electric power DR(Demand Response) among DCs over the globe

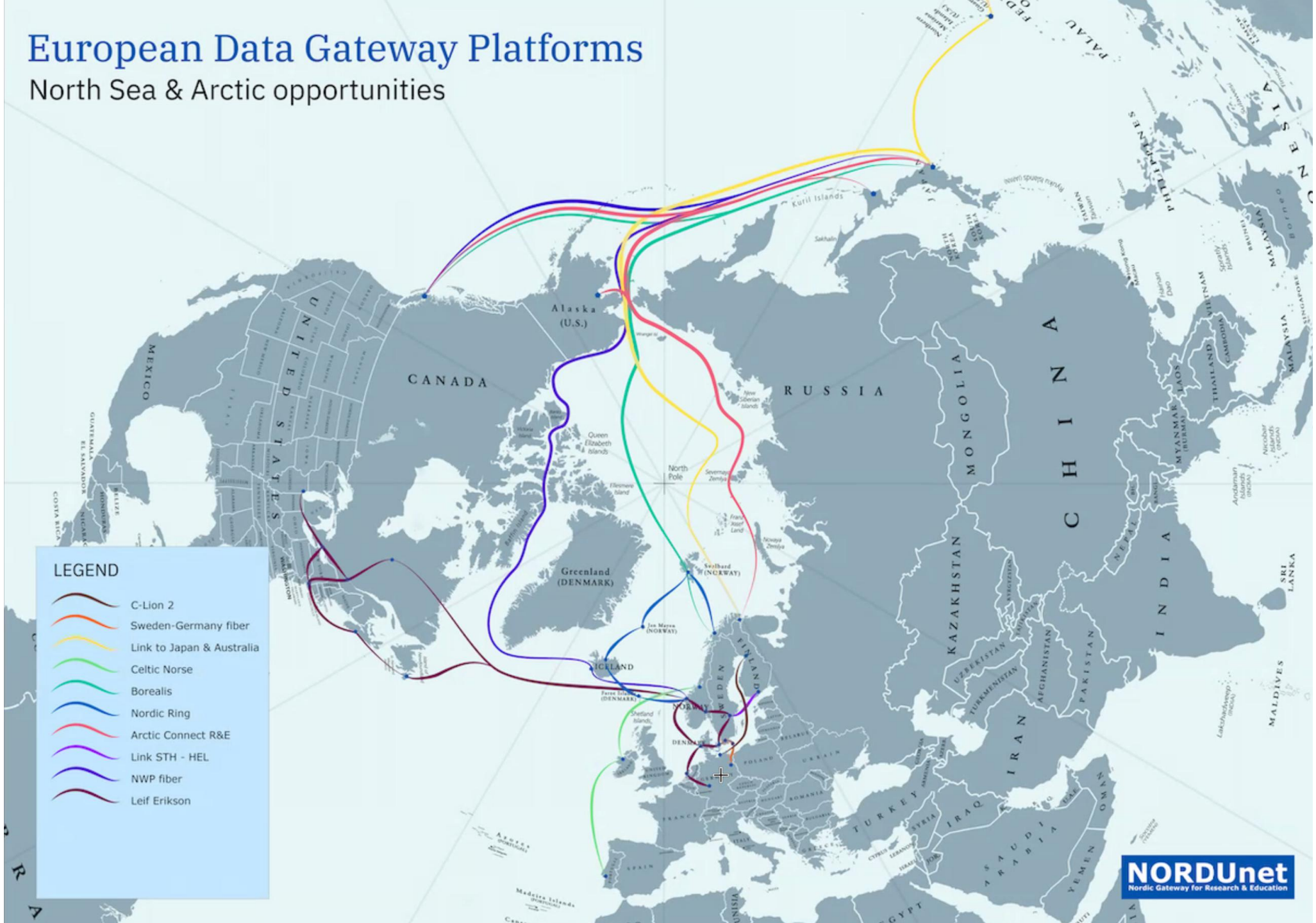
Arena-PAC

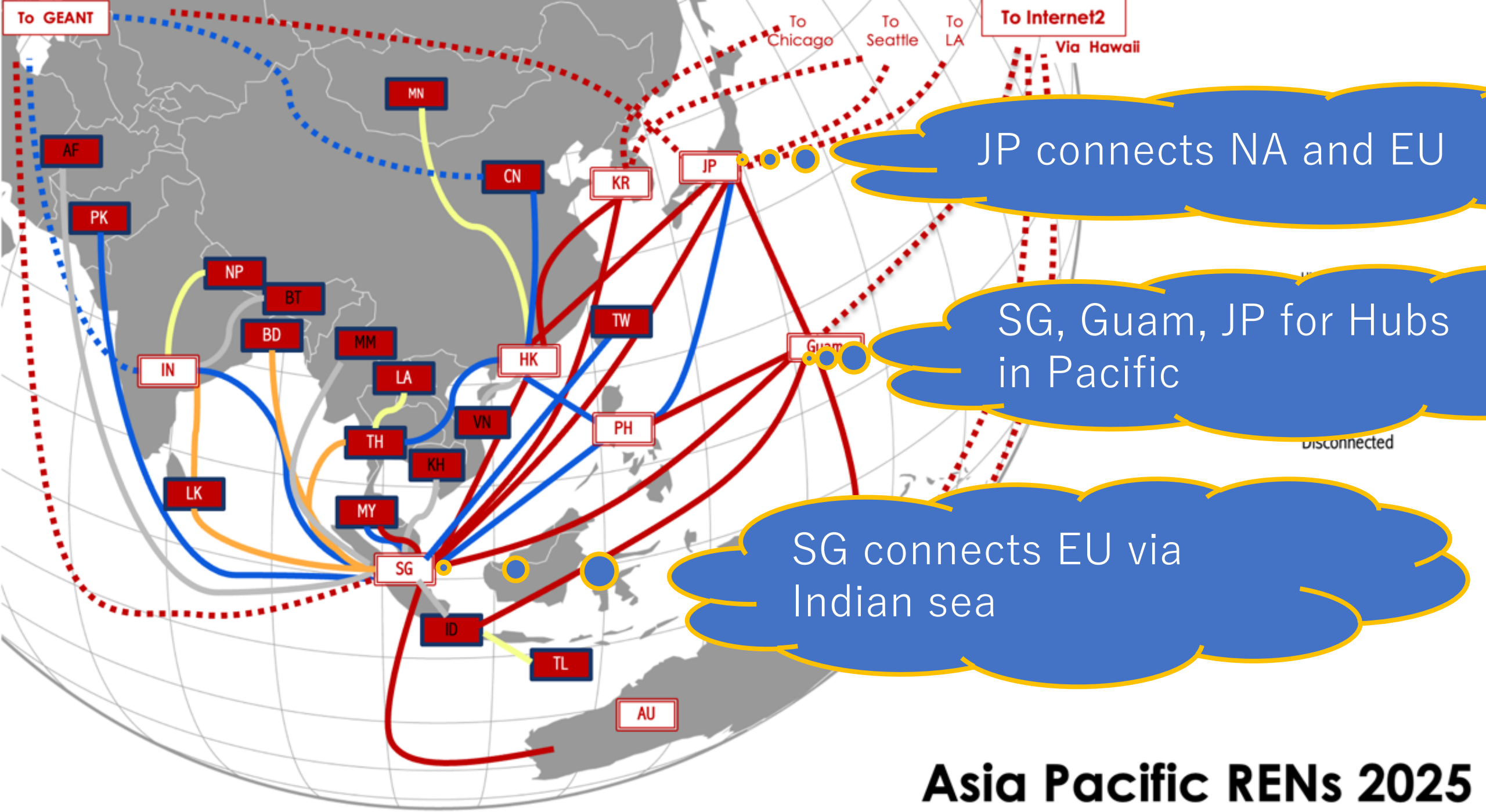
Arterial
Research
and
Educational
Network
for
Asia
and
PACific



European Data Gateway Platforms

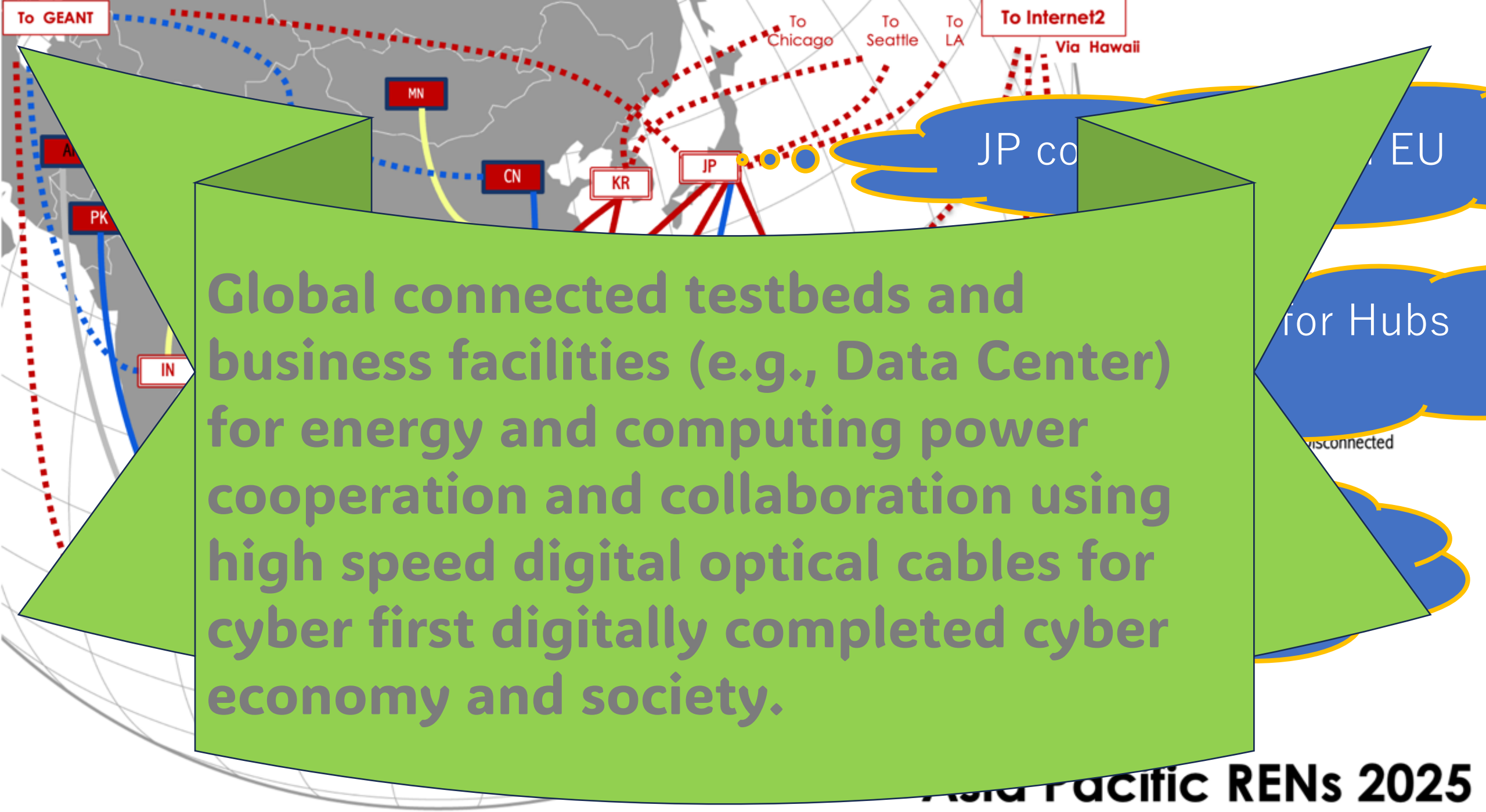
North Sea & Arctic opportunities





Asia Pacific RENs 2025

Based on Asi@Connect Map (April 2025 ver.) and APOnet map (Aug 2)

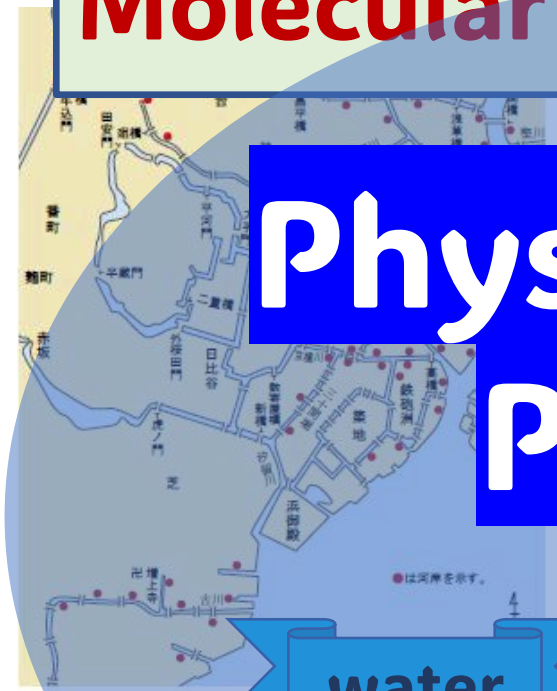

To GEANT
To Chicago
To Seattle
To LA
To Internet2
Via Hawaii
MN
CN
KR
JP
PK
IN
JP co
EU
for Hubs
isconnected
Global connected testbeds and business facilities (e.g., Data Center) for energy and computing power cooperation and collaboration using high speed digital optical cables for cyber first digitally completed cyber economy and society.
Pacific RENs 2025
Based on Asi@Connect Map (April 2025 ver.) and APOnet map (Aug 2)

Main infrastructure,,,

Molecular

Molecular
＋
Energy(electricity)

Physical Geo-Politics



water

Transport/Logistics
Energy/Power

【Extended land】
Logistics, water &
sewage, defense
～Sharing Economy～

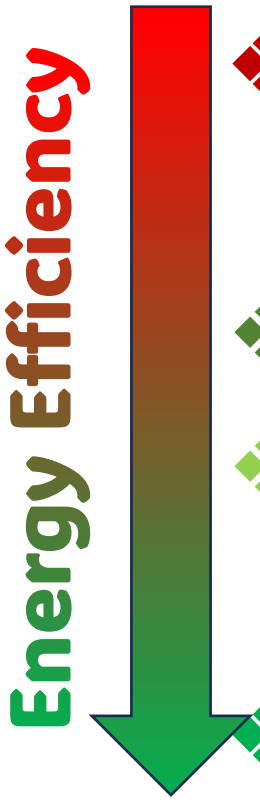
Bits

Information
Digital

Digital
Geo-
Politics

Toward Digital/Cyber Complete

Legacy; Physical/Molecule



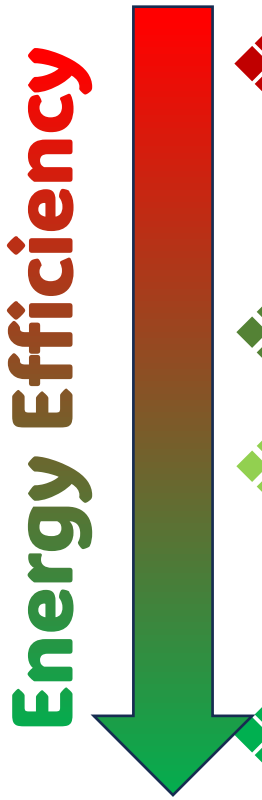
- Physical Complete; Run only by molecule
  - ✓ Run; Electricity replaces Gas engine
- Physical First; Optimize molecule by Bits
- Cyber First; Design molecule by bits
  Replace molecule by bits
- Cyber Complete; Run only by bits

