Data Spaces Symposium 2024

Data Spaces Testbed Seen by the Japanese Data Society Alliance

MARCH 13, 2024

Noboru Koshizuka/越塚登

Professor, The University of Tokyo

This presentation is based on results obtained from “Research and Development Project of the Enhanced Infrastructures for Post 5G Information and Communication Systems” (JPNP20017), commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

Noboru Koshizuka
越塚　登

Professor, The University of Tokyo

Chair, Data Society Alliance

Director-General, Smart City Social Implementation Consortium

Chair, Green x Digital Consortium, JEITA

Chair, Weather x Business Consortium

Member, National Strategy Special Zone Advisory Council

Member, Digital Society Initiative Committee

Member, Communications and Information Technology Council

etc.

Bio., Noboru Koshizuka (leading initiatives, etc…)

東京大学
THE UNIVERSITY OF TOKYO

Professor
The University of Tokyo

DATA-EX
Data Society Alliance

Chair
Data Society Alliance

IDSA

IDSA Japan Hub Coordinator
IDSA Ambassador

AI Data Consortium

IV Industrial Value Chain Initiative

VLED

スマートシティ社会実装
コンソーシアム

Director
Smart City Social Implementation Consortium

WxBC

Director
Weather x Business Consortium

Green x Digital
Consortium

Director
Green x Digital Consortium
JEITA

UM International Universal Menu Association

Smart City Institute Japan

Bio., Noboru Koshizuka (Governments Relationships)

内閣府
Cabinet Office

国土交通省
Ministry of Land, Infrastructure, Transport and Tourism

東京都

Ube City

内閣官房
Cabinet Secretariat

気象庁
Japan Meteorological Agency

Kochi Prefecture

熊本 山江村

デジタル庁
Digital Agency

文部科学省
MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

横須賀市
Yokosuka City

熊本市
Kumamoto City

総務省
MIC Ministry of Internal Affairs and Communications

IPA

市原市
ICHIHARA CITY

札幌市
City of Sapporo

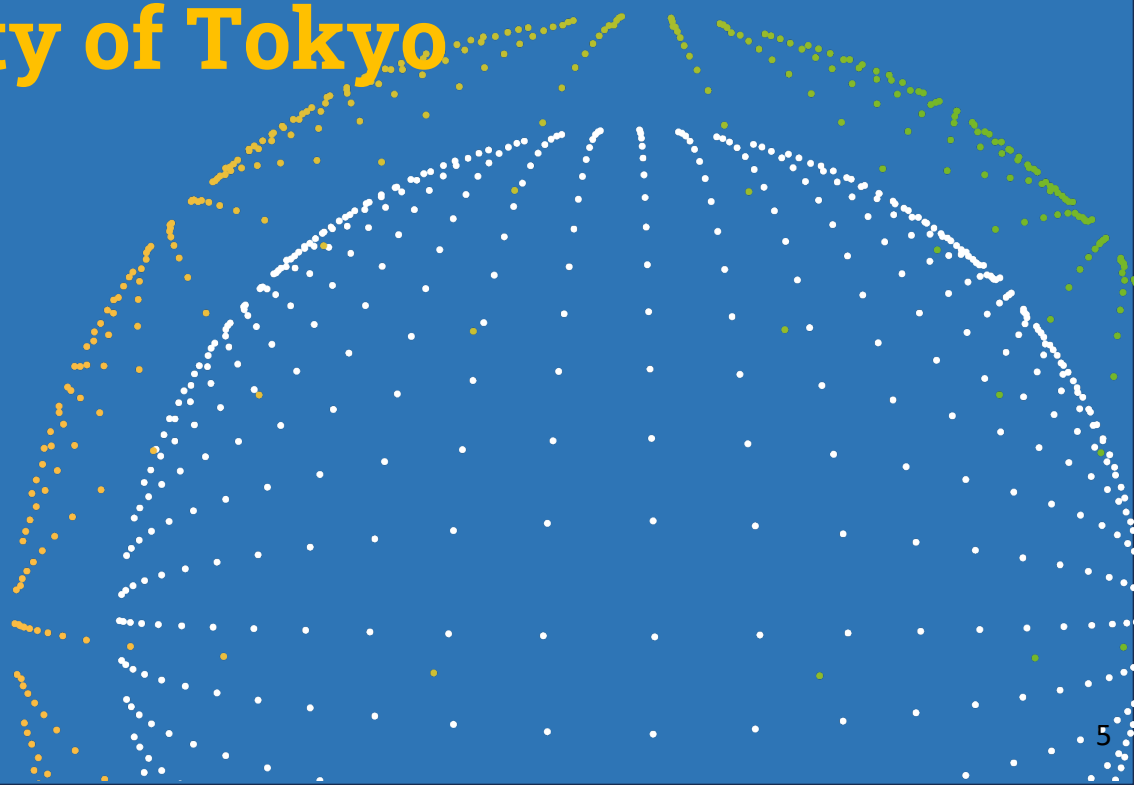
経済産業省
Ministry of Economy, Trade and Industry

NEDO
新エネルギー・産業技術総合開発機構
New Energy and Industrial Technology Development Organization

小田原市

三重県

PART 1
The University of Tokyo



UTokyo

THE UNIVERSITY OF TOKYO

東京大学
THE UNIVERSITY OF TOKYO

Photos courtesy of Hiroyuki Shima
Unless stated otherwise, all data is as of January 2023
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YouTube

東京大学

2022-2023

Number of Staff

(as of May 1, 2022)

Total 11,490	Academic staff 5,942
	Administrative staff 5,548

Number of Students

(as of May 1, 2022)

Total 28,691	Undergraduate 14,013
	Graduate 14,678

Undergraduate Enrollment

Division	Faculty	Regular Students		Research Students		Auditors		Total	
Junior	College of Arts and Sciences	6,637	145					6,637	145
Senior	Law	940	13			18		958	13
	Medicine	533	1	2				535	1
	Engineering	2,133	45	4	1	10		2,147	46
	Letters	753	13	2				755	13
	Science	662	14	2		2		666	14
	Agriculture	594	5	6				600	5
	Economics	792	13			2		794	13
	Arts and Sciences	497	47					497	47
	Education	228	1	1				229	1
	Pharmaceutical Sciences	193	5	1		1		195	5
Total		13,962	302	18	1	33	0	14,013	303

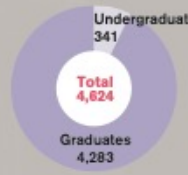
Graduate Enrollment

Graduate School	Regular Students						Research Students etc.		Total	
	Master's		Professional		Doctoral					
Humanities and Sociology	301	44			396	73	33	31	730	148
Education	189	14			255	26	26	20	470	60
Law and Politics	42	20	485	10	77	30	14	12	618	72
Economics	235	108			107	14	4	3	346	125
Arts and Sciences	541	141			652	153	68	60	1,261	354
Science	805	114			671	134	52	34	1,528	282
Engineering	2,346	640	15		1,271	630	105	91	3,737	1,361
Agricultural and Life Sciences	646	146			421	175	50	38	1,117	359
Medicine	105	40	57	3	934	124	35	17	1,131	184
Pharmaceutical Sciences	180	22			195	31	5	4	380	57
Mathematical Sciences	91	9			76	15			167	24
Frontier Sciences	902	316			574	254	67	66	1,543	636
Information Science and Technology	584	143			294	106	30	26	908	275
Interdisciplinary Information Studies	251	81			181	64	17	16	449	161
Public Policy			273	135	19	12	1	1	293	148
Total	7,218	1,838	830	148	6,123	1,841	507	419	14,678	4,246

Note: Figures in red indicate the number of international students.
Special Auditing Students and credited auditors are not included.

Number of International Students

(as of May 1, 2022)



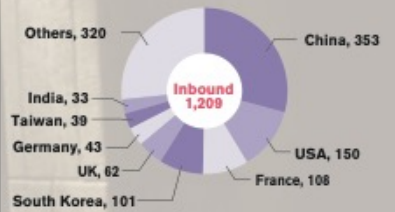
Top 10 Countries and Regions

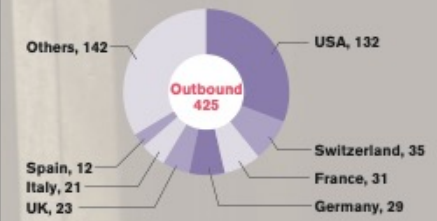
1	China	3,036	6	USA	86
2	South Korea	372	7	Thailand	59
3	Taiwan	162	8	Philippines	56
4	Indonesia	98	9	Singapore	34
5	India	87	10	Canada	33

Note: Special Auditing Students and credited auditors are included.

Visits by Researchers

(as of May 1, 2022)





Organization

- President
  - Board of Directors
  - Administrative Council
  - Education and Research Council
  - Office of the President
    - Academic Promotion Office
    - Committee for Presidential Initiatives
    - UTokyo Global Navigation Board
    - IR Data Office
    - UTokyo Future Society Initiative
    - Institute for Open Innovation
    - Office of University Professors
    - Office of Senior Professors
    - 150-year History Compilation Office
    - Division for Financial Management
    - Internal Audits Office
    - UTokyo Legal Division
    - Division for Digital Transformation
  - Administration Bureau
  - University Library
  - The University of Tokyo Archives
  - Faculties/College
  - Graduate Schools
  - Institutes
  - University Joint Education and Research Institutes
  - The University of Tokyo Institutes for Advanced Study (UTIAS)
  - Interdisciplinary Research Institutes
  - National Joint-Use Institutes
  - Collaborative Research Organizations

Undergraduate Education

Faculties/College

Faculty of Law
Faculty of Medicine
Faculty of Engineering
Faculty of Letters
Faculty of Science
Faculty of Agriculture
Faculty of Economics
College of Arts and Sciences
Faculty of Education
Faculty of Pharmaceutical Sciences

The University of Tokyo has a total of 9 Faculties and 1 College for undergraduate education. A key feature of the undergraduate education at the University of Tokyo is that the first two years (referred to as the Junior Division) are devoted to the acquisition of fundamental skills necessary for further study. In the final two years of undergraduate education (referred to as the Senior Division), students pursue their fields of specialization.

Graduate Schools

Graduate Schools

Graduate School of Humanities and Sociology
Graduate School of Education
Graduate Schools for Law and Politics
Graduate School of Economics
Graduate School of Arts and Sciences
Graduate School of Science
Graduate School of Engineering
Graduate School of Agricultural and Life Sciences
Graduate School of Medicine
Graduate School of Pharmaceutical Sciences
Graduate School of Mathematical Sciences
Graduate School of Frontier Sciences
Graduate School of Interdisciplinary Information Studies
Graduate School of Information Science and Technology
Graduate School of Public Policy

The University of Tokyo has 15 Graduate Schools that offer distinctive education and research opportunities. The University takes advantage of its feature as a multifaceted university possessing graduate schools specialized in diverse fields, to provide a broad-ranging, highly specialized education system for fostering scholars and professionals with a high level of expertise.

Education & Research

The University of Tokyo's greatest strength lies in its educational and research excellence. The new discoveries made on its campuses today become excellent research that benefits society tomorrow. The University is a place where outstanding students and researchers cultivate each other's skills while working together.

Nobel Prize Winners

The number of UTokyo professors and alumni receiving Nobel Prizes underscores the University's commitment to excellence. Professor Takaaki Kajita, who was awarded the 2015 Nobel Prize in Physics, researched under Special University Professor Emeritus Masatoshi Koshiba, one of the Nobel Prize in Physics recipients in 2002. In 2016, Honorary Professor Yoshinori Ohsumi won the Nobel Prize in Physiology or Medicine. The significant research breakthroughs that contributed to Professor Ohsumi receiving this recognition were made during his time as an associate professor at the University of Tokyo.

(as of November 22, 2022)

Cited Papers

One indicator of a researcher's achievements is how frequently their academic papers are cited by others. Papers by researchers at the University of Tokyo are highly cited.

*Number of times that UTokyo papers published from 2017-2022 were cited by papers indexed in Web of Science during the same five-year period (Source: data from the Essential Science Indicators database, accessed on November 15, 2022)

Books and Other Materials

(as of November 22, 2022)

In addition to the General Library on the Hongo Campus, many University organizations maintain collections of books in their own libraries. Materials kept include not only Japanese books, but also journals and numerous books written in languages other than Japanese.

Start-up Companies

(as of March 31, 2022)

The University of Tokyo offers an extensive range of support for entrepreneurial members of the University community who want to start companies that utilize research and educational outcomes produced at the University. Approximately 430 UTokyo-related start-ups have been established, and that number continues to grow.

学環・学府とは About

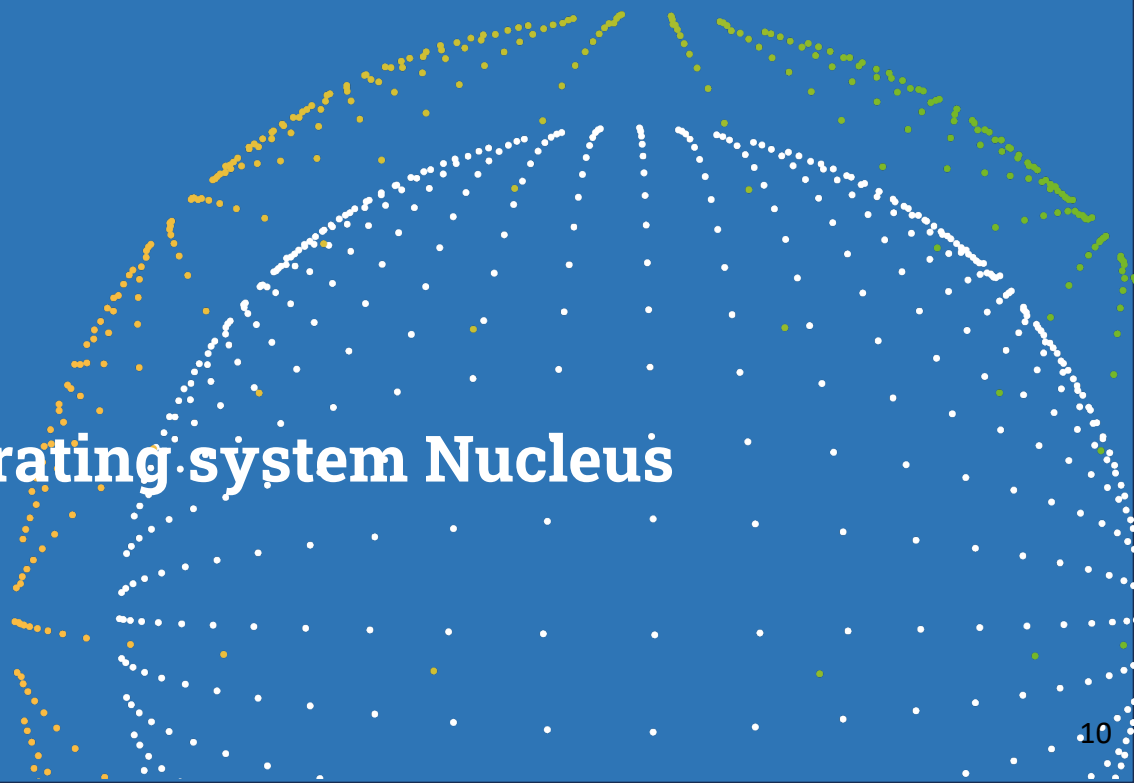
東京大学大学院情報学環・学際情報学府は、2000年に創設された大学院です。東京大学全学にわたる「情報」をめぐる諸領域を流動的に連携させるネットワーク組織として設計されました。「情報学環」（研究組織）と「学際情報学府」（教育組織）という分離された2つの機関が相関して両立することによって構成されています。情報学分野の総合的で高度な研究と教育を先端的かつダイナミックに推進する、斬新で独創的な組織です。

現在、人間の意識や行動、生命や身体、社会や文化、技術や芸術、産業や政治経済、法や政策、環境や国際関係など、人類文明のあらゆる側面が、「情報」によってラディカルな大転換を遂げつつあります。大学の知の制度も急激に変動するなかで、「情報」を共通言語とした「知の組み替え」が求められています。それに応えるため、情報学環・学際情報学府は、「情報」を交点として「知」を結び付け編み直していく先進的な研究教育活動を展開しています。「情報学」を探求することで、「知の構造化」に積極的に参加し、「知の公共性」を担保していくことを使命としています。

The dual structure comprising the III and GSII began its existence in the year 2000. It is a flexible network-like organization for graduate-level research and education that seeks to bind together the various fields of research related to "information" previously carried out separately in different departments of the University of Tokyo. It is structured in such a way that its two main components (III and GSII) work in tandem while retaining their separate identities as organizations devoted to research and education respectively. Together they form a creative and innovative structure for the pursuit of advanced research and education in all areas of the broad academic field of information studies.

Information is bringing about radical change in all areas of human civilization, including consciouness and behavior, life and the body, society and culture, technology and art, industry and the political economy, law and policy, and international relations and the environment. The very structure of academic knowledge is also being transformed. There are calls for a "restructuring of knowledge" based on the common language of "information". It is therefore the mission of the III/GSII to pursue advanced research and education that reformulates "knowledge" around the node of "information". By exploring all aspects of a broadly conceived field of "information studies", the aim is to contribute purposefully to the "restructuring of knowledge" with a commitment to the public nature of knowledge.

1-1. Background
TRON Project



The Realtime Operating system Nucleus

TRON Project （Japan、Since 1984）

- **TRON Project （Establihsed, 1984）**
  - The Realtime Operating system Nucleus

- **Ultimate goal is to realize IoT/Ubiquitous Computing Environments**
  - “Highly Functionally Distributed System”
  - “MTRON” (Macro TRON)
  - “Computer Everywhere Environment”