To-Be; Cyber/Bits

(*) molecule= “thing”
bits =“function/code”

Toward Digital/Cyber Complete

Legacy; Physical/Molecule



- Physical Complete; Run only by molecule
  - ✓ Run; Electricity replace Gas engine
- Physical First; Optimize molecule by Bits
- Cyber First; Design molecule by bits
  - Replace molecule by bits
- Cyber Complete; Run only by bits

To-Be; Cyber/Bits

(*) molecule= "thing"
bits ="function/code"

Techniques for reducing energy consumption in each business segment

Carbon Neutral infrastructure by EP-x00 (Energy Productivity)

	Of Digital	By Digital
AS IS	• Virtual Machine • Huge Memory & Processor • Program(i.e.,code)	Digital Twin (CPS; Cyber Physical System) with LoD*
TO BE	Electron → Photon → Quantum	Cyber First

(*) LoD; Linked Open Da

Carbon Neutral infrastructure by EP-x00 (Energy Productivity)

	Of Digital	By Digital
AS IS	• Virtual M • Huge Me Processor • Data Center	win er Physical System) ith LoD*
TO BE	Electron → Photon → Quantum	Cyber First

Operational Carbon

(*) LoD; Linked Open Da

Carbon Neutral infrastructure by EP-x00 (Energy Productivity)

	Of Digital	By Digital
AS IS	• Virtual Machine • Huge Memory & Processor • Data Center	Digital Twin (CPS; Cyber Physical System) with LoD*
TO BE	Elect → → Q	st

Embodied Carbon
Life-time/Supply-Chain

(*) LoD; Linked Open Da

Techniques for reducing energy consumption in each business segment

1. Reduce the number of {physical} things newly required when we build a system

2. Reduce the amount of required energy during system operation (AS IS)

3. Reduce costs required for system construction and operation (TO BE)

Techniques for reducing energy consumption in each business segment

1. Reduce the number of {physical} things newly required when we build a system
   a. Replacing “things newly needed” with “things manufactured in the past” by applying reusing/recycling/circular economy
   b. Reduce “things newly needed” by sharing economy
2. Reduce the amount of required energy during system operation (AS IS)
3. Reduce costs required for system construction and operation (TO BE)

(1) Reusing/recycling/circular economy

Practical examples:

i. **Reuse of used EV battery and computing capacity**

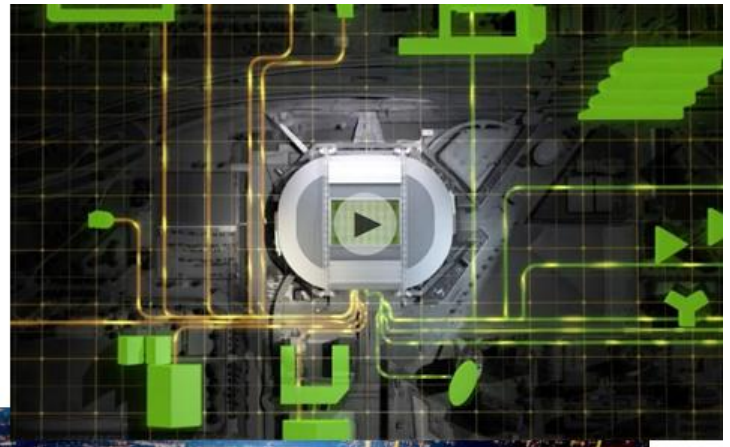
ii. **Scrap & Build to Skelton & Infill in Buildings**

i. Reuse of used EV battery at Amsterdam stadium

■{Electric} Power distribution base

Capacity of EV's **used battery packs**

- ✓**3MWh only with 148 EVs**
- ✓100KW in peak per EV
- ✓20KW in average per EV



1. Normal situation;

   Power **DR (Demand Response)**

2. Emergency case;

   Local self power supply

Energy x Digital

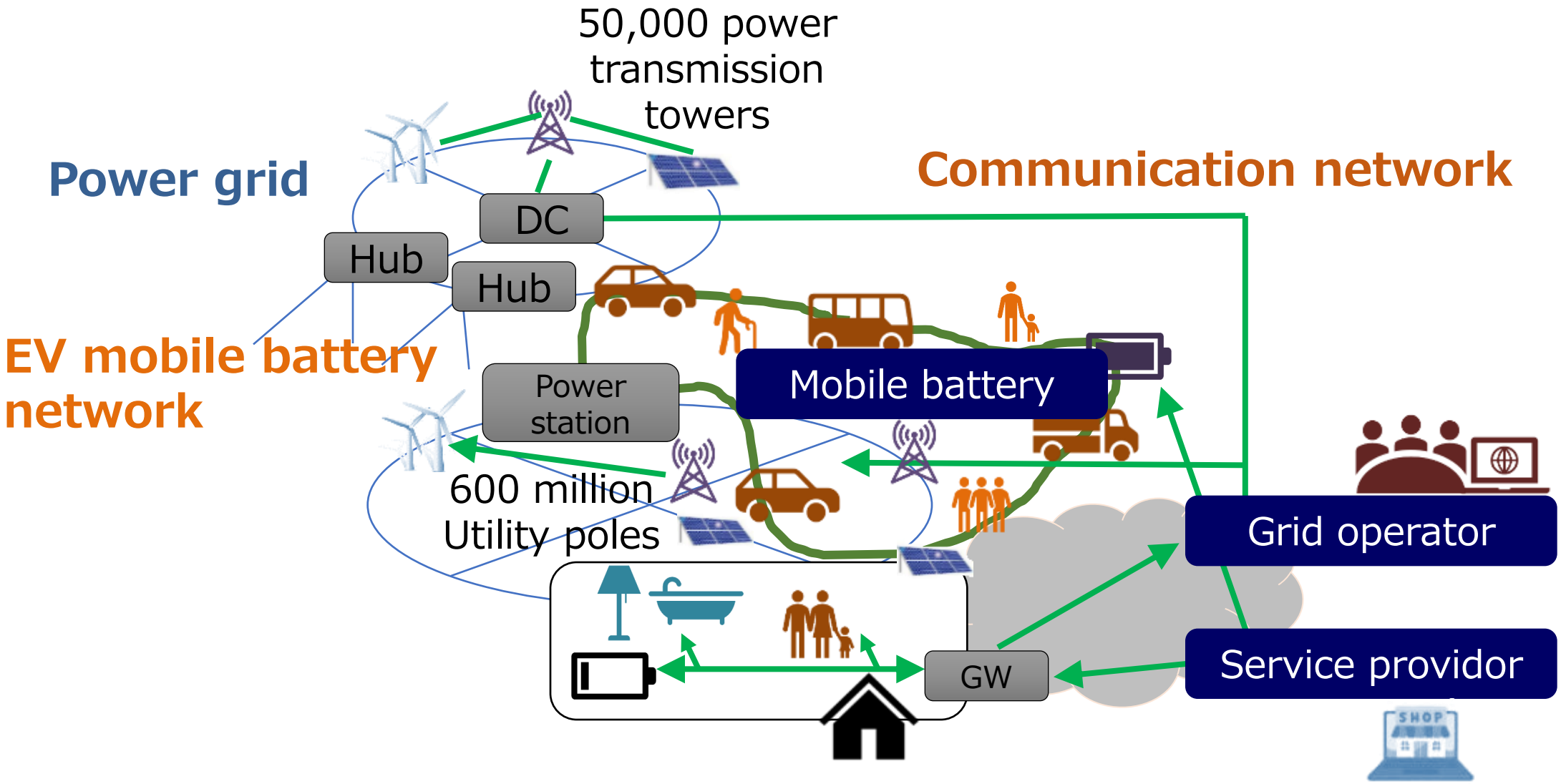
EV as new component

【Operating rate】

- Private : 4～5%
- Commercial : 24%

1. Battery
2. Computation
3. Mobility

①Battery x ②Computation x ③Mobility



（出所）岡本(2021)「GRIDで理解する電力システム」、電気新聞出版

①Battery x ②Computation x ③Mobility

- Nissan EV：30kW(Ave.), {100kW(Peak)}, 100kWh

👇

1. 10^6(1 millions)：30GW(Ave.), 100 GWh(Peak)
   - Pumped storage power in TEPCO (=9GWh) **x 10**
   - 黒部ダム(=335MW) **x 10**
2. 100 EVs ： 3MW(Ave.), {30MW(Peak}
   - Eng.No.2 Bldg (12F)： 700kW (≒35 EVs)
   - Hongo Campus(No.2 in Tokyo)：30MW (≒1 k EVs)

(出所) 岡本(2021)「GRIDで理解する電力システム」、電気新聞出版

①Battery x ②Computation x ③Mobility

50,000 power

◆ Tesla(by AMD@CES2023) ： **10 TFLOPS** (10^{13})

https://car.watch.impress.co.jp/docs/news/1469629.html

◆ 富岳(No.3 Super Computer) ： **1,000 PFLOPS** (10^{18})

- **3 TFLOPS/node**
- 158,976 nodes (1.5×10^5)

https://www.fujitsu.com/jp/about/businesspolicy/tech/fugaku/specifications/

👇

100k($=10^5$) Tesla ≒ 富岳(No.3 Super Computer)

（出所）岡本(2021)「GRIDで理解する電力システム」、電気新聞出版

ii. Scrap & Build to Skelton & Infill in Buildings

by Prof. Nicolaas John Habraken of MIT in the 1960s.

- ① No need to dismantle and rebuild the frame, ② waste (including industrial waste) can be reduced, and resources and energy required for ③ rebuilding can be reduced
  - ✓Condominium in China
  - ✓Rapid functioning in East Germany after cold war

- Sharing hardware
  - Owner's exclusive (not sharing) asset among multiple generations
  - Sharing assets by tenants among same generation

- Digital Twin in Hardware and Software

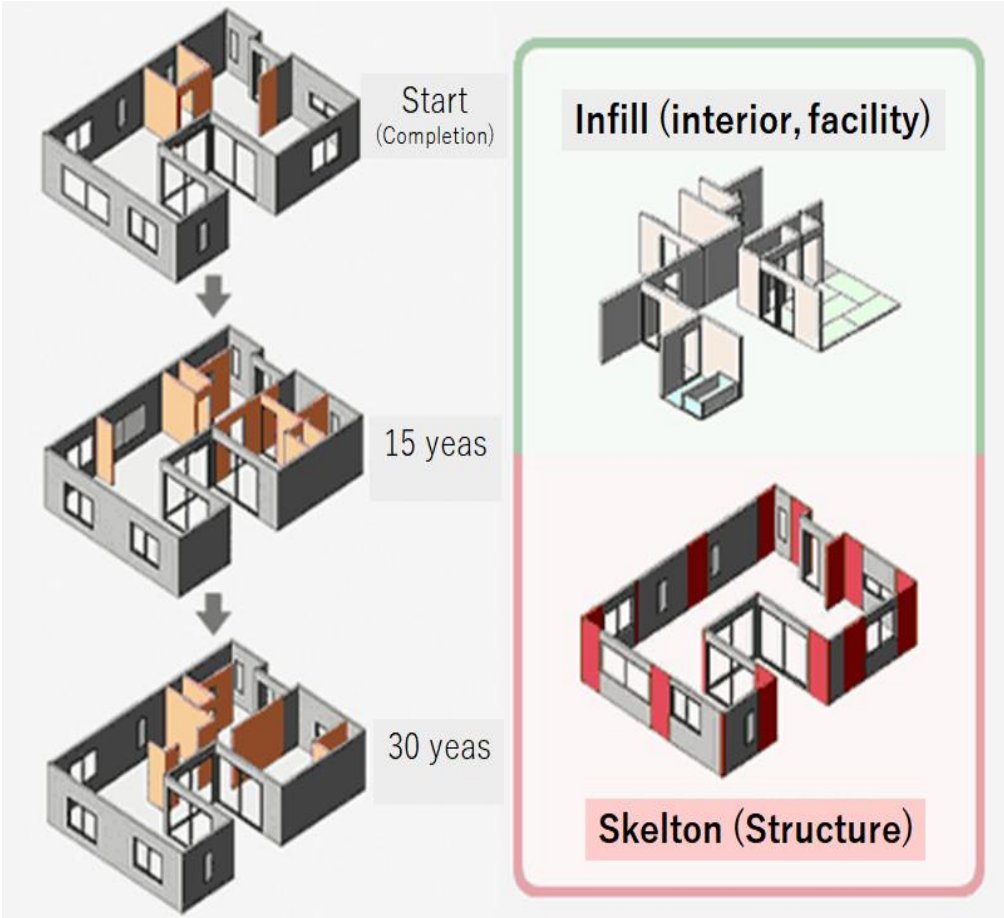


Fig.8 Skelton & Infill (as Hardware)

Techniques for reducing energy consumption in each business segment

1. Reduce the number of {physical} things newly required when we build a system

2. **Reduce the amount of required energy during system operation (AS IS)**
   - **Cloud by Default**
   - **Application and diffusion of digital twins**

3. Reduce costs required for system construction and operation (TO BE)

Carbon Neutral by EP-x00 (Energy Productivity)

	Of IT	By IT
AS IS	• Virtual Machine • Huge Memory & Processor	Digital Twin (CPS; Cyber Physical System) with LoD
TO BE	Electron → Photon → Quantum	Cyber First

“Cloud-by-Default” for multiple pay off

(June 2018 by Japanese gov.)

1. **De-Silo-ing**: Silo-structure of ministries and agencies should be interconnected as a shared infrastructure to deliver **innovative use of data**, while collapsing walls among them.
2. Leave infrastructure cybersecurity operation to experts.
   Also **reduces & improve fixed costs for personnel** in charge of on-premises facilities.
3. Reduce & improve **CAPEX and OPEX**, {incld labor costs,}.
   Hardware, software, people: from ownership (BS) to usage (PL)
4. Expand **BCP against natural disasters and cyber attacks**.
5. Achieve **energy savings** for contribution to global warming.

Tremendous earth quake on March 11, 2011

Smart HQ office of
Microsoft Japan in Tokyo

【Moving branch offices went to a HQ】
① Any server moves to Data Center
② Full online business operation

【Right after earth quake…】
① Business continuation only with few % of employees in HQ office
② Work at home = Safety for employees

【After earth quake】
① Referenced recommended office for all Microsoft offices
② Supporting handicapped employees

Tremendous earth quake on March 11, 2011

Smart HQ office of
Microsoft Japan in Tokyo

①Life time cost reduction with comfortable working environment by no noisy, hot and big eating servers !!