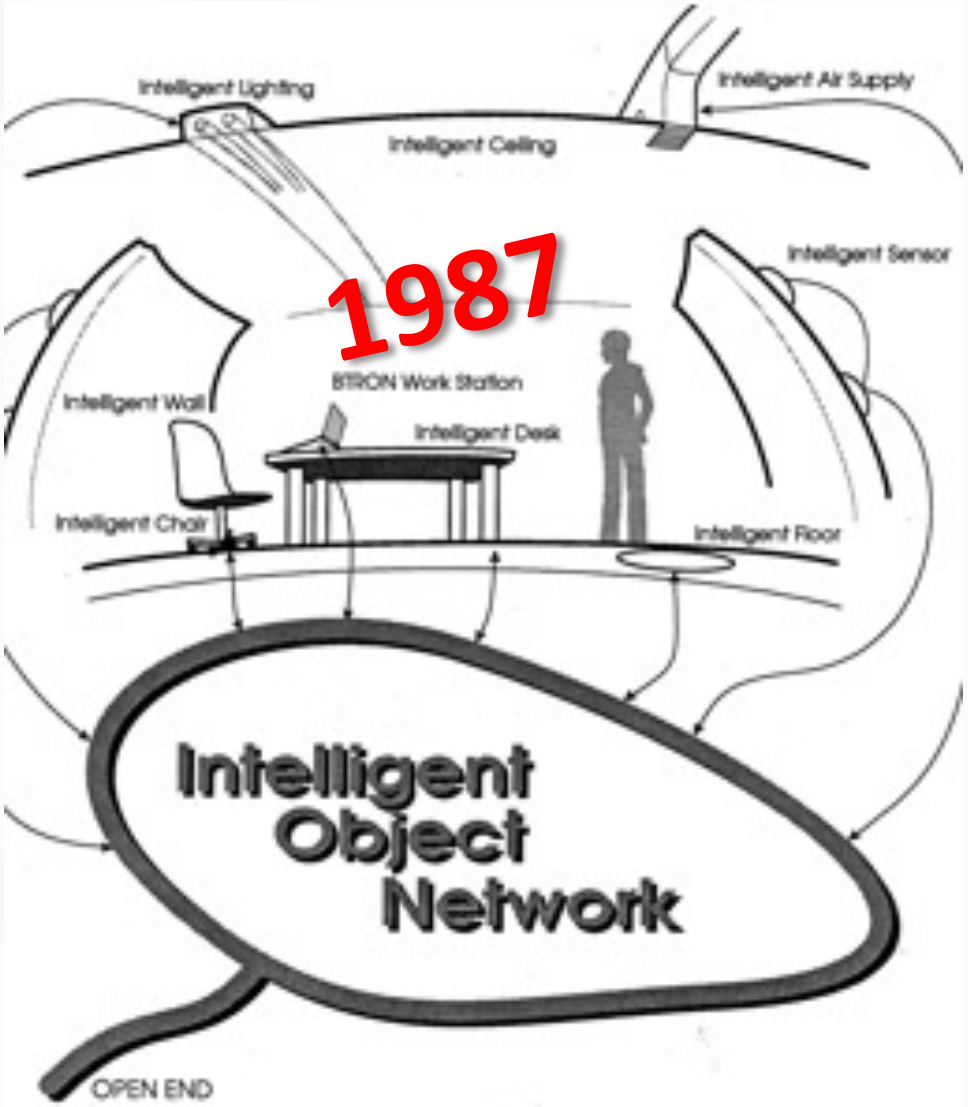
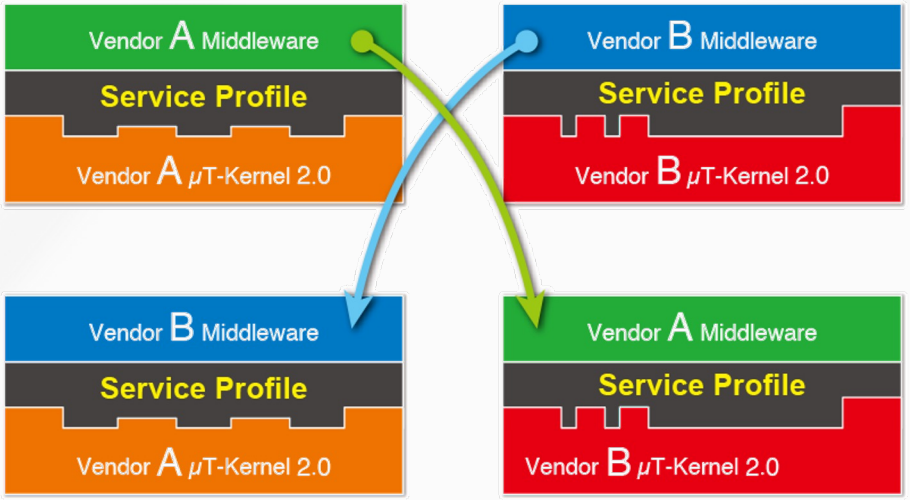


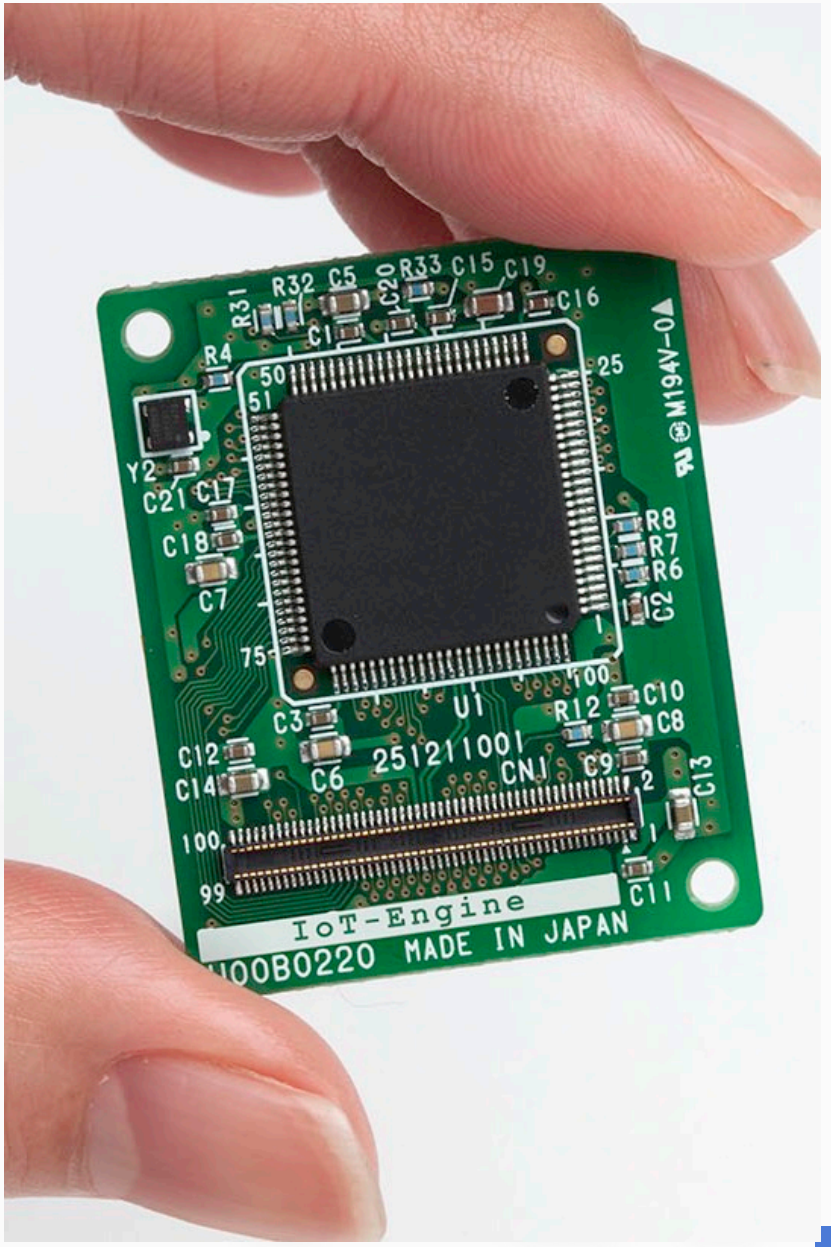
Figure 1. Highly Functionally Distributed System Environment

Dr. Ken Sakamura: “TRON Project 1987”

µT-Kernel: RTOS for IoT of TRON Architecture

- **The latest version of TRON OS for small-scale microcomputer**
  - For 16-bit single-chip microcomputer and environments where the amount of ROM and RAM is limited
  - "µT-Kernel" designed to meet the demands to use small-scale MCU
- **Keep balance of two conflicting demands**
  - "strict specification" for improving the development efficiency
  - acceptance of adaptation/optimization for improving execution performance





TRON has been embedded into various products!

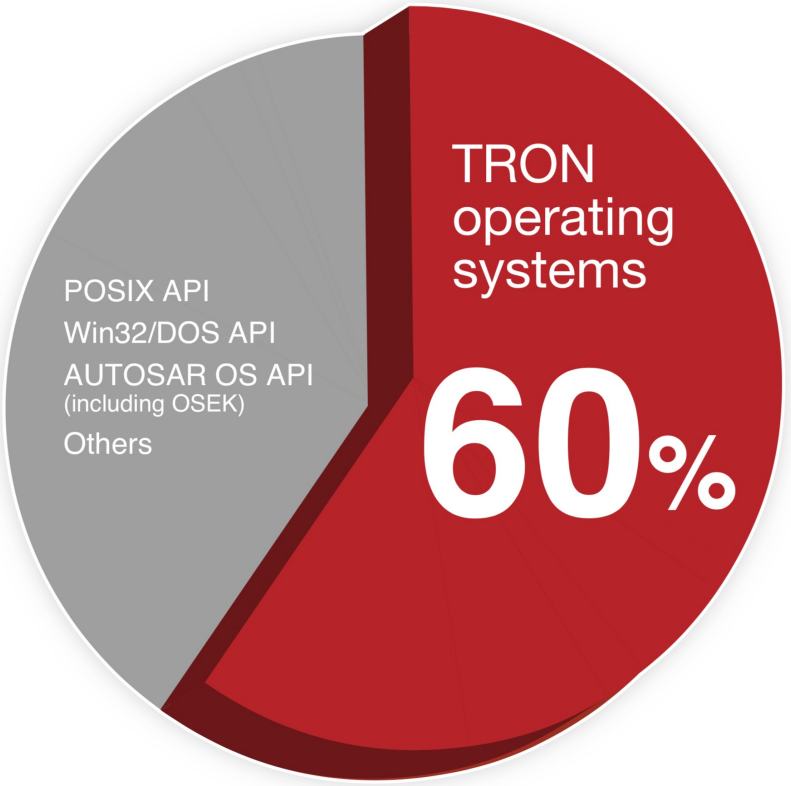
Spaceship Hisaki (Sprint-A) was launched by Epsilon-1 (2013, JAXA)

"Hisaki (Sprint-A)"

- Spectroscopic Planet Observatory for Recognition of Interaction of Atmosphere
- T-Kernel controls all functions

Epsilon-1: controlled by ITRON

Market-share of TRON OS in Embedded Real Time OS Field

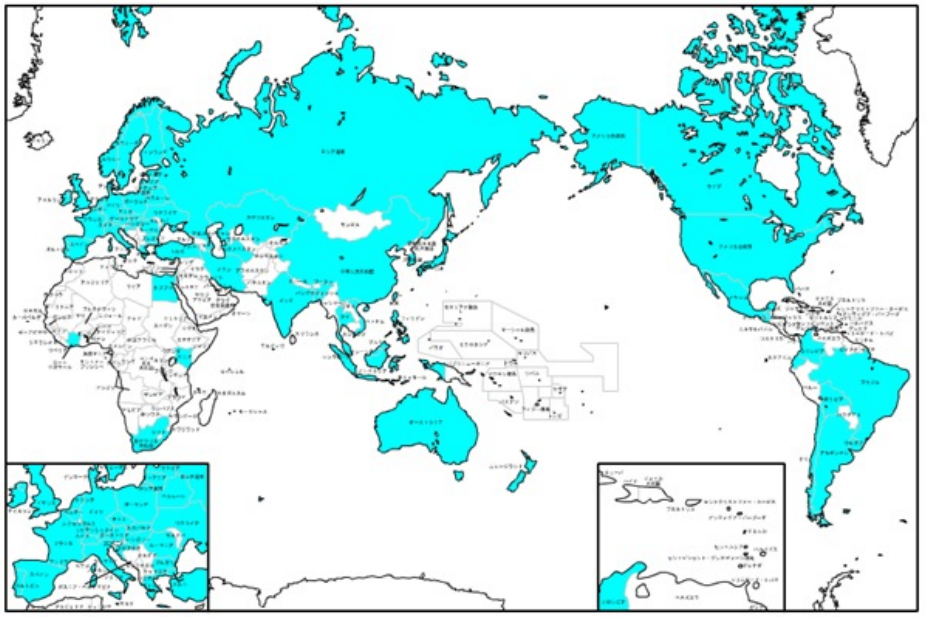


Usage in the RTOS field of TRON operating systems

- No.1 in "API of embedded operating systems" category since the start of survey in 1999