1. Initial move-in
2. During occupancy
3. Exit and return to status quo

②Cyber security improvement (=BCP)

1. Intellectual property on the computers
2. Information leaking

③Energy saving (=CSR)

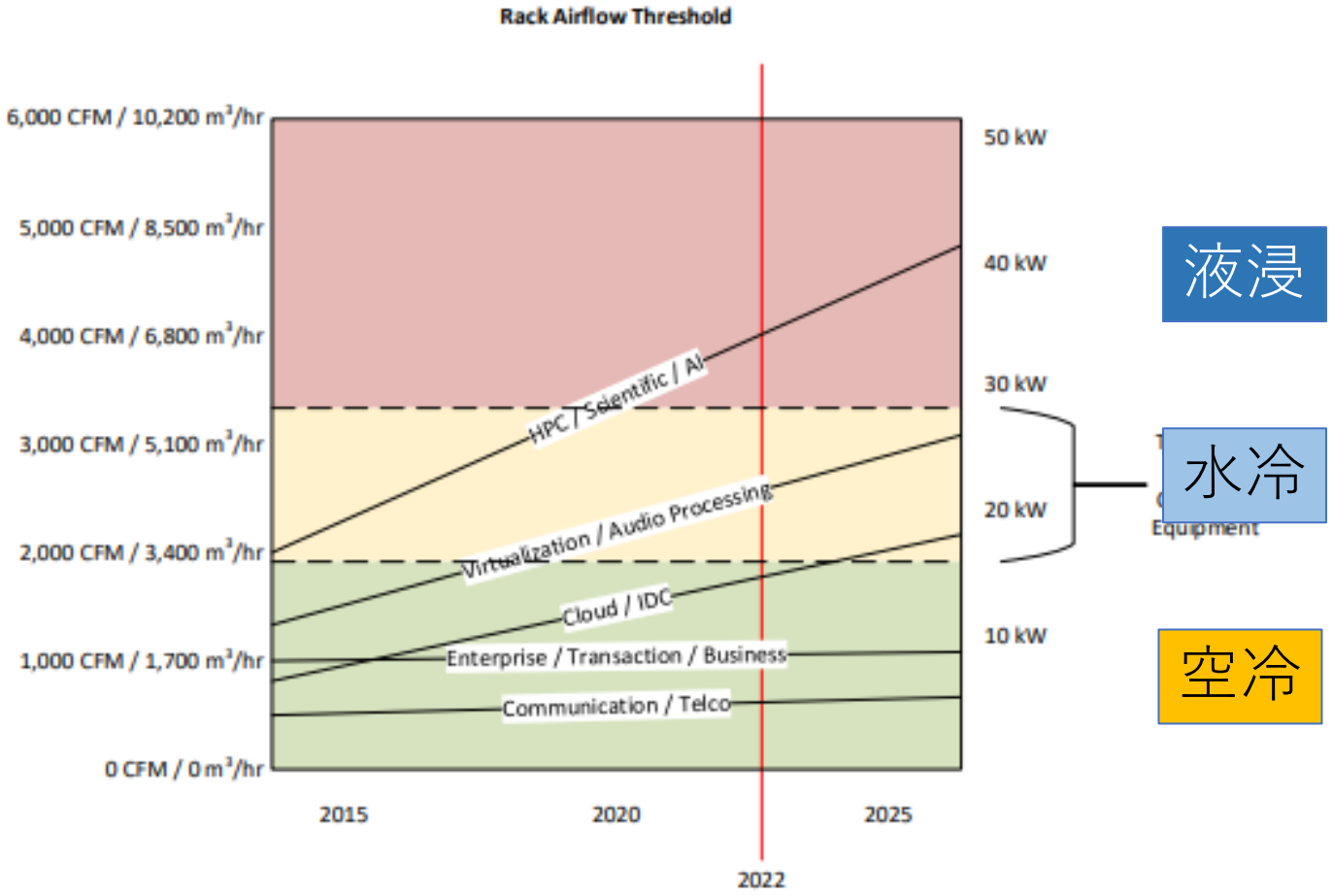
1. Digital Twin + Cloud computing
2. Big eating computers go to DC

What happened in Data Center and Servers ❓

1. Implosion(=high density heat & power)
2. IoF, Internet of Function = VM/GPU moves on the net.
3. Optical technologies(electron ➔ photon)
4. Growth of demands (Digital Twin ➔ HW/SW robots & AI)
5. Massive scale & energy saving
6. Networking DCs with fat pipes (power and com.)
7. WhiteBox (customization with common tech.s)
   ✓Including modulization and pre-fabric construction
8. Migrate DCs beside Renewal Energy sources
9. Open system (not only IT, but also OT)
10. Hybrid and diverse of DC profiles

What happened in Data Center and Servers ❓

1. Implosion(=high density heat & power)
2. IoF, Internet of Function = VM/GPU moves on the net.
3. Optical technologies(electron ➔ photon)
4. Growth of demands (Digital Twin ➔ HW/SW robots & AI)
5. Massive scale & energy saving
6. Networking DCs with fat pipes (power and com.)
7. WhiteBox (customization with common tech.s)
   ✓Including modulization and pre-fabric construction
8. Migrate DCs beside Renewal Energy sources
9. Open system (not only IT, but also OT)
10. Hybrid and diverse of DC profiles

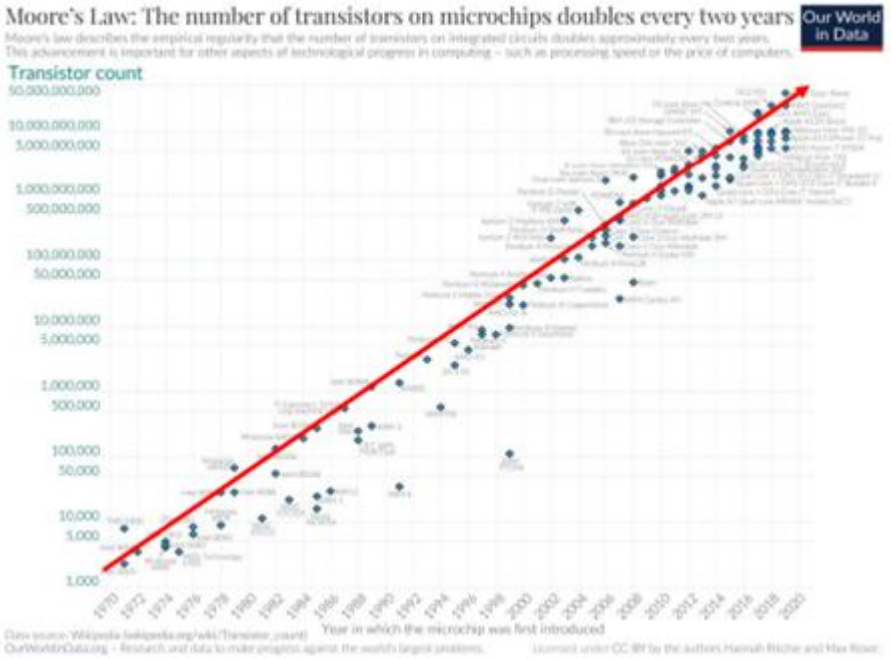


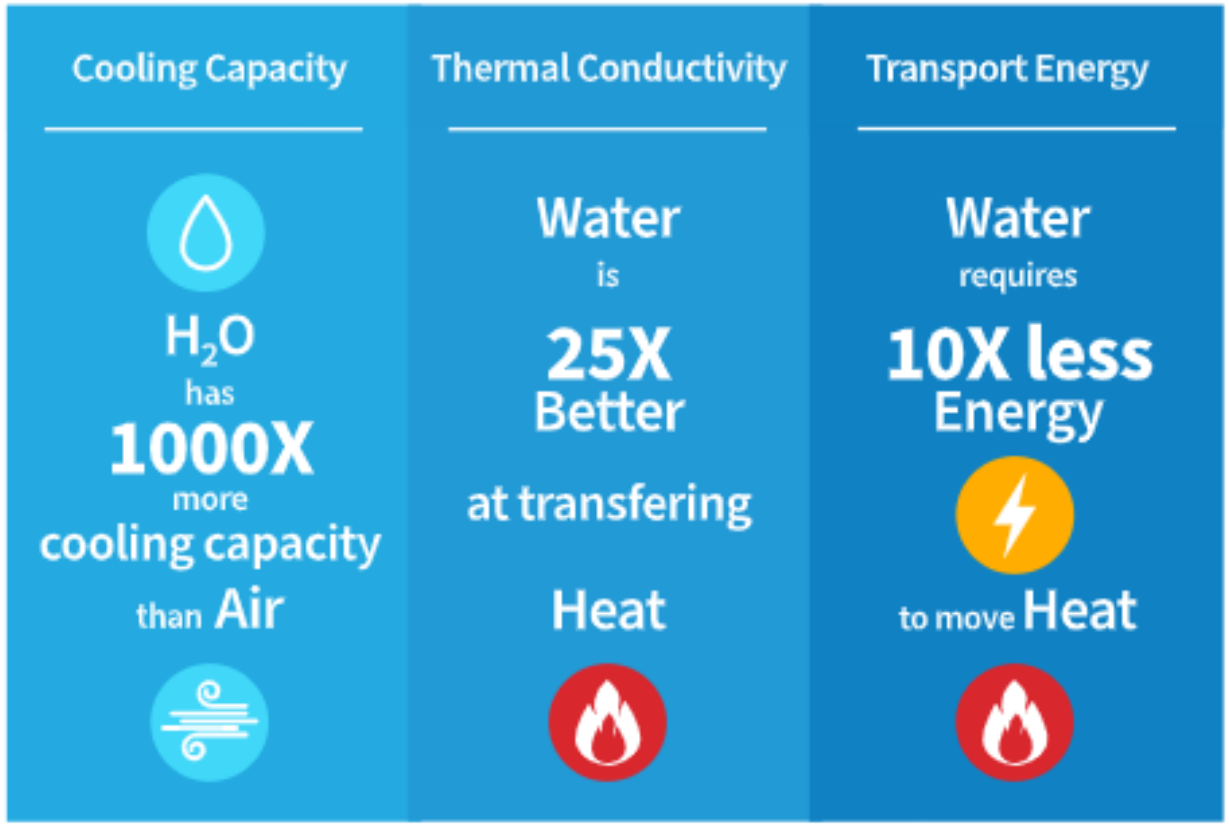
液浸

水冷

Equipment

空冷

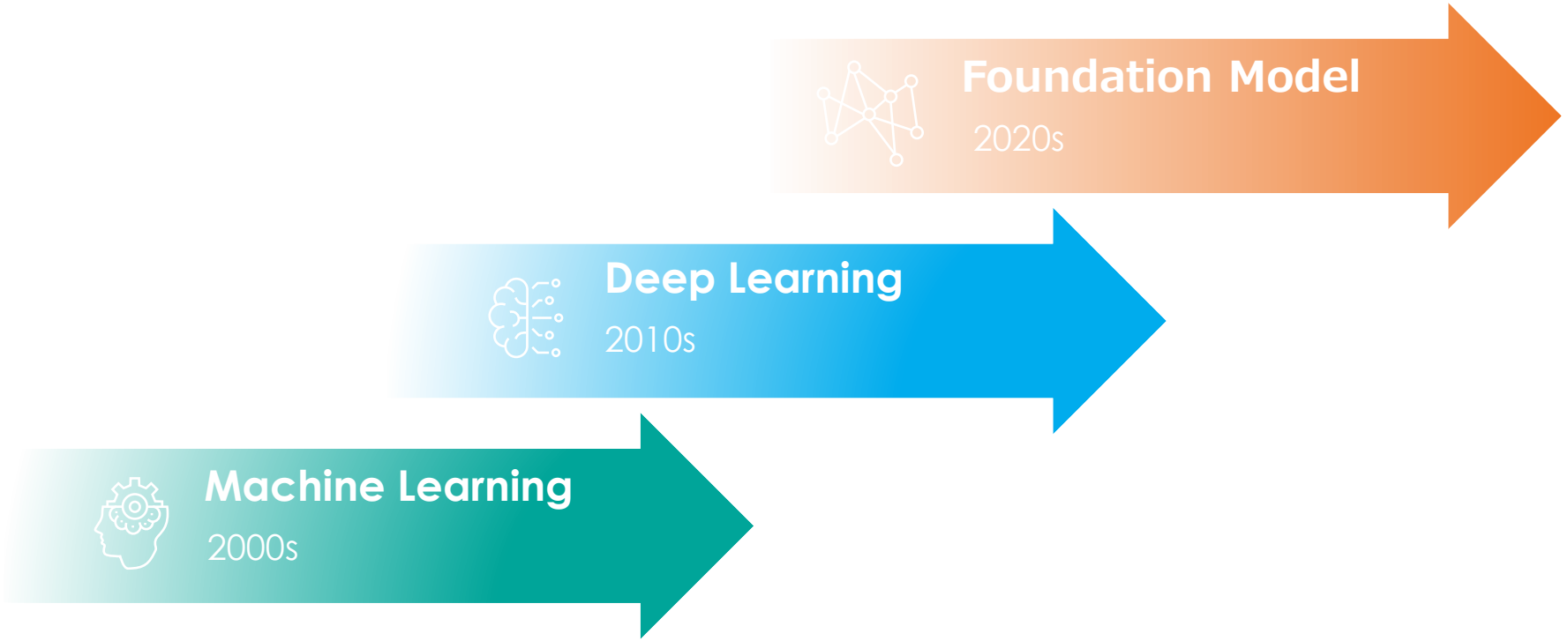




https://www.supermicro.com/ja/solutions/liquid-cooling より引用

New challenges

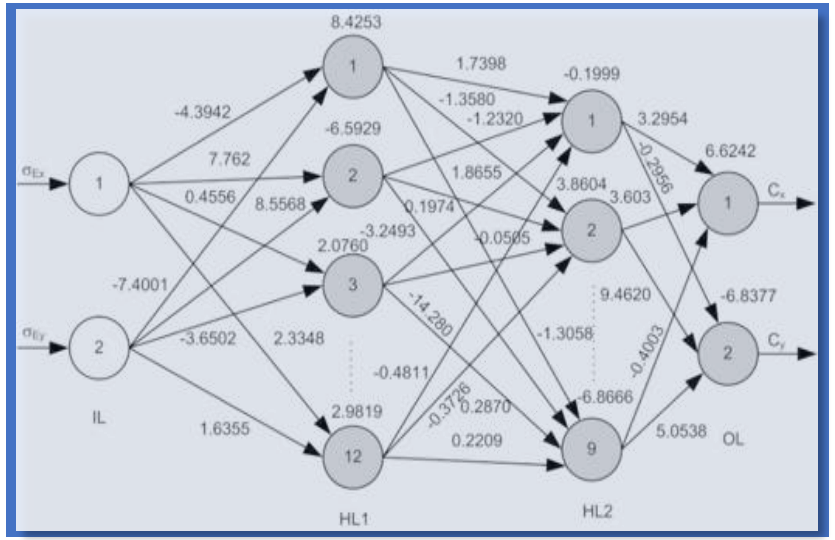
1. WUE(Water Usage Effectiveness)
2. Storage: Semiconductor, Disk, Tape
   ➔ Optical, Quantum
3. Computation:
   i. GPU for AI : Dense matrix ➔ Sparse matrix
      (image/video bitmap) (semantic data, e.g.,LLM)
   ii. Quantum as accelerator
4. Embodied carbon (Scope 3 supply chain)