Source: Result of the Survey on Embedded Real-time OS Usage Trends at Embedded Technology Exhibitions in November 2018 (Tentative result)

S



Map of TRON OS User Countries

TRON Smart House (1989)

- More than 1,000 of computers and sensors in the house of 333m^2

Chiba TRON Smart City (1989)

http://umdb.um.u-tokyo.ac.jp/DKankoub/Publish_db/1997DM/DM_CD/DM_TECH/BTRON/PROJ/CITY.HTM

Computerized City for Human

Future city in which vast number of intelligent objects and communication machines are integrated by highly functionally distributed system

- Function Distribution
- Space Distribution
- Cooperation Distribution
- Time Distribution

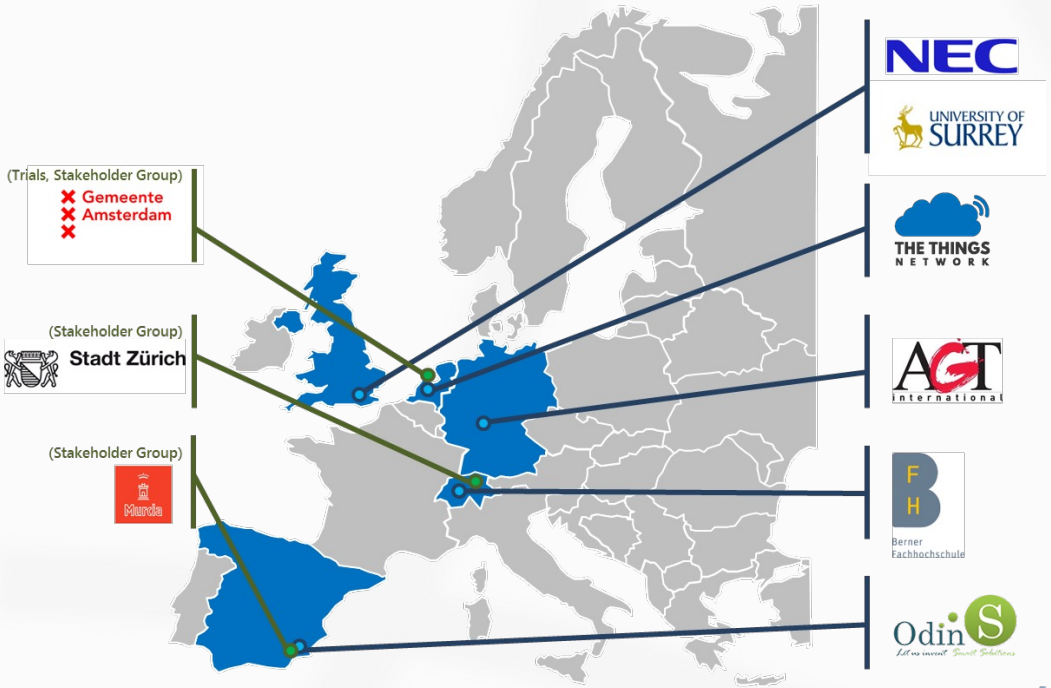
Basic Concept

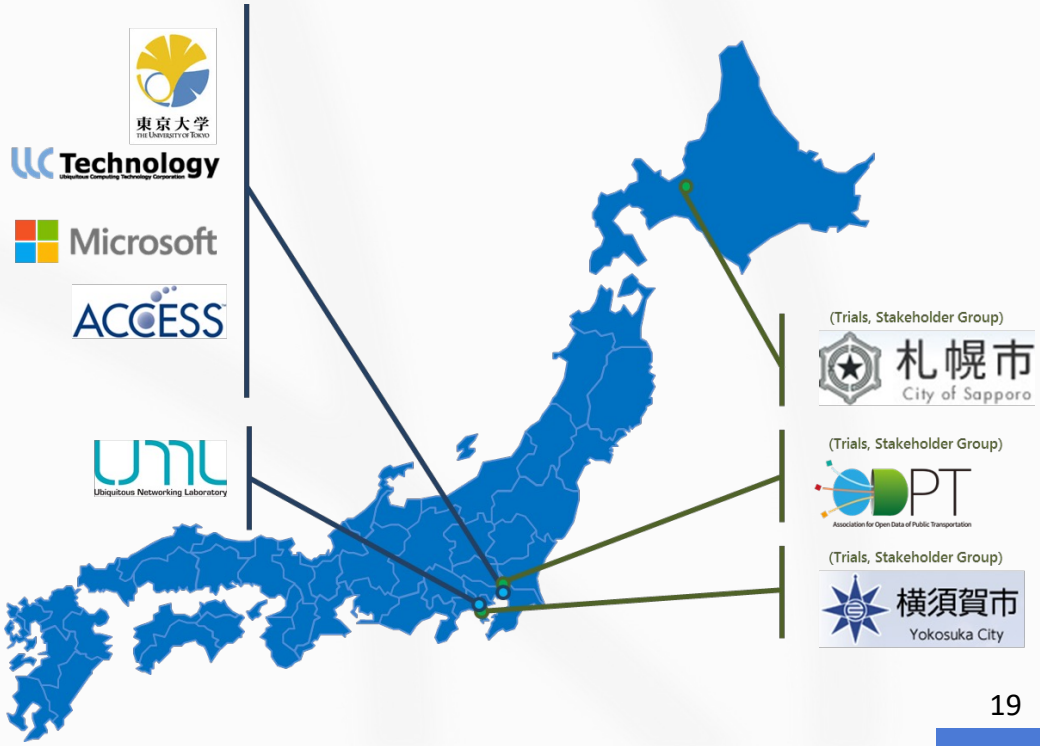
- Harmony with nature, environmental protection, resource conservation
- Comfort, safety and inclusive
- Increased intellectual productivity/intellectual stimulation

1-2. Background
CPaaS.io: City Platform as a Services Integration and Open EU-Japan Collaboration for Smart Cities

The Realtime Operating system Nucleus

CPaaS.io Project Partners





FIWARE-TRON Interoperable Architecture for Smart City Platform

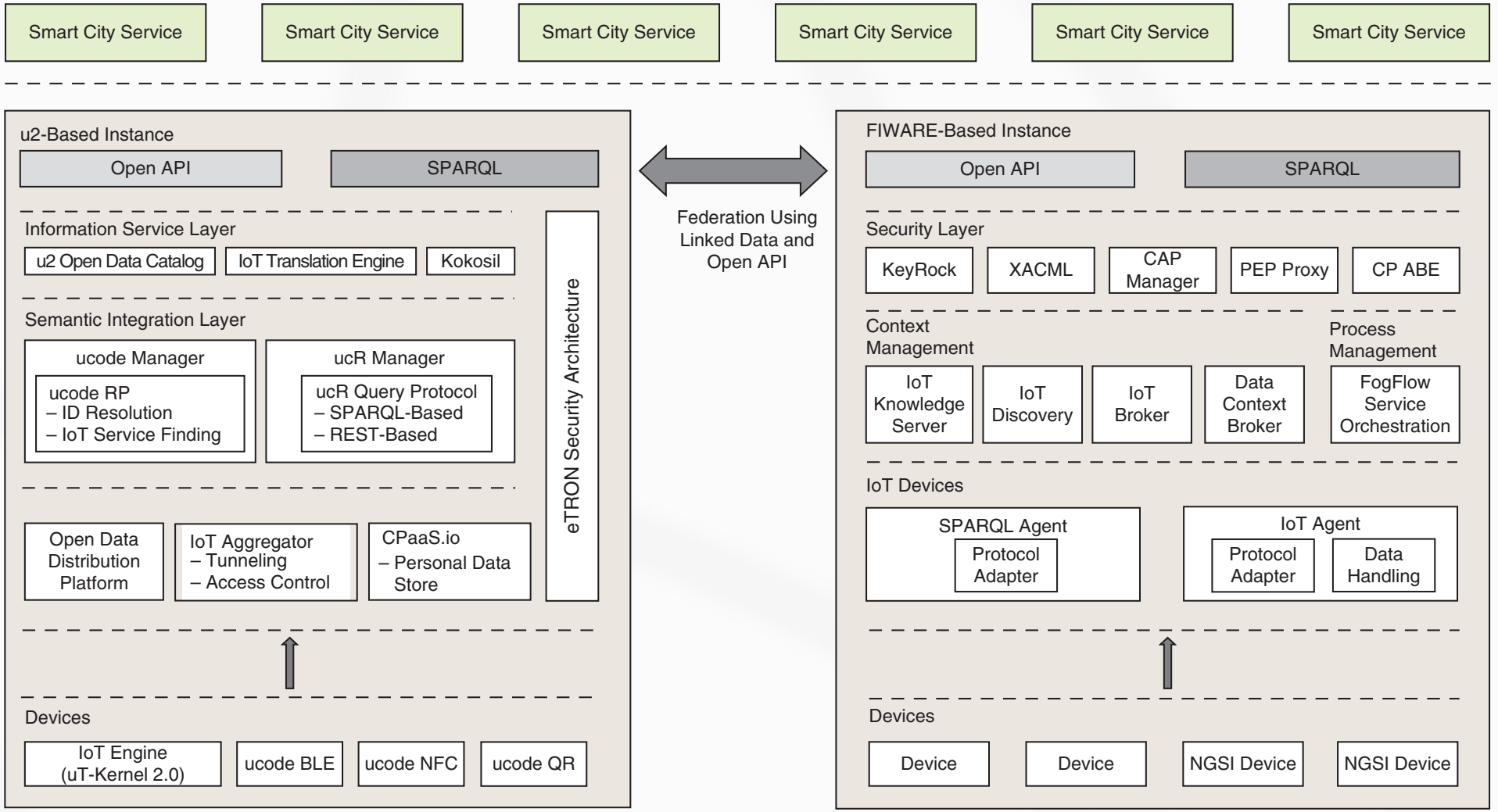


FIGURE 1. The CPaaS.io platform architecture showing the components and the federation between a u2-based instance and a FIWARE-based instance. CAP: capability; PEP: policy enforcement point; CP ABE: ciphertext-policy attribute-based encryption; NFC: near-field communication.

N. Koshizuka, S. Haller, and K. Sakamura: "CPaaS.io: An EU-Japan Collaboration on Open Smart City Platforms," IEEE Computer, December, 2019.

CPaaS.io: An EU–Japan Collaboration on Open Smart City Platforms

Noboru Koshizuka, The University of Tokyo
Stephan Haller, Bern University of Applied Sciences
Ken Sakamura, Toyo University

Data-driven cities and governments rely significantly on data collection, management, and distribution platforms. In this article, we introduce CPaaS.io, a collaborative project between Japan and the European Union with the goal of establishing common smart city platforms for deployment in real smart city use cases.

Today, data are crucial to the functioning of society. In fact, it is sometimes said that the most competitive area in information and communications technology (ICT) is not algorithms but data. The ICT National Strategy of Japan known as *Society 5.0* proposes a data-driven society in which data help solve problems in the fields of mobility, supply chains, healthcare, and lifestyle to name a few. This will generate further economic growth and increase quality of life. Consequently, both in Japan and the European Union (EU), data have been termed the *oil of the 21st century*. These data come from a variety of sources: the Internet of Things (IoT) and sensors, open government resources, social media, and industry and business repositories, not to mention the wealth of personal information from individual users. These can be obtained, linked, and analyzed to extract valuable intelligence and transform our society for a better future. In the deployment of smart city services, providing a platform for data collection, management, and distribution is crucial.

Digital Object Identifier 10.1109/MC.2018.2880019
Date of publication: 5 February 2019

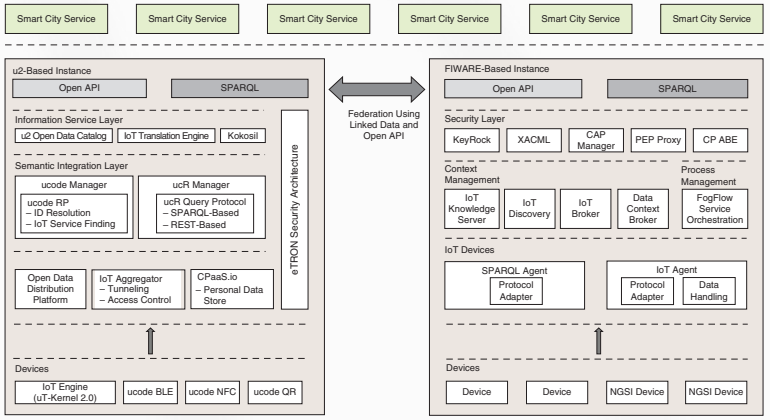


FIGURE 1. The CPaaS.io platform architecture showing the components and the federation between a u2-based instance and a FIWARE-based instance. CAP: capability; PEP: policy enforcement point; CP ABE: ciphertext-policy attribute-based encryption; NFC: near-field communication.

currently making efforts to build a Public Transportation Open Data Center offering information on railways, buses, airlines, and all other means of transportation in Tokyo (Figure 2). The demand for open data of public transportation has become very high, and the number of association members has increased to 56 corporations (as of 23 April 2018) and nine observers.

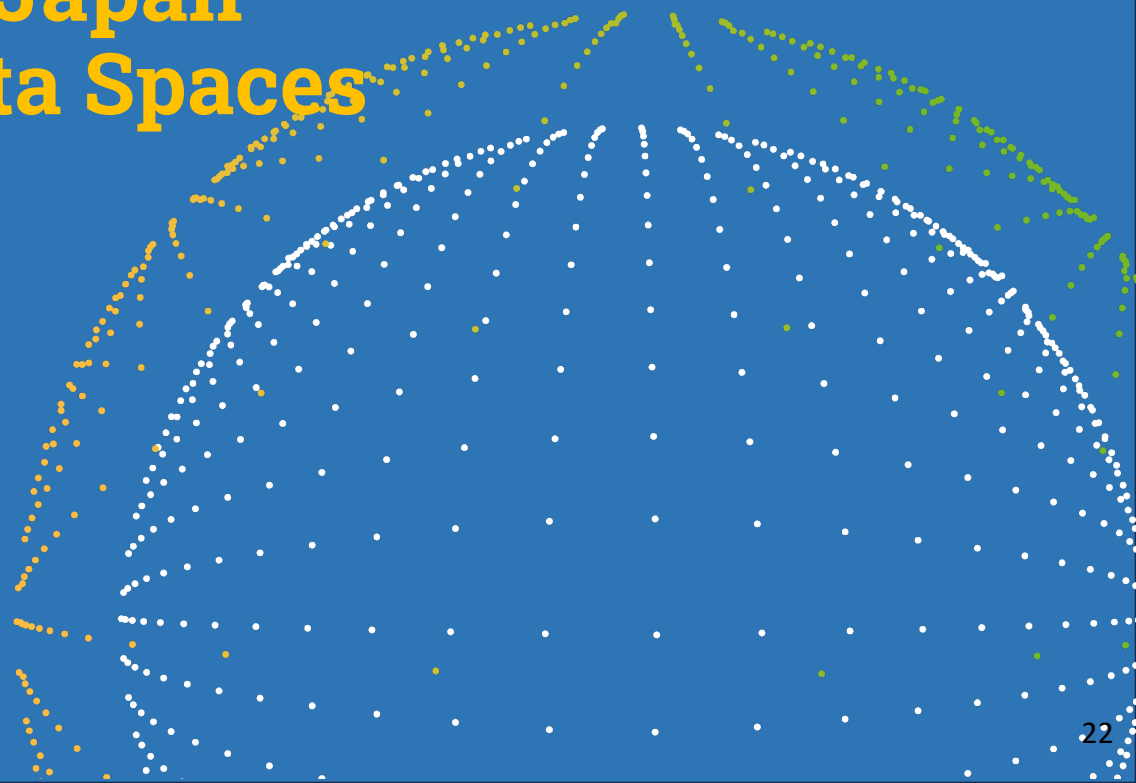
From the standpoint of technology, ODPT uses IoT and open data for this activity. Static data, such as timetable and station map data, can easily be distributed using only open data technologies, but dynamic, real-time data, such as train/bus location and their real-time operation status data, must be dealt with using IoT technology such as sensor networks and geolocation systems.

Location-aware city guide services based on open data, Sapporo

International tourism is a big industry both in Japan and Europe. For example, in 2016, the number of international tourists arriving in Japan increased to over 24 million; in the EU, close to 500 million arrivals were counted. Clearly, tourism support is a relevant application for the smart city. Sapporo is one of Japan's most popular tourist cities, offering nearby ski resorts, hot springs, and many other attractions. Promoting tourism using digital technologies and a smart city platform is very much in the interest of Sapporo.

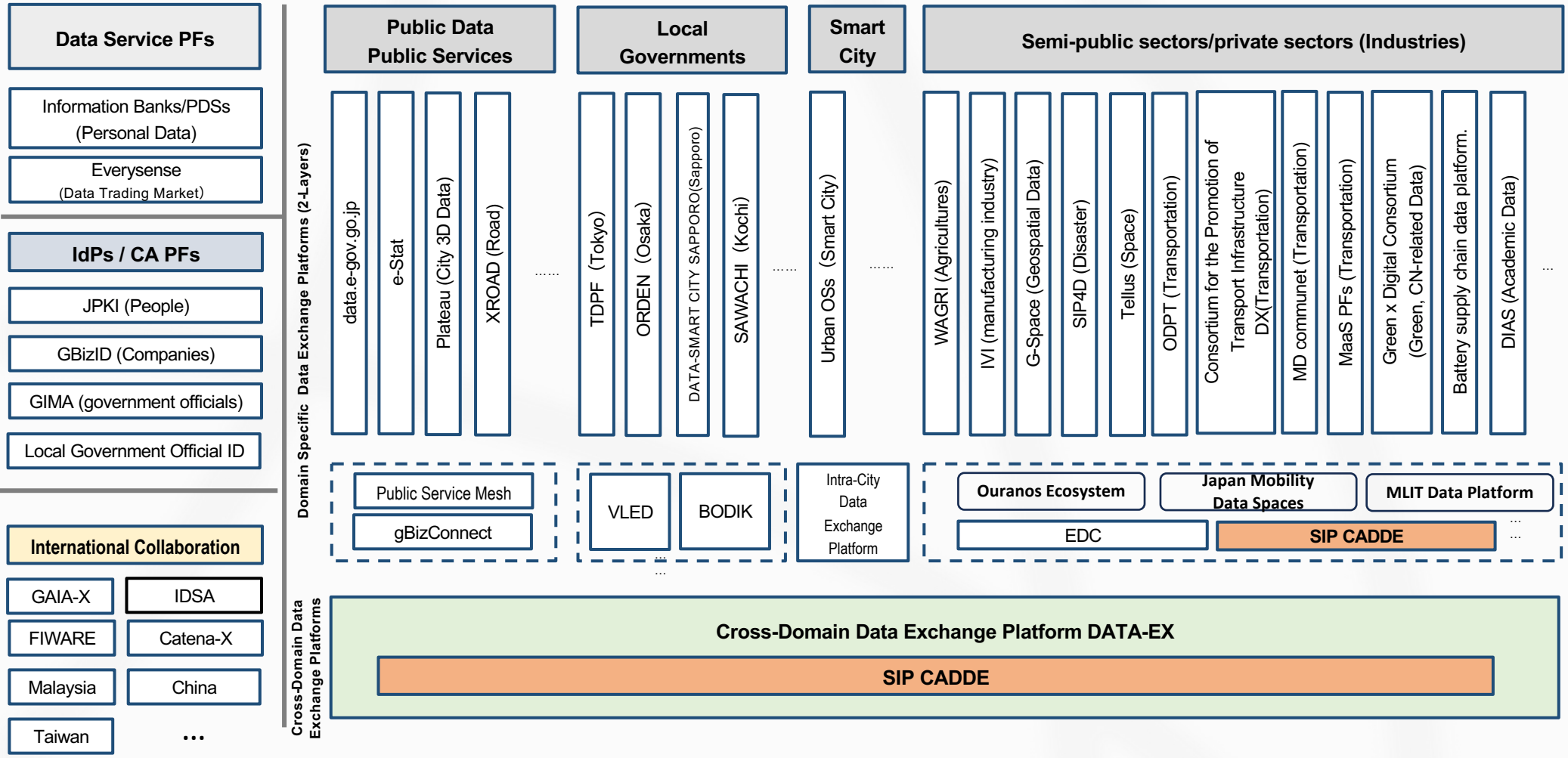
In a joint project with the city, we first established the Sapporo Open Data Association in 2016 with 22 organizations (sapporo.odcity.org). This association conducts research, such as studying open data provisioning and its uses for Sapporo tourism and public transportation, and holds events like application contests, hackathons, and ideathons; promotes open data usage; and encourages application usage on smart phones during feasibility study experiments. We have collected, integrated, and published many data sets related to tourism, e.g., sightseeing, hotel, restaurant, and public transportation information. For the latter, we use the Public Transportation Open Data Center, as mentioned previously.