Source： SambaNova
https://sambanova.ai/

Latest AI calculation is of Data-Flow

```
#include <iostream>
using namespace std;

int _tmain (int argc, _TCHAR* argv[])
{

     int iVal1 = 0, iVal2 = 0, iVal3 = 0;

      printf("Enter three numbers:");
      scanf("%d %d %d", &iVal1, &iVal2, &iVal3);

     if (iVal1 >= iVal2)
      {
          if(iVal1 >= iVal3)
            printf("Largest number = %.2d", iVal1);
          else
            printf("Largest number = %.2d", iVal3);
      }
      else
      {
          if(iVal2 >= iVal3)
            printf("Largest number = %.2d", iVal2);
          else
            printf("Largest number = %.2d", iVal3);
      }

 getchar ();
 return 0;
}
```



Software 1.0

- Algorithm is written by code (e.g., C++, ...)
- Programmer, called as domain expert needs domain specific experty, knowledge and experiences

AI is Data Flow（Software2.0）

- Data, not code, delivers and trains model.
- Deep Neural Networks
- Weight of works define/deliver parameters

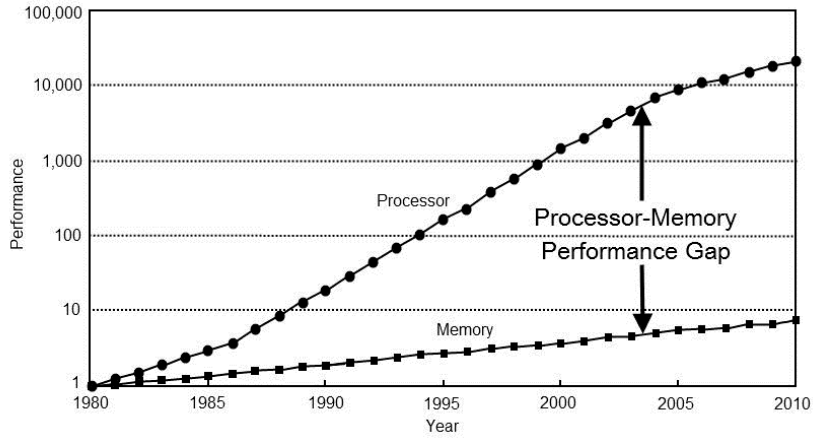
Source： SambaNova
https://sambanova.ai/

Semiconductors for AI processing

Recent AI computing, such as LLM, requires sparse matrix computation and huge electric power by CPU and GPU

- Big gap between processors and memories, is exponentially growing
  - Hierarchal memory structure conceals data transmission latency
  - Depending on cache hit ratio/character
  - Optimized for Dense GEMM
  - Poor performance for Sparce GEMM
- Data transmission and copying computation consumes far larger electric power than data calculation/processing data does.
  - **Performance of computation depends on how close the data stored so sa to let short/small for data transmission from memory/storage location to ALU location.**

Most of {start up} companies propose legacy semiconductor design for {dense matrix computing based} AI solution.



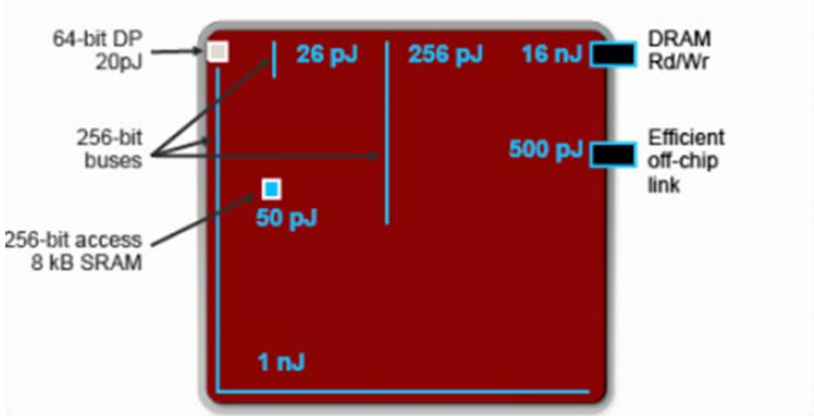


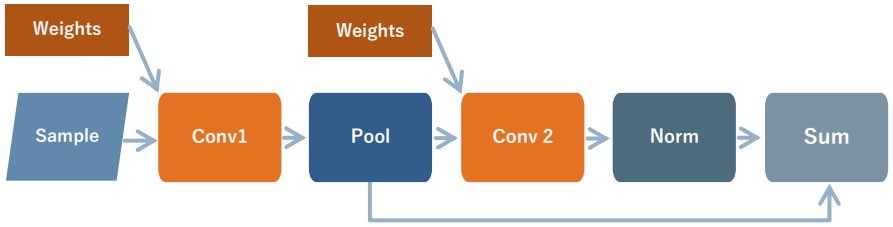
Figure: Computation cost is significantly lower than communication cost in 28nm NVIDIA chips (Source: Bill Dally)

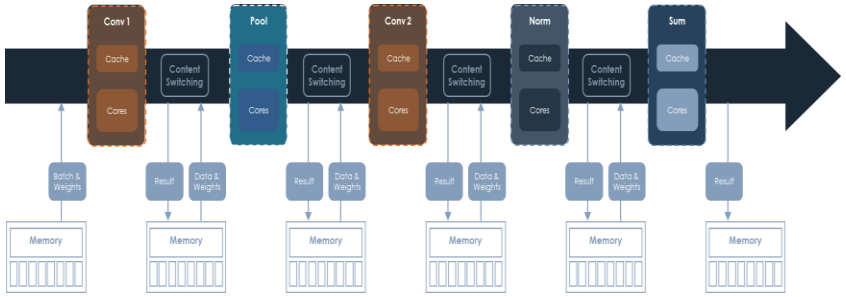
Source： SambaNova
https://sambanova.ai/

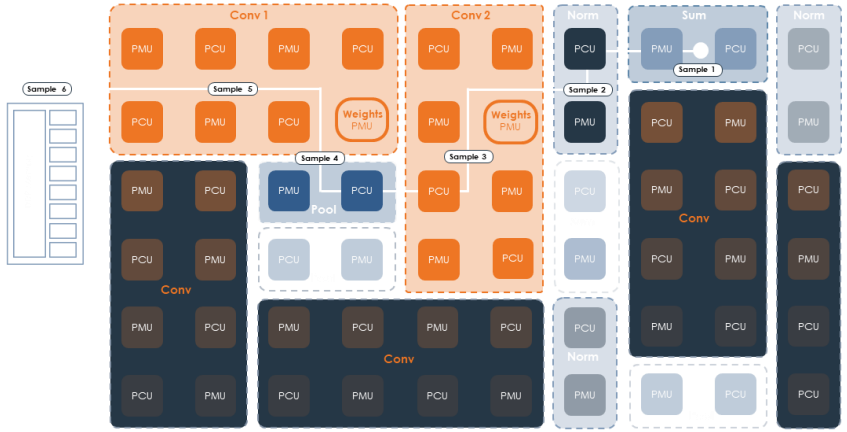
Innovation of data-flow data processing architecture

Flow of data and processing is defined by locality and parallelism

CONVOLUTION GRAPH







Since memory access is required for each calculation kernel, it is necessary to place high-speed memory near the computing unit.

➔ **High-Speed memory has a small capacity**

External memory access can be minimized, to eliminate the need of high-speed memory
→ we can have larger capacity for memory
Calculation is triggered only by data migration
→ good for sparce matrix

Source： SambaNova
https://sambanova.ai/

What happened in Data Center and Servers ?

Missing piece……

➔ Energy productivity of Software(code)

(*) challenging with USP Mongolia

- Bad code
  - ① A lot of wasted operations
  - ② Less flexibility
- Good code
  - ① Small wasted operation
  - ② Good flexibility

Reduction of

① Operational Power

② Total System Resource,

i.e., embodied carbon

Hybrid and diverse of DC profiles

Python vs. Unicage by USP

work	Unicage by USP	Python
Count number of raws in 20GB file	1	16.7
Sort 5GB file	1	48.89
Pick corresponding raws in 20GB file	1	More than 140 (not completed)
Transform to CSV format file from 10GB file	1	53.22

Carbon Neutral by EP-x00 (Energy Productivity)

	Of IT	By IT
AS IS	• Virtual Machine • Huge Memory & Processor	Digital Twin (CPS; Cyber Physical System) with LoD
TO BE	Electron → Photon → Quantum	Cyber First

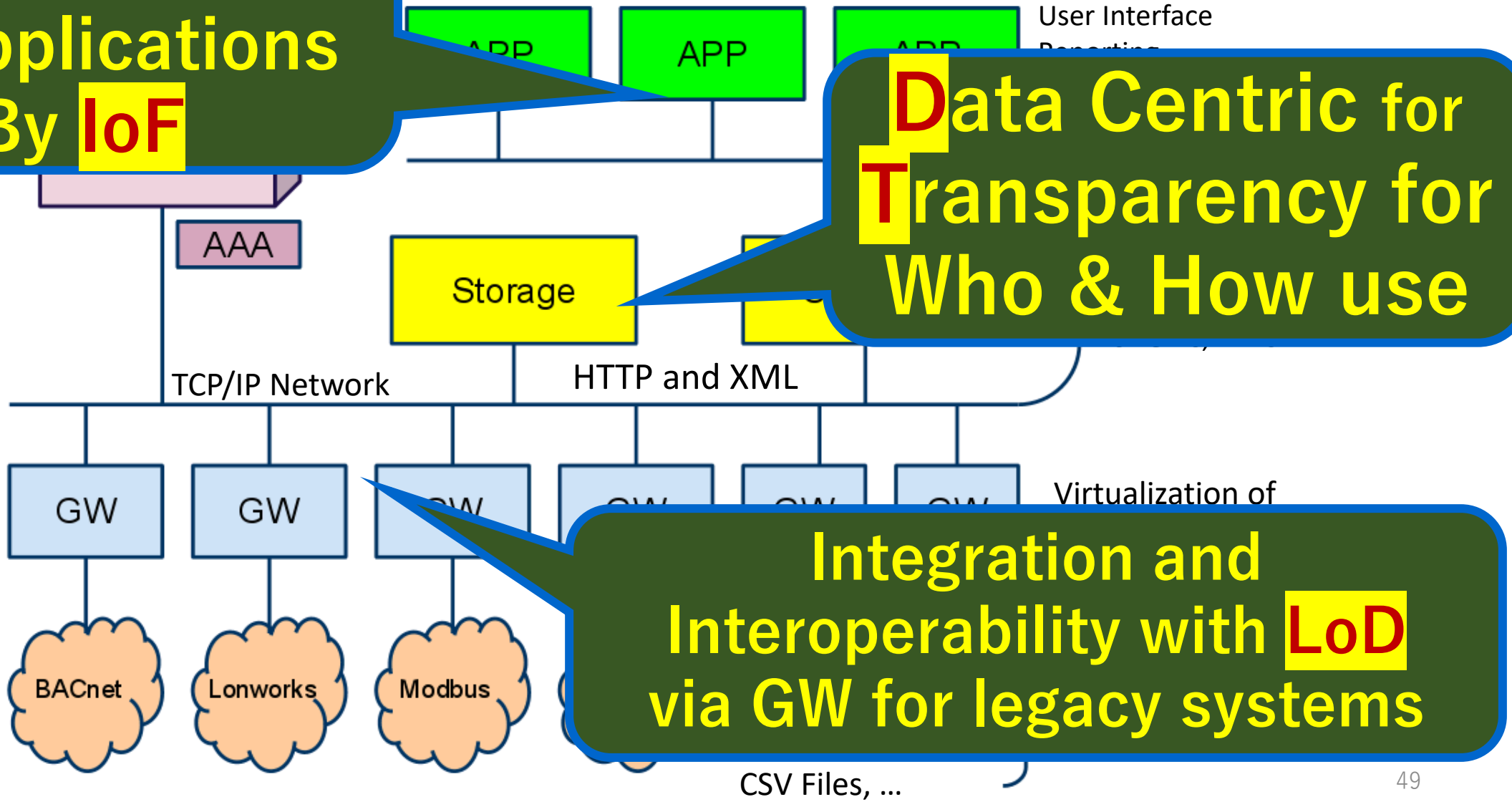
System Architecture

Green university of Tokyo Project
グリーン東大工学部プロジェクト

Independency from hardware for applications By IoF

Data Centric for Transparency for Who & How use

Integration and Interoperability with LoD via GW for legacy systems



The University of Tokyo in Summer of **2011**

Hacking building/campus facilities with IP

	Peak (2010)	Peak (2011)	Total (2011)	RoI
Major 5 campuses	66 MW	69% (△31%)	75%-78% (22%-25%)	less than 1 month
Eng. No2 Bldg.	1 MW	56% (△44%)	69% (△31%)	2 years

【Contributions】

1. **Multi-Vender for sustainability by TCP/IP**
2. **Global standard for interoperability**

Green university of Tokyo Project

The University of Tokyo in Summer of **2011**

Hacking building/campus facilities with IP

[Fact/Lesson 1]

{almost} Only by visualization
(aka., by Digital Twin)

👇

25% reduction in total

👇

EP-50

2. Global standard for interoperability

The University of Tokyo in Summer of **2011**

Hacking building/campus facilities with IP

[Fact/Lesson 2]

-- Important rule --

Capacity of power network is determined by **peak power demand !!**

Reduction of demand at peak time contribute to the reduction of **the cost for capacity of power supply network**.

2. Global Standard for Interoperability

Techniques for reducing energy consumption in each business segment

1. Reduce the number of {physical} things newly required when we build a system
2. Reduce the amount of required energy during system operation (AS IS)
3. **Reduce costs for construction and operation (TO BE)**
    1. Things can be selected by unbundling things and things
       = IoF(Internet of Functions)
    2. Strategic use of communication infrastructure
       "Movement of physical things
       >>Movement of energy (including power)
       >>Movement of digital bits (things and functions that are digitized)".
       (*) More than two orders of magnitude smaller

Innovation in Logistics

19th century = exclusive separated system

Container
Parrett
(1956)

20th century
(1) Physical Sharing Economy

Late 20th century
(2) Sharing Economy
in cyber space

2020s =Cyber-First Sharing Economy

General printer
e.g., 3D printer

Digital package
(=IP Packet)

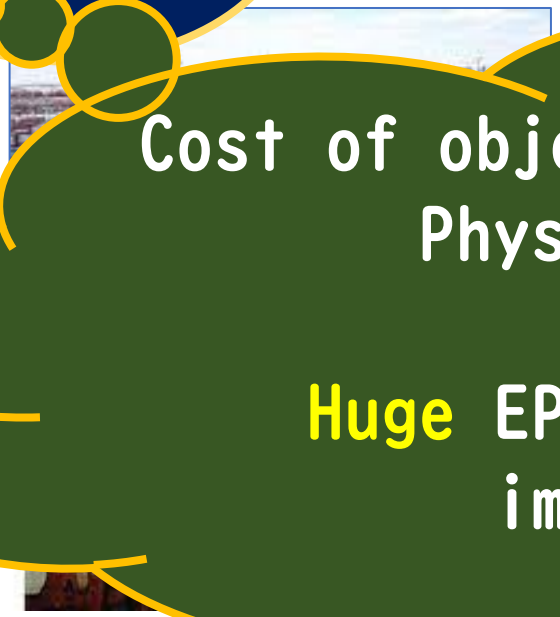
Innovation in Logistics

=Cyber-First Sharing Economy

19th century =

Object transfer/mobility
over sharing platform !!
1. Physical object
2. Digital object

Sharing Economy



Cost of object transfer/mobility?
Physical ≫ Digital

Huge EP(Energy Productivity)
improvement !!!