PART 2
Initiatives in Japan Related to Data Spaces

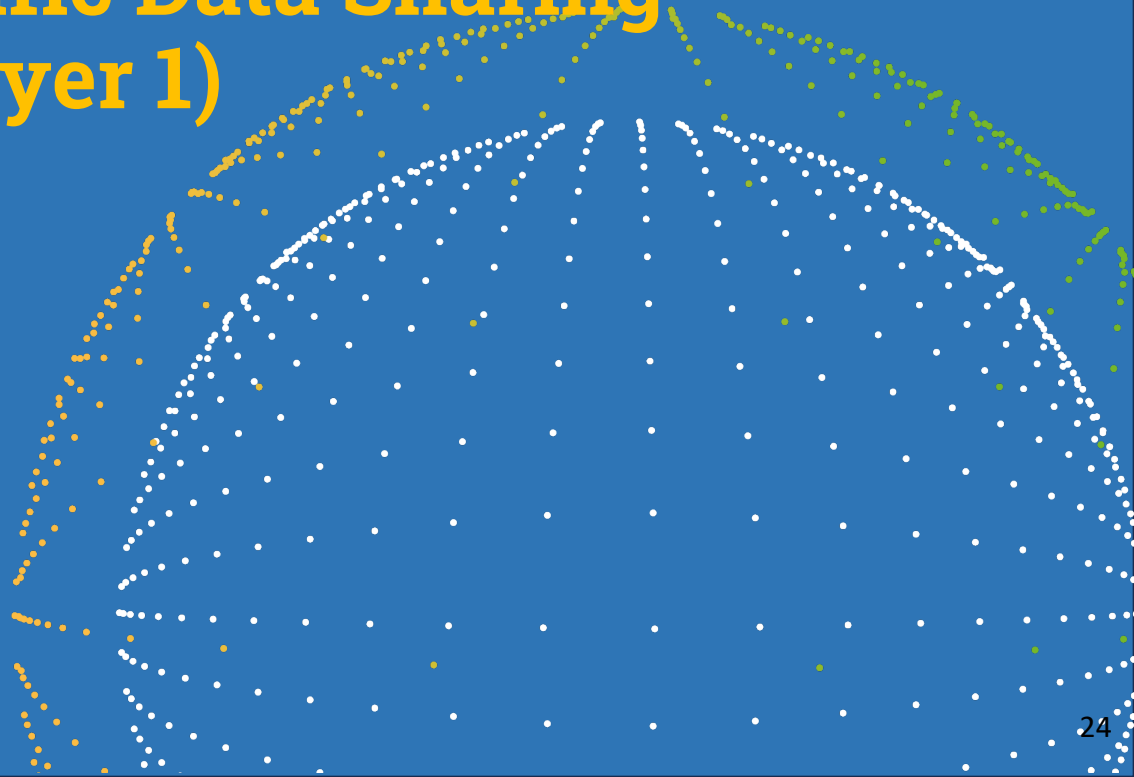


Overall Status of Data Platform Initiatives in Japan

Prepared on the basis of the 4th (in 2022) Data Strategy Promotion WG document and other documents



2-1
Domain Specific Data Sharing Platforms (Layer 1)



Domain Specific Data Sharing Platforms (1st Layers)

National Government Open Data

Local Government Open Data

Next 次世代 Internet of Plants

Tokyo Metropolitan Government

Personal Data Store

Information Bank (Personal Data)

Weather

Data Trading

Public Transportation

Public Transportation

Manufacturing

Academia

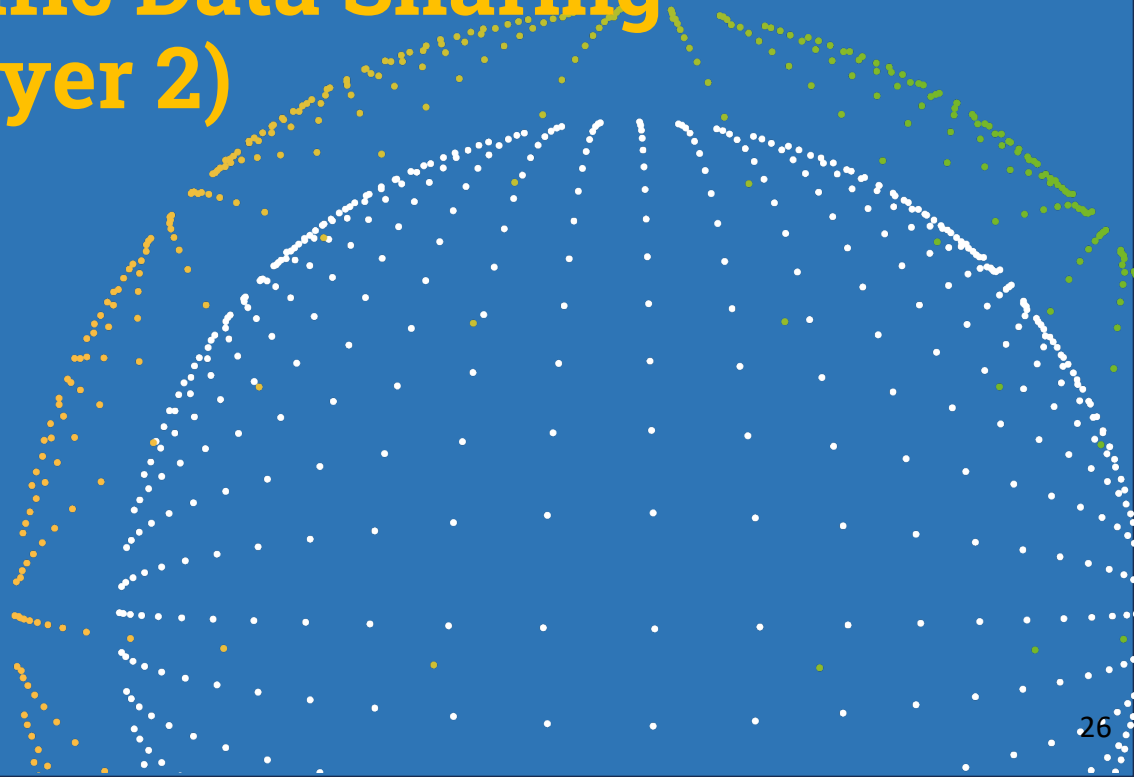
AI

Space

Agriculture

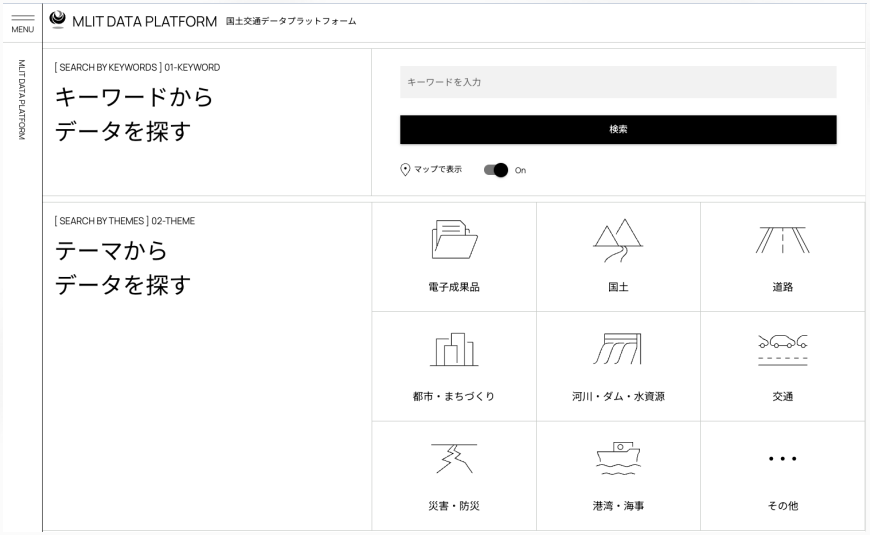
Geography

2-2
Domain Specific Data Sharing Platforms (Layer 2)

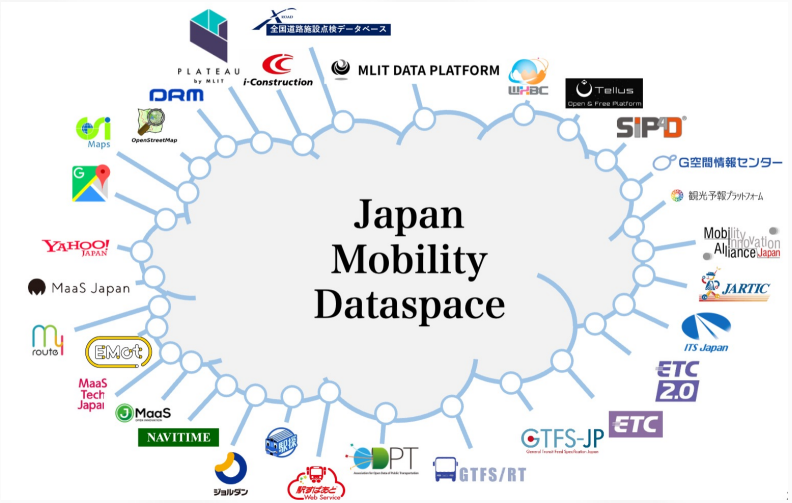


Domain Specific Data Sharing Platforms (2nd Layers)