Containe
Parrett
(1956)

【Message 2/2】

Transfer cost ... ...

= Energy Productivity…

Material >> Electricity >> Digital bits

(Power) (digital Function)

x0000	**:**	**x00**	**:**	**1**

～When we Think about the Earth～

① Speed of light is not fast….

Inter-Continent: 200-300 msec.

Domestic: 30- 50 msec.

Intra-facility: 2- 3 msec.

② Mal-distribution of Renewal Energy

Far North/South Cold!!

rural area Carbon Negative

～When we Think about the Earth～

① Speed of light is not fast…

Dom

I

3 layered global Reconfigurable "Computing" Networks

② Mal-distribution of Renewal Energy

Far North/South　　Cold!!

rural area　　Carbon Negative

Business case

BMW in Germany

Before

Germany

100%
of IT Load
Tier III

5 MW

200万ユーロ

200万ユーロ

After

Germany

20%
of IT Load
Tier III

1MW

Iceland

50%
of IT Load
New standard

2.5 MW

Sweden

30%
of IT Load
New standard

1.5 MW

Small latency
&
Critical data
at {dark-side}DC

Allowing large latency
&
Non-Critical data
at cheap and green DC

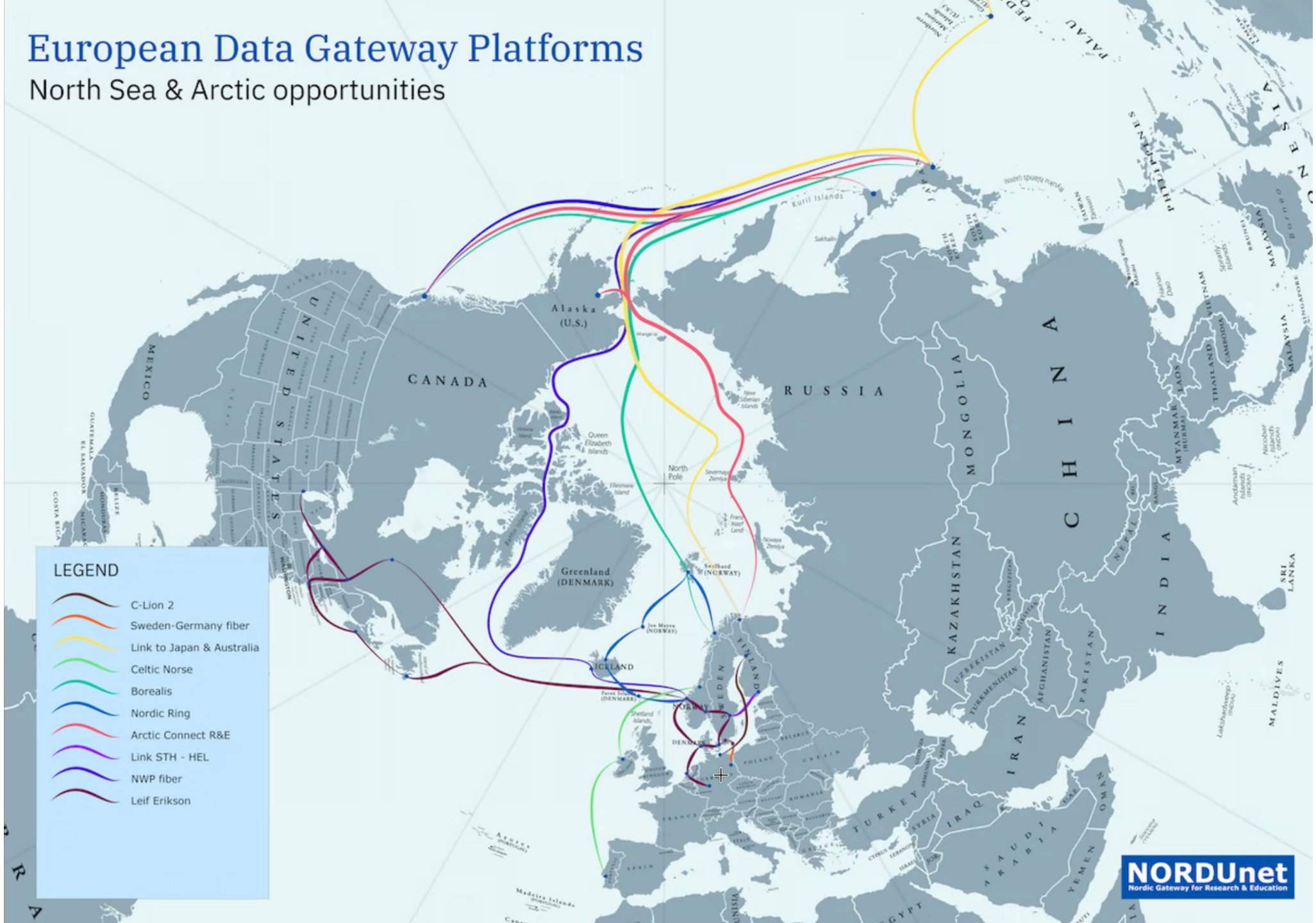
Transfer DCs to energy clean sites (Iceland & Sweden)

- ✓100% Renewal Energy (Hydro & Geothermal)
- ✓There are a lot of non-real time processes

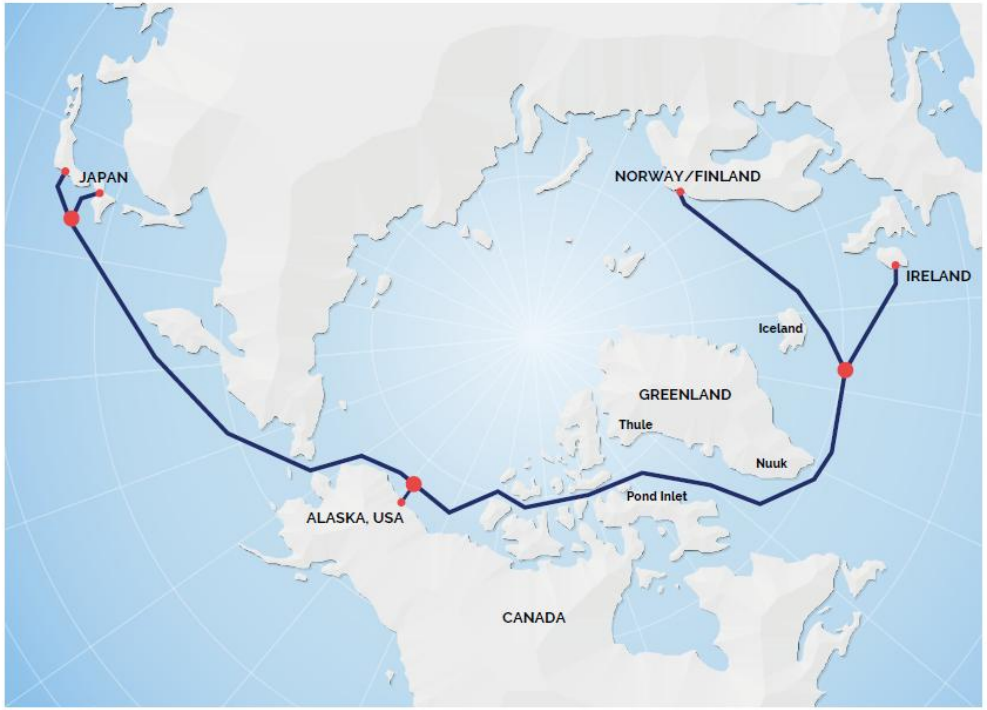
1. Gentle to Earth
   - ✓ by use of renewal energy (RE-100)
   - ✓ by use of cool air (EP-100)
2. Cost reduction (EP-x000)
   - ✓ Replacing power cable (copper) to communication cable (glass)

European Data Gateway Platforms

North Sea & Arctic opportunities



HIGH LEVEL OVERVIEW



CURRENT DESIGN

- The cable transits the Northwest Passage offering a new route in subsea cables
- Significant latency reduction versus routes available today
- 16 fiber pair system
- Landings: dual landings in Japan (Hokkaido and Tokyo region), Europe (Ireland, Norway/Finland) and North America (Prudhoe Bay)
- Branching Units to support remote northern regions

ESTIMATED LATENCIES

Segment	RTD/ms
Japan (Chikura) – Ireland	152
Japan – Norway/Finland	166
Japan – Alaska (Prudhoe Bay)	70
Alaska – Ireland	82
Alaska – Norway/Finland	96

PROJECT TIMELINE, PRELIMINARY:

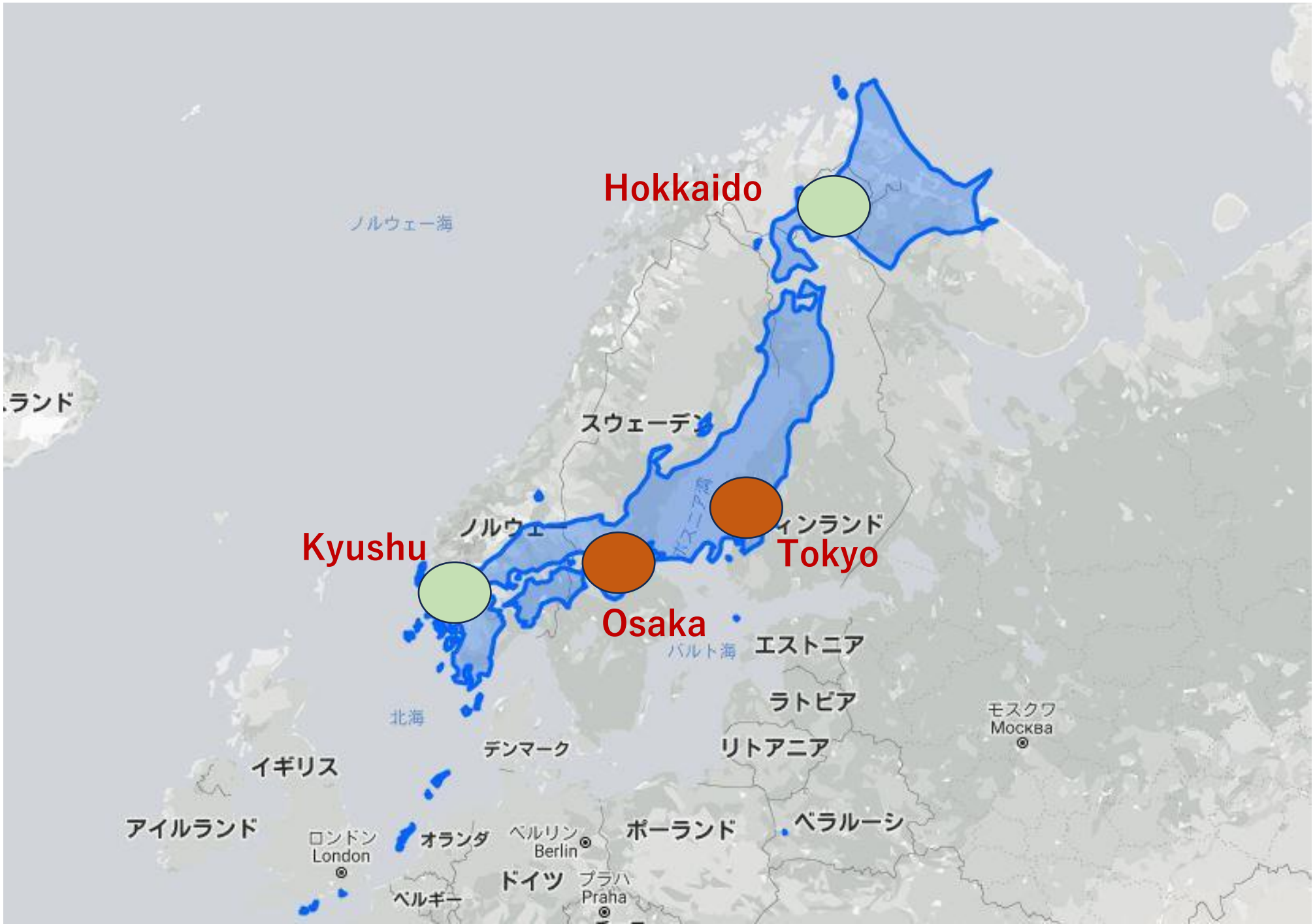
- **2022** – Supply Contract-in-Force (CIF)
- **2022 – 2023** – Marine Route Survey
- **202 – 202** –
- **2026** –

Far North Digital, LLC

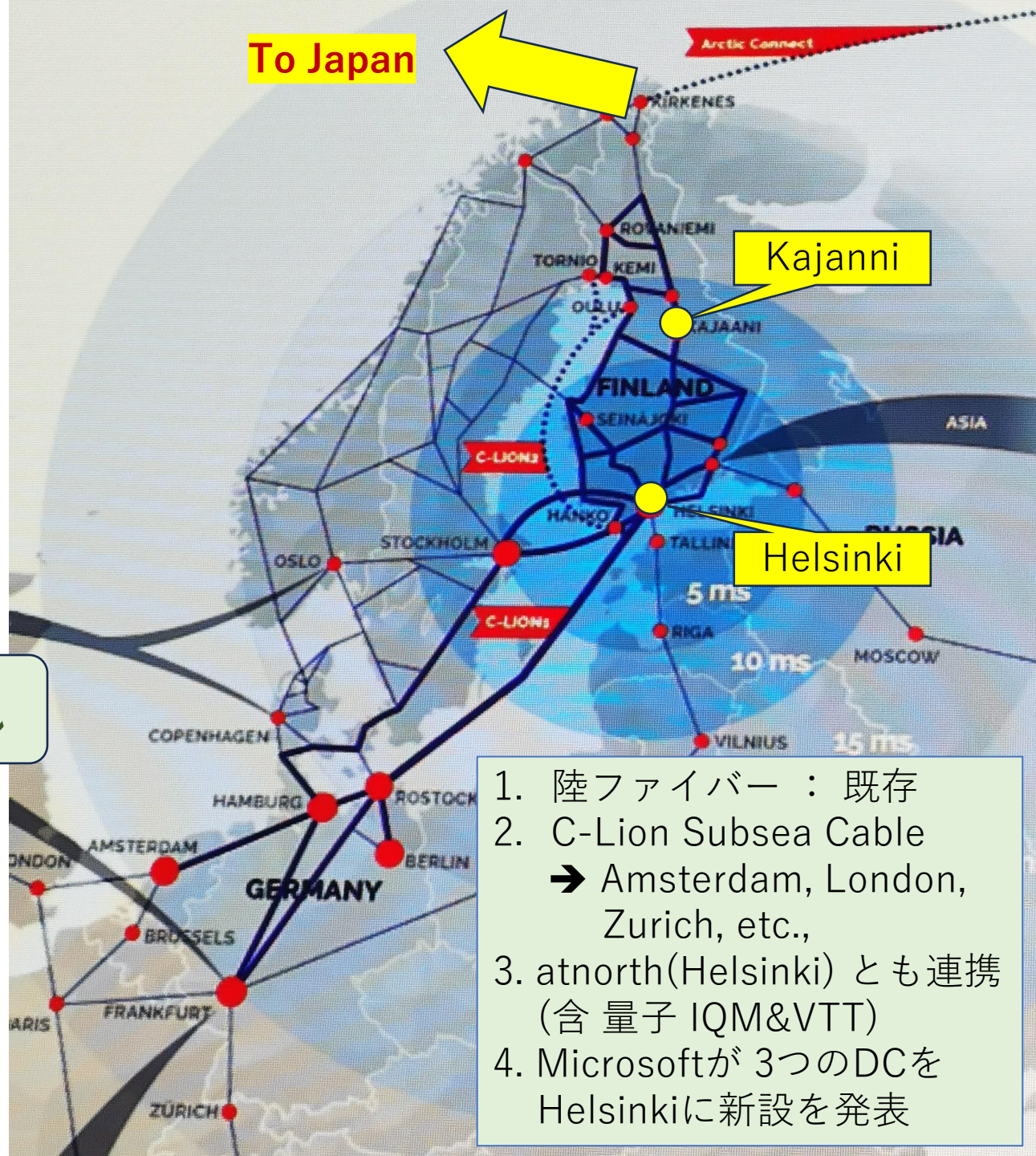
Cinia

ARTERIA

アルテリア・ネットワークス株式会社


Hokkaido
Kyushu
Tokyo
Osaka
ノルウェー海
スウェーデン
ノルウェー
フィンランド
バルト海
エストニア
ラトビア
リトアニア
モスクワ
Москва
北海
デンマーク
イギリス
アイルランド
ロンドン
London
オランダ
ベルリン
Berlin
ドイツ
プラハ
Praha
ベルギー
ポーランド
ベラルーシ