Ouranos Ecosystem (METI)

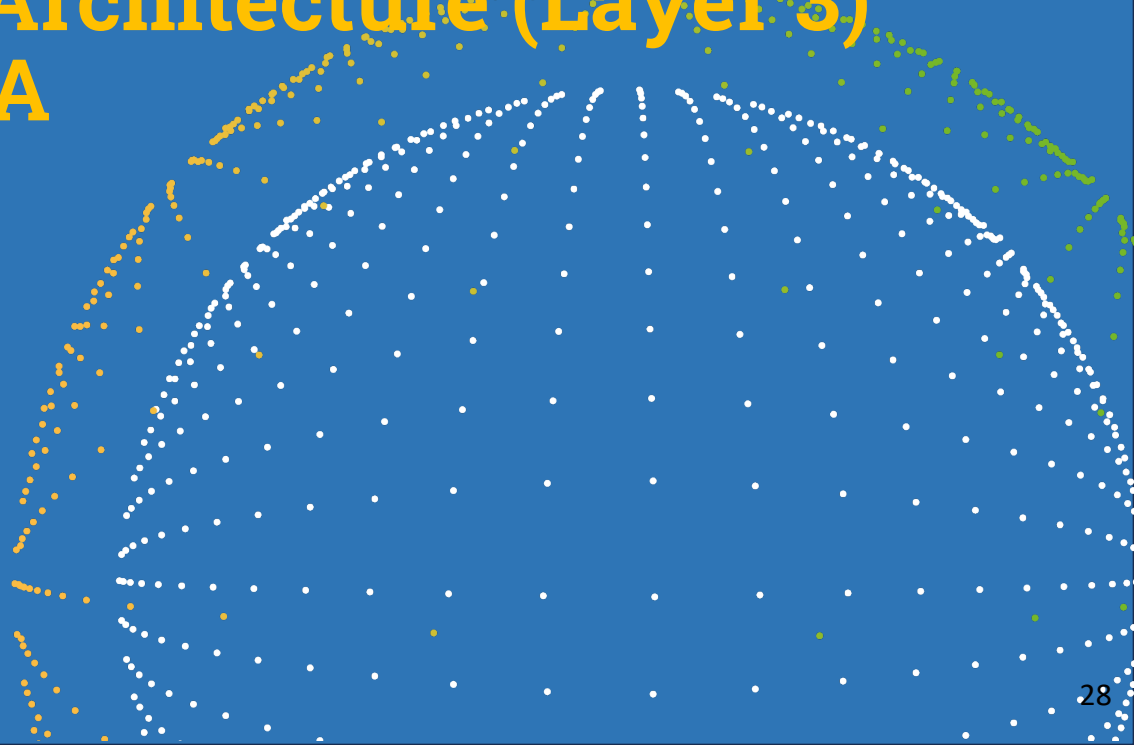


MLIT Data Platform (MLIT)



Japan Mobility Data Spaces (SIP3)

2-3
Cross-domain Data Sharing Platform in Federated Architecture (Layer 3)
DATA-EX/DSA



DATA-EX/DSA (Data Society Alliance)
https://data-society-alliance.org/

DATA-EX

DATA-EX is the collective name for the efforts of the Data Society Alliance (DSA) to realize cross-domain data exchange.
The DATA-EX cross-domain data exchange platform (hereinafter referred to as "DATA-EX"), which is at the core of these efforts, is a technical and social platform that enables the discovery and use of data across fields.

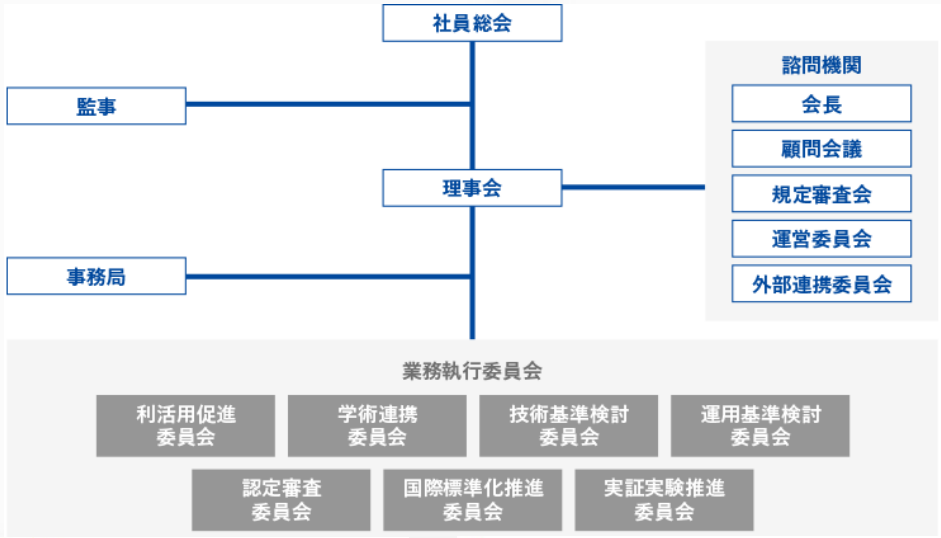
Vision

“World of Data-Driven Innovation”

Mission

1. Establish Data Driven Society with democracy of innovation
2. Develop data-distribution infrastructure for the world
3. Accelerate social implementation with Technology and Service development
4. Collaboration and Contribution to the World

Organization of Data Society Alliance (DSA)



A Members

BIPROGY
BRIDGE MULTILINGUAL SOLUTIONS
pwc
SAP
TIS INTEC Group
aws
IIJ Internet Initiative Japan
interfusion
uhuru
NTT Communications
NTT DATA
EverySense
Deloitte. デロイト トーマツ
国際航業
salesforce
SoftBank
iSiD IT Solution Innovator
DNP
NEC
TRUST ARCHITECTURE
NS Solutions
HITACHI Inspire the Next
FUJISOFT
IBM
FUJITSU
ORACLE
B-EN-G
RYOBI SYSTEMS
Microsoft
BIT
MITSUBISHI ELECTRIC

B Members

JVCKENWOOD JAPAN
ROBON INC.
True Data
ID
KPMG あずさ監査法人
KONICA MINOLTA
LAC
NTT DATA 株式会社 NTTデータ 経営研究所
INTEC TIS INTEC Group
ABeam Consulting
株式会社オーイーシー
MUFG 三菱UFJリサーチ&コンサルティング
OMRON
KG 兼松
KYOCERA
RICOH imagine. change.
TOMOWEL 共同印刷株式会社
SIGMAXYZ CREATE A BEAUTIFUL TOMORROW TOGETHER
SONY
D.A.Consortium
TOSHIBA
TOSHIBA 東芝データ株式会社
TOSHIBA 東芝テック株式会社
TOPPAN
TOPPAN TOPPANエッジ株式会社
JDEX
日本総研 The Japan Research Institute, Limited
NEXWAY TIS INTEC Group
HUAWEI
Hakuhodo DY holdings
Panasonic

The Japan Dataspace: Nation Level Cross-Industry Data Platform

Carbon Neutral Society

Efficient operation and management of critical social infrastructure

Disaster prevention and response
Rapid rescue operations, provision of appropriate information

Food security and safety Strengthening the international competitiveness of Japanese agricultural products.

Medical/healthcare/well-being
Rapid emergency patient transport to hospital

DATA-EX
Data Society Alliance

Bridge strain monitoring.