1. 100% 水冷
2. 非常用自家発電機は無し
   (データバクアップは有り)
3. 場所・電力の拡張性 有り



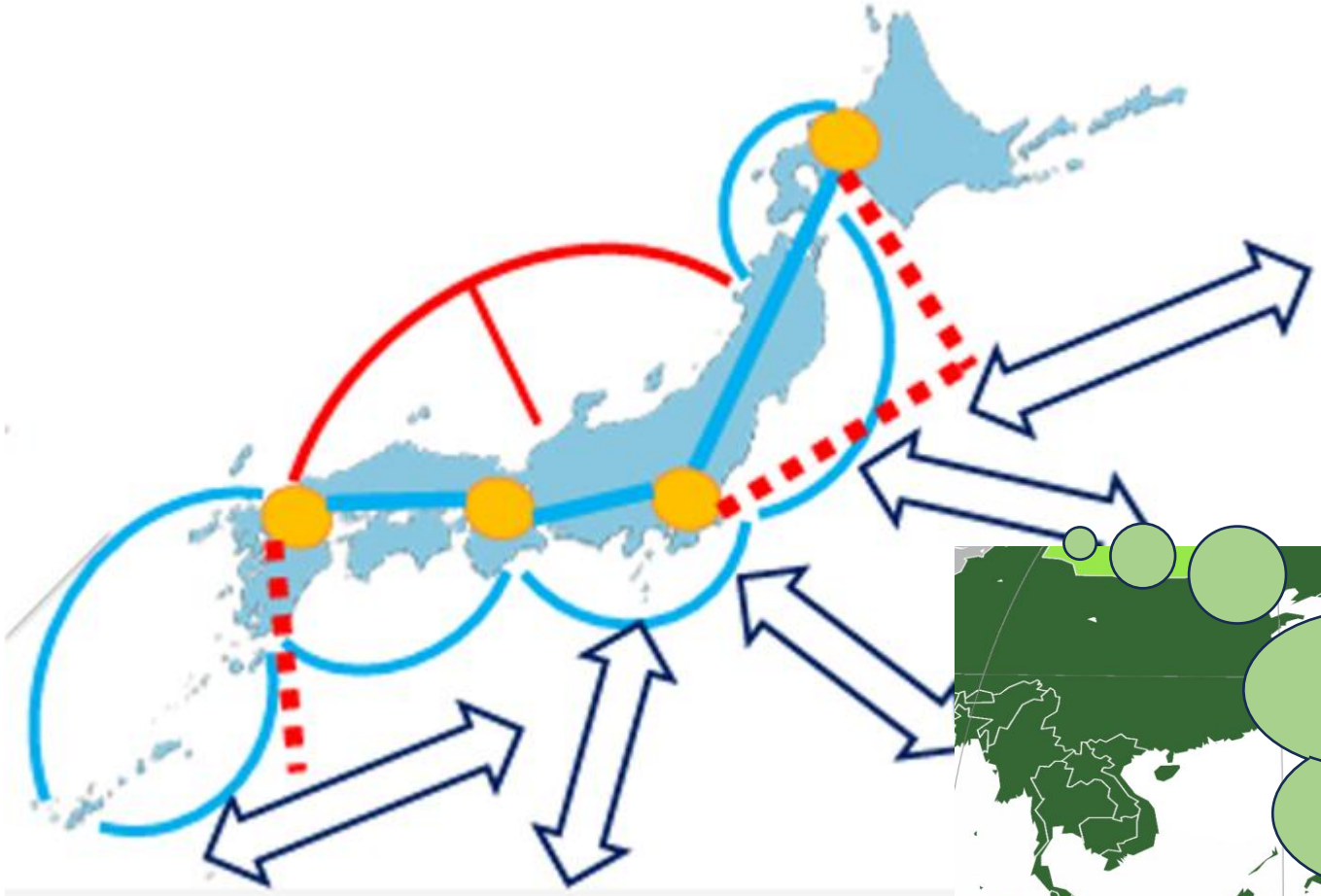
1. 陸ファイバー ： 既存
2. C-Lion Subsea Cable
   ➔ Amsterdam, London, Zurich, etc.,
3. atnorth(Helsinki) とも連携
   (含 量子 IQM&VTT)
4. Microsoftが 3つのDCを Helsinkiに新設を発表

ICT Solutions for Brilliant Minds

CSC

visited September 20(Wed), 2023

- 電気代： **1/5 ～ 1/7** !!!
  - ✓30 € MWh (5-7円/kWh) from PPA
  - ✓日本 35円/kWh
  - ✓Carbon **“Negative”** も発生
- **製紙工場の跡地を再利用**
  - ✓ 工場の躯体をそのまま利用
  - ✓ 250MWの(既存)電力引き込み
  - ✓ **100% 再生可能エネルギー電力**
- 地域冷暖房システムへの 熱供給
  - ✓夏季も販売可能(病院や宿泊施設等)
  - ✓大きな **税制優遇(22 € ➔ 0.6 € /MWh)**
  - ✓拡大予定
- 北極海ケーブル(FNF)は前提
  - ✓2027年 サービス開始の予定



We need “Global” collaboration and cooperation

～When we Think about the Earth～

① Speed of light is not fast….

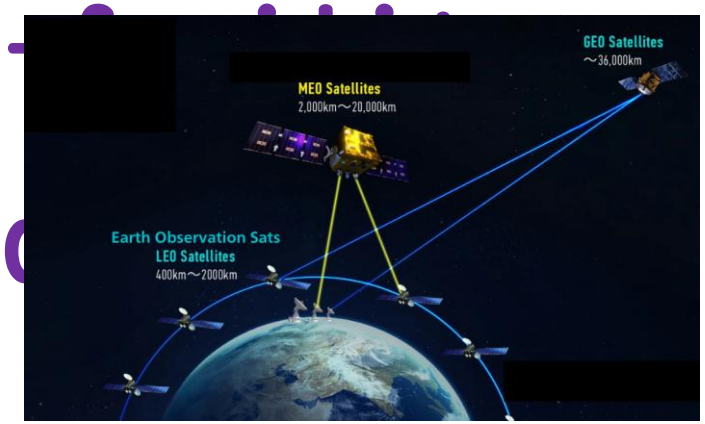
Moon 1,000 msec.

Inter-Continent: 200-300 msec.

Domestic: 30- 50 msec.

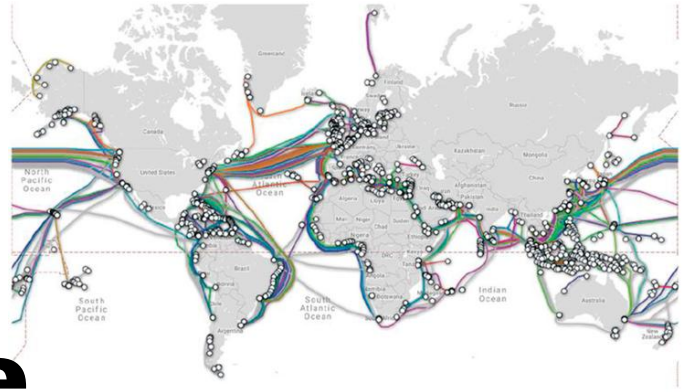
LOE satellite 3- 30 msec.

Intra- 2- 3 msec.



② Mal- of Renewal Energy

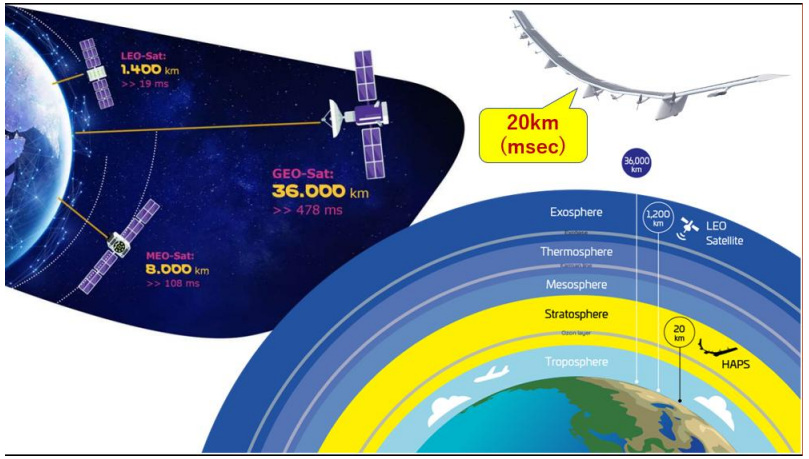
Infrastructure of Beyond 5G



1. Global Internet infrastructure

(a) Terrestrial

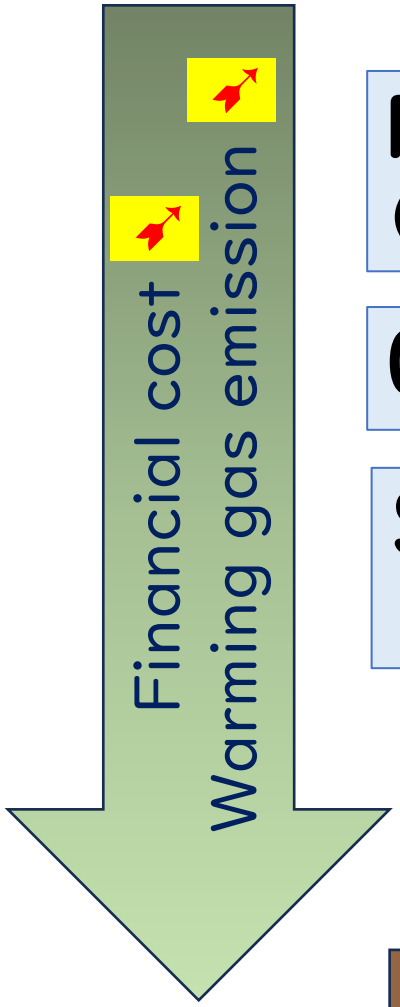
(b) Non Terrestrial



2. Energy consumption

(a) Radio AP and front hole

(b) Data Center



Railway,Road (train) (vehicle) vs Air/Sea Port (airplane) (ship) vs {n/a} (drone)

Optical fiber vs Cellular radio vs Satellite/WiFi

Synchronous (Japan) vs Local grid (USA/EU) vs Mobile (EV Power grid)

【Surface】 【{fixed}Point】 【{mobile}Point】

Installation, maintenance, and modification costs
= Global warming gas emission

Once again...

【Message 2/2】

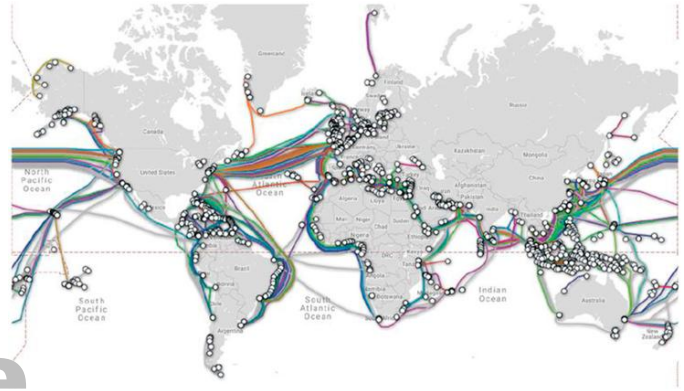
Transfer cost ... ...
= Energy Productivity…

Material >> Electricity >> Digital bits

(Power) (digital Function)

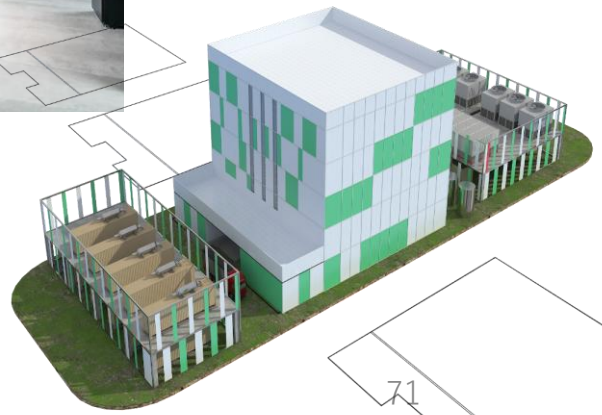
x0000 : x00 : 1

Infrastructure of Beyond 5G



1. Global Internet infrastructure
   (a) Terrestrial
   (b) Non Terrestrial

2. Energy consumption
   (a) Radio AP and front hole
   (b) Data Center with Power Grid

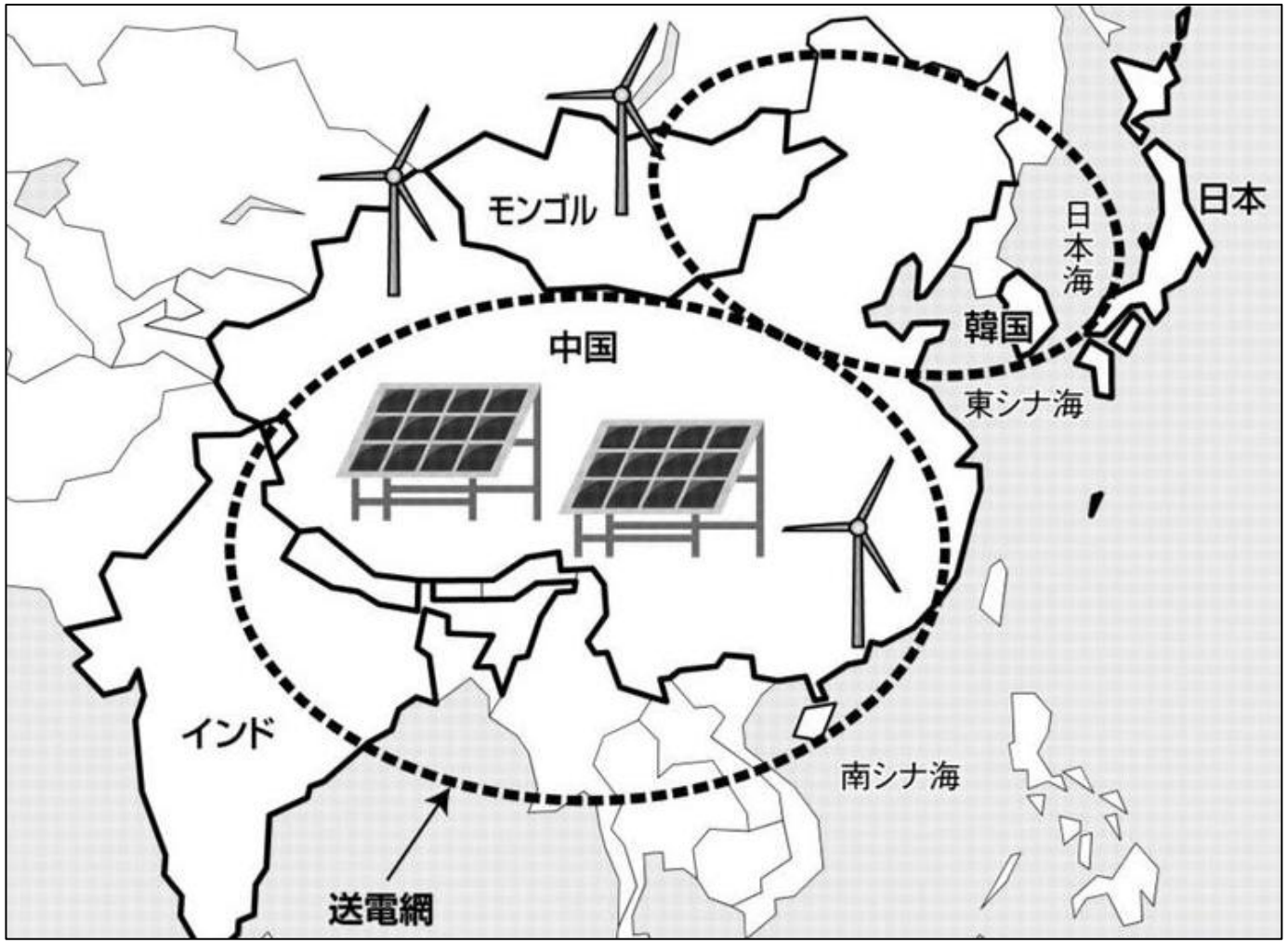


Best Practice in China:

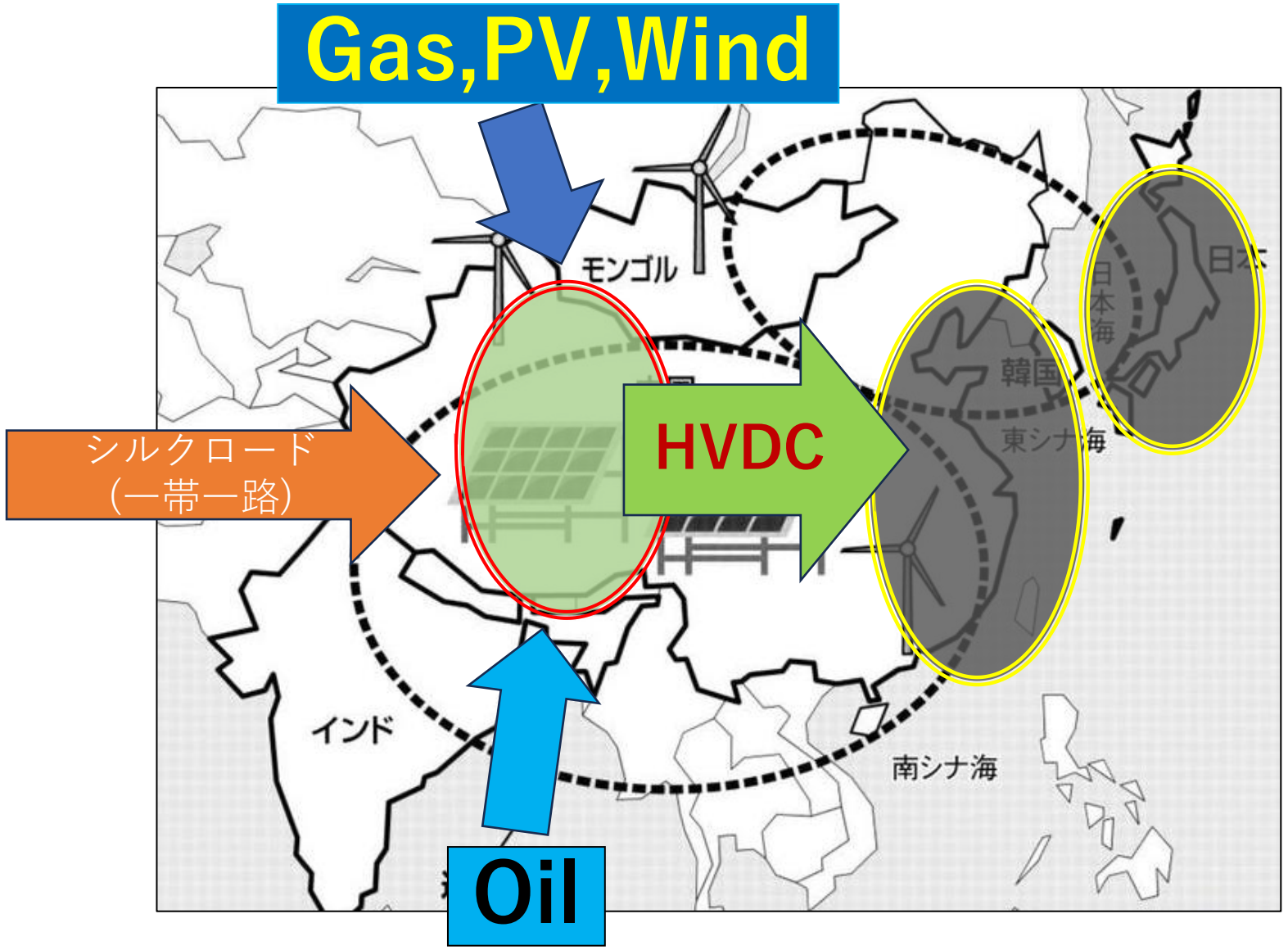
Electric Power Grid

➔ Cooperation with digital computation grid

Asian Super Power Grid Plan (2017)



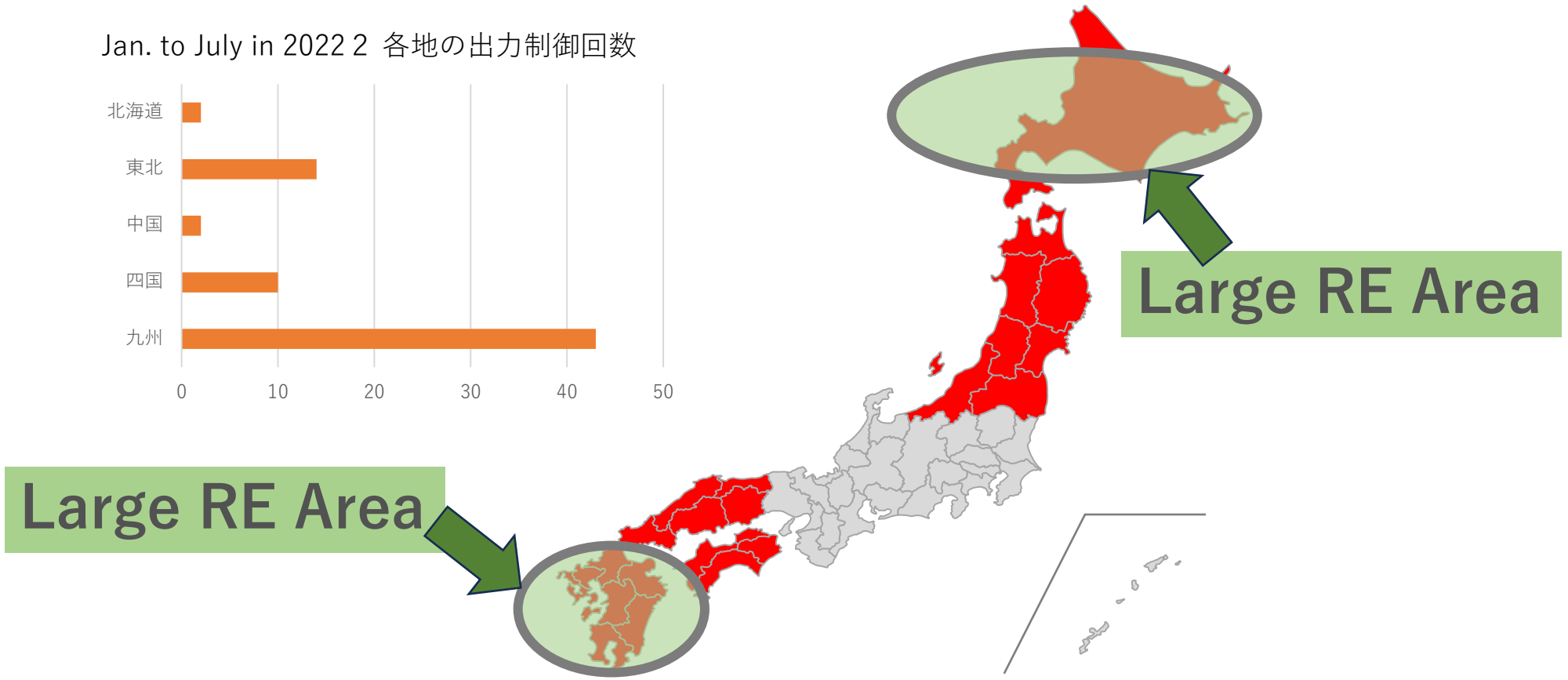
Asian Super Power Grid Plan (2017)



西電 東送
w/ HVDC

Electrical Power shortage in spring and winter in Japan

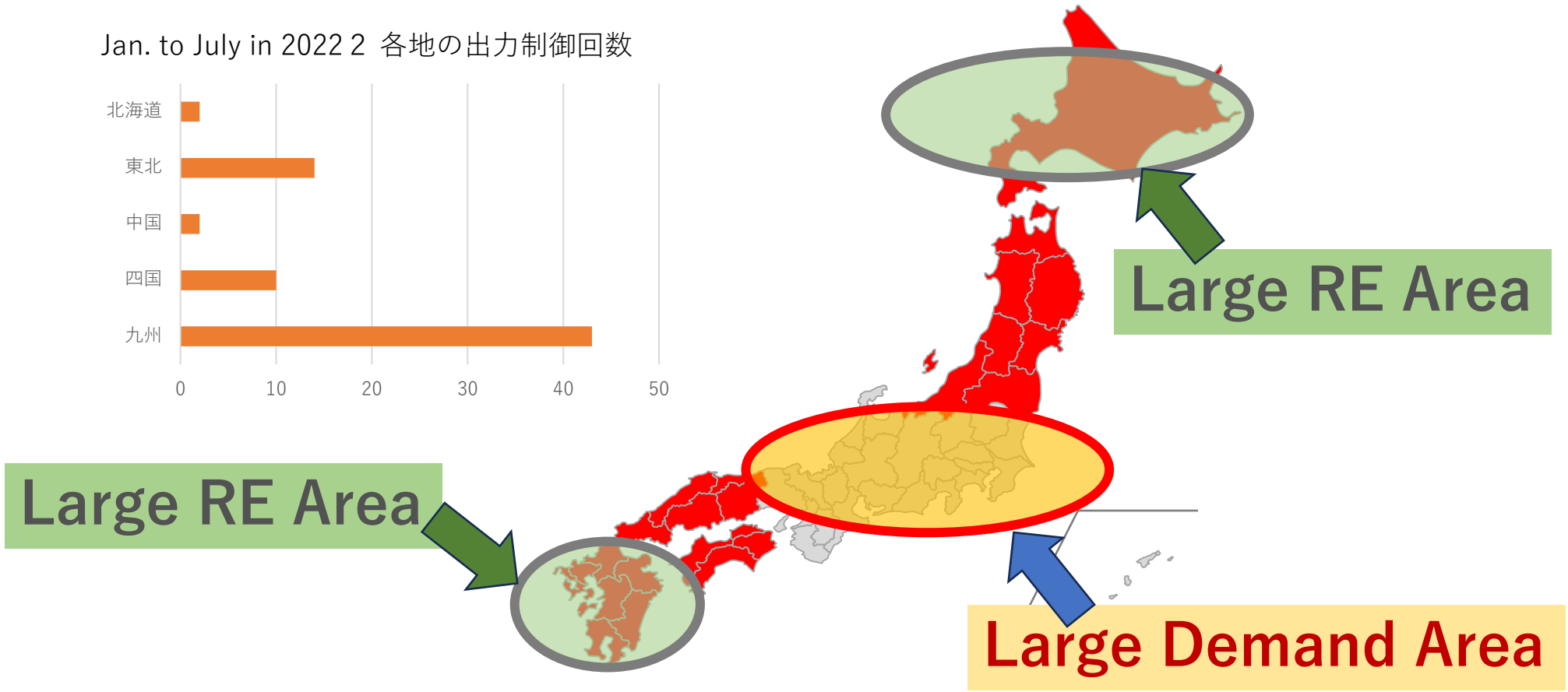
- ２０２２年再エネ出力制御は四国・中国・東北・北海道電力管内に拡大



【資料】 ビットメディア 代表取締役社長 高野 雅晴 氏
第４回イベント（2022年9月28日）
「データセンターの地域エネルギー貢献」

Electrical Power shortage in spring and winter in Japan

- ２０２２年再エネ出力制御は四国・中国・東北・北海道電力管内に拡大



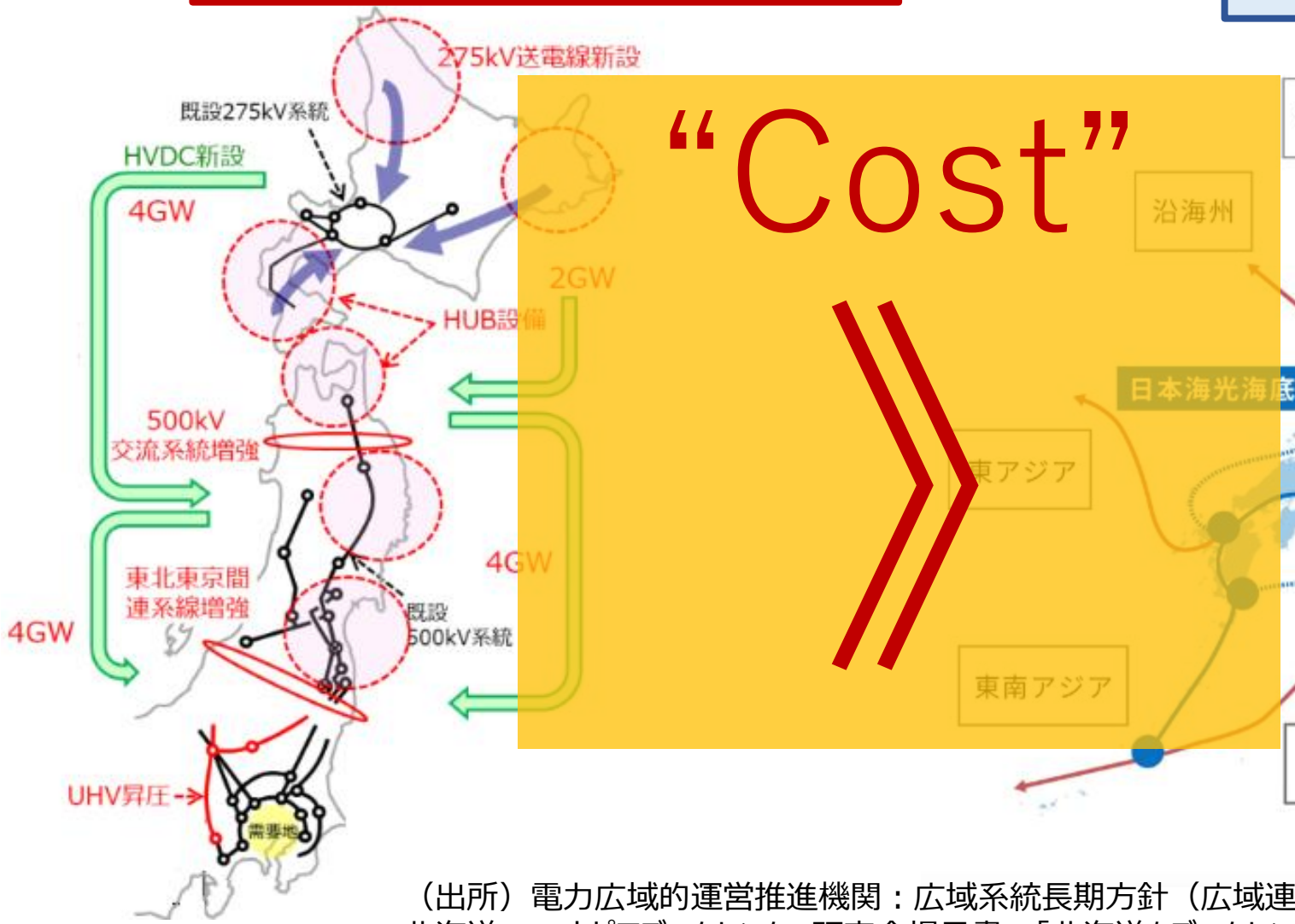
【資料】 ビットメディア 代表取締役社長 高野 雅晴 氏
第４回イベント（2022年9月28日）
「データセンターの地域エネルギー貢献」

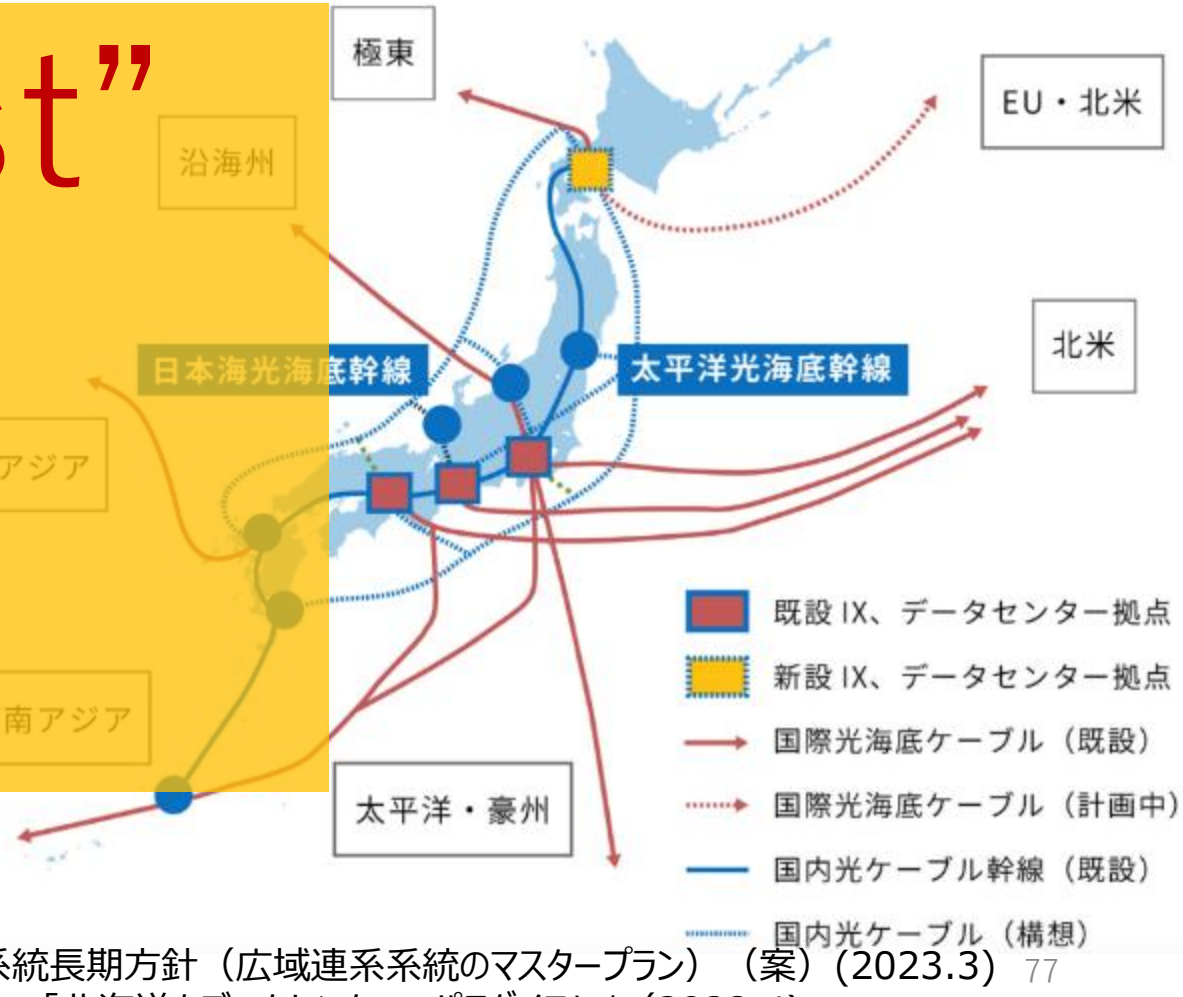
As a デジタル田園都市国家構想(Digital Garden City Initiative)

Electric Power

Information

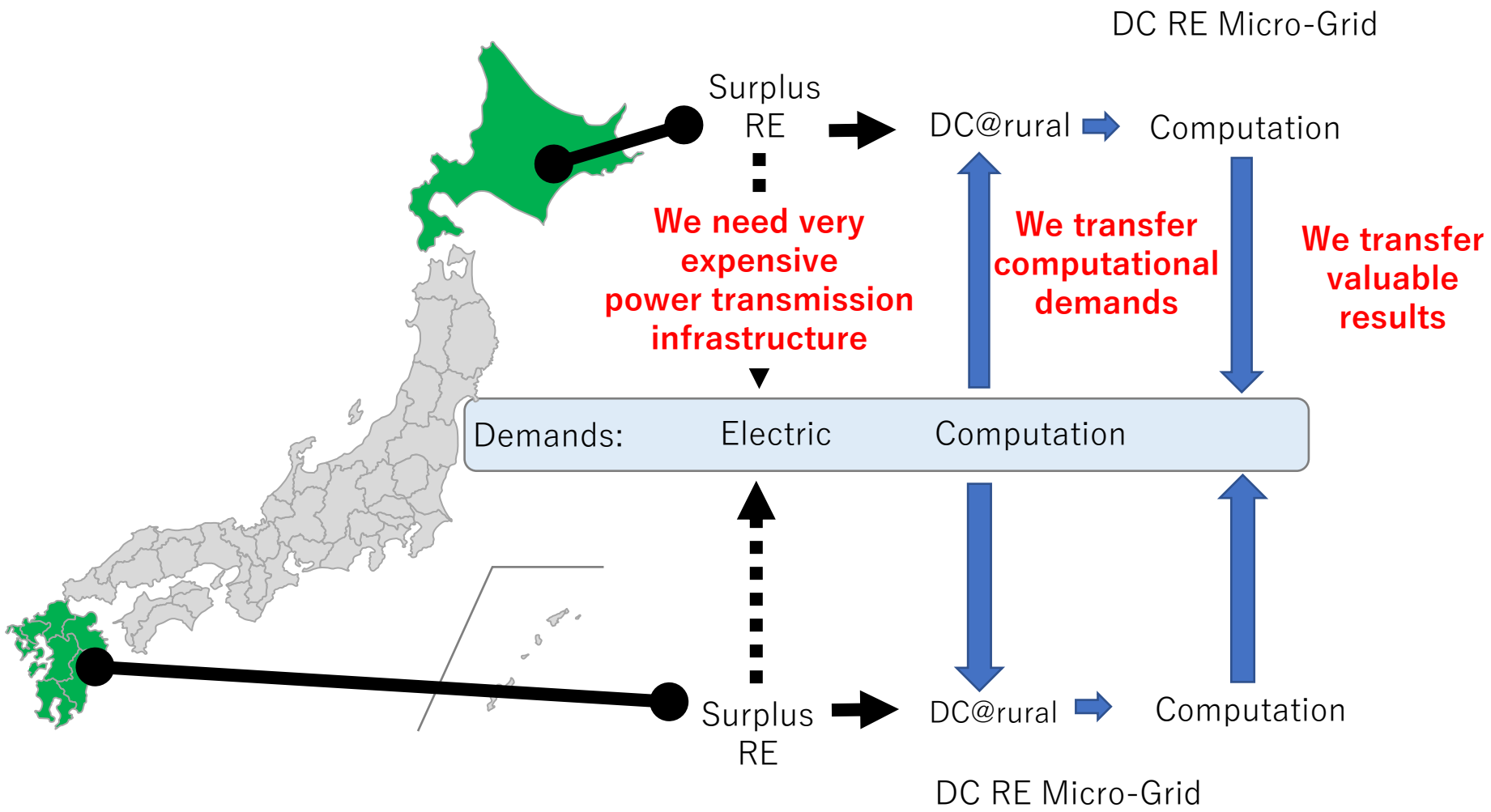
“Cost”





（出所）電力広域的運営推進機関：広域系統長期方針（広域連系系統のマスタープラン）（案）(2023.3)
北海道ニュートピアデータセンター研究会提言書：「北海道をデータセンターのパラダイスに」(2022.4)

Data Center in rural area can help !!!

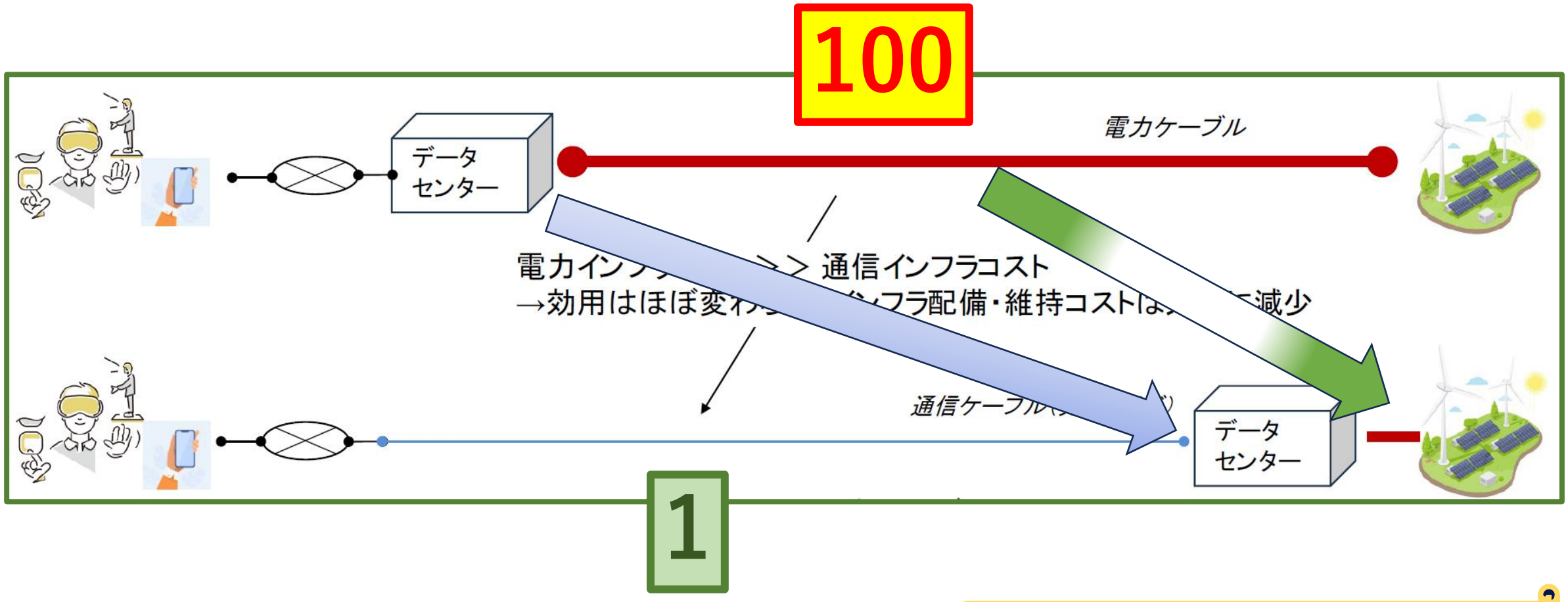


【資料】 ビットメディア 代表取締役社長 高野 雅晴 氏
第４回イベント（2022年9月28日）
「データセンターの地域エネルギー貢献」

https://highreso.jp/gpu/consulting

Practical implementation
Focusing on AI and Big Data Processing !!

1. Only for HPC/GPU service
   ➔ not serious PKIs
      ① Latency
      ② Service outage time
2. Cooperation with power grid company {@北陸}
   ➔DR: Demand Response
      ① ΔkW (=critical shortage)
      ② kWH (=Daily operation)



By Digital Twin

Carbon Neutral by EP-x00 (Energy Productivity)

	Of IT	By IT
AS IS	• Virtual Machine • Huge Memory & Processor	Digital Twin (CPS; Cyber Physical System) with LoD
TO BE	Electron → Photon → Quantum	Cyber First