Disaster Situation Monitor

weather observation

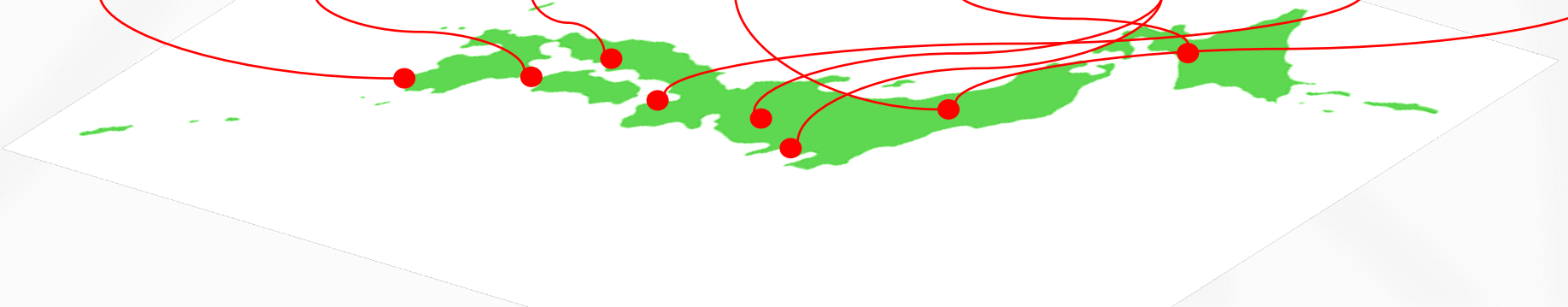
Remote Sensing

Food production environment monitors

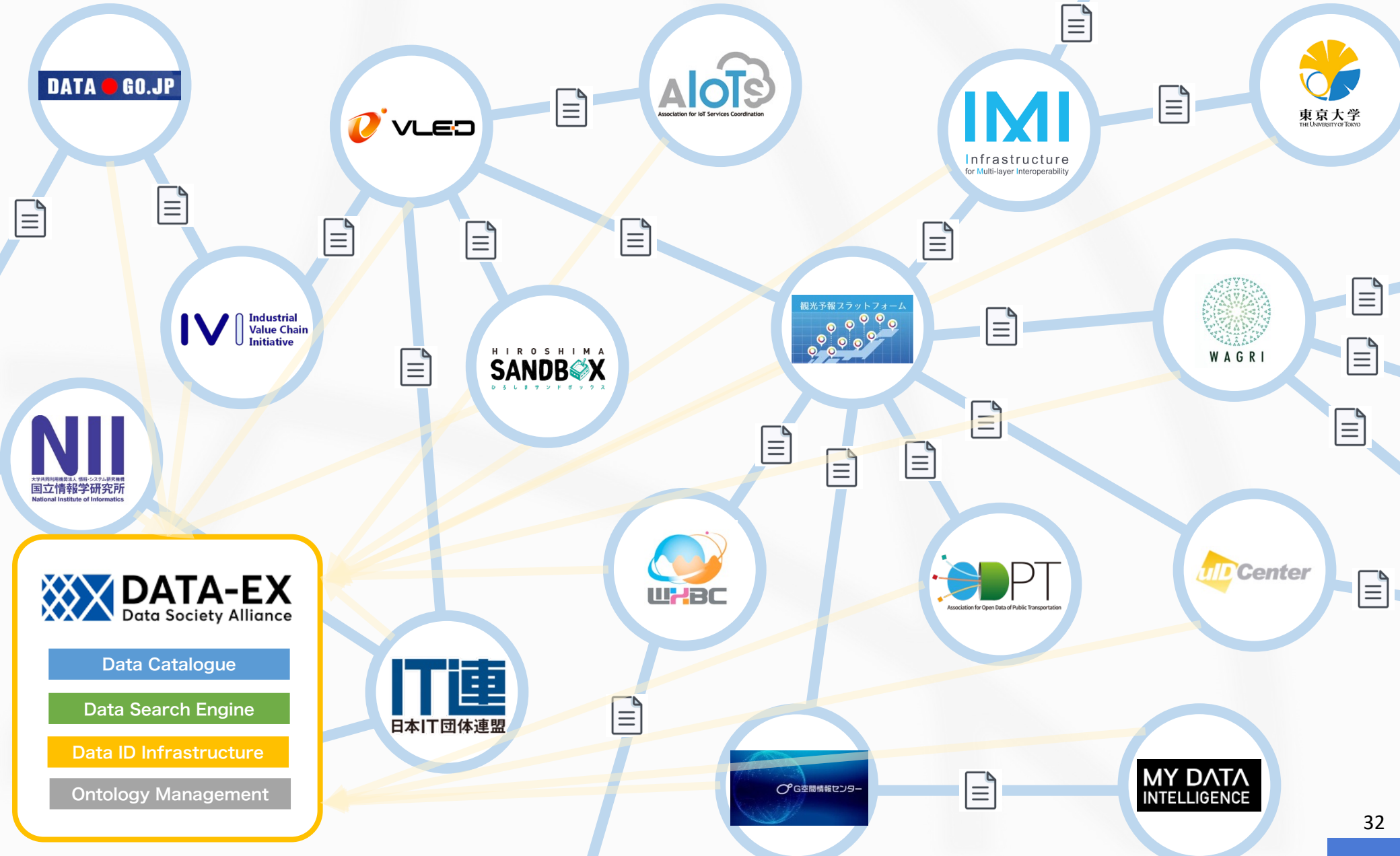
Logistics status monitor

Hospital occupancy monitors.

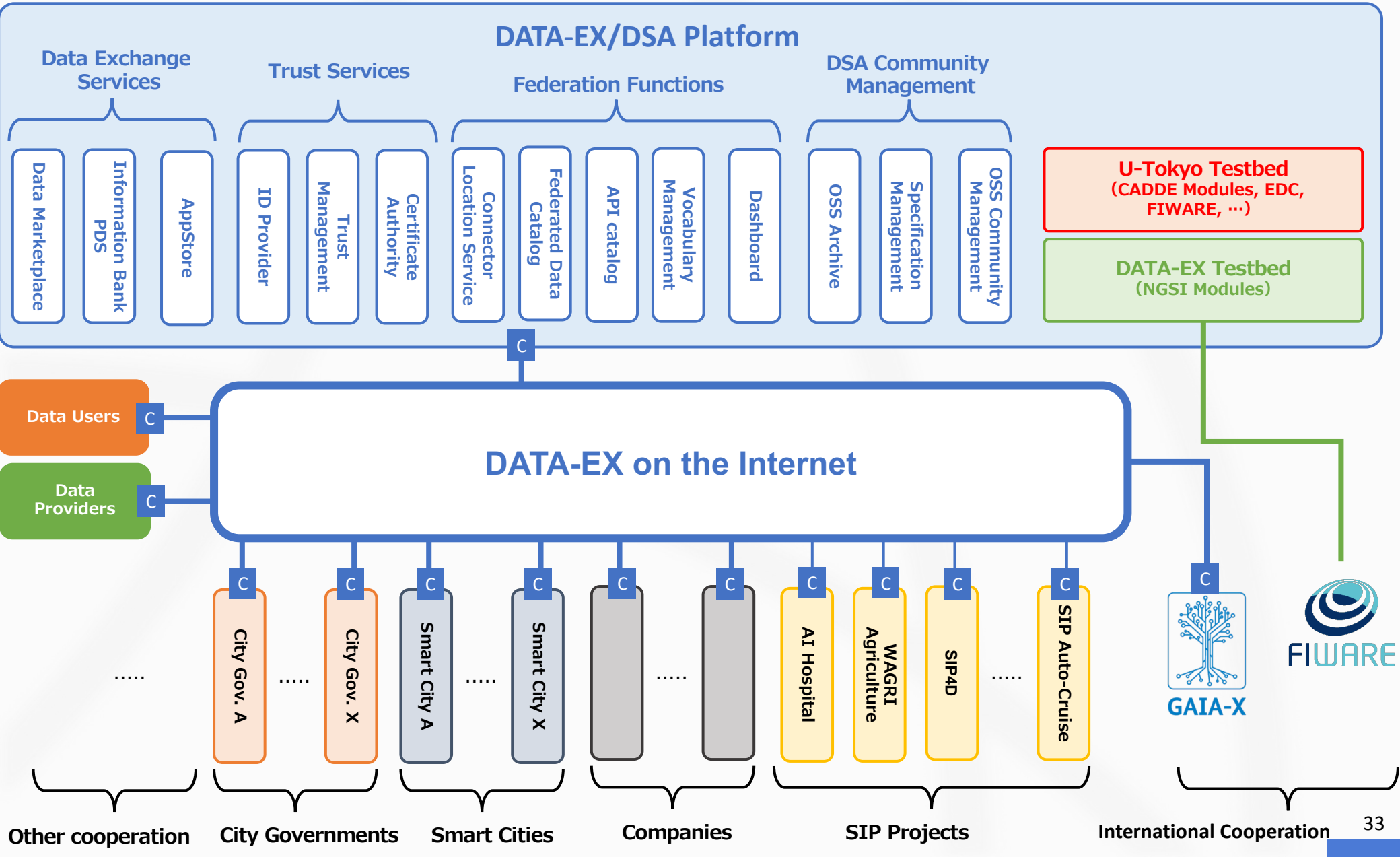
Patient status monitor



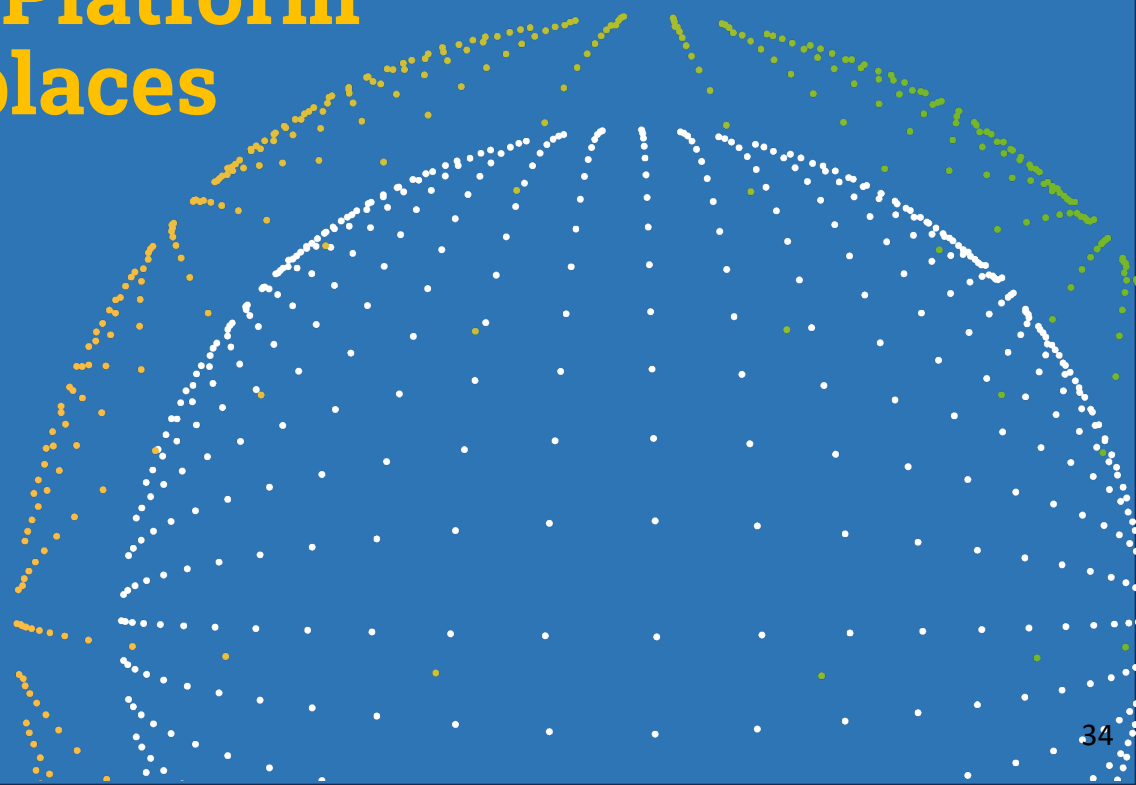
Federation Architecture of Cross-domain Data Platform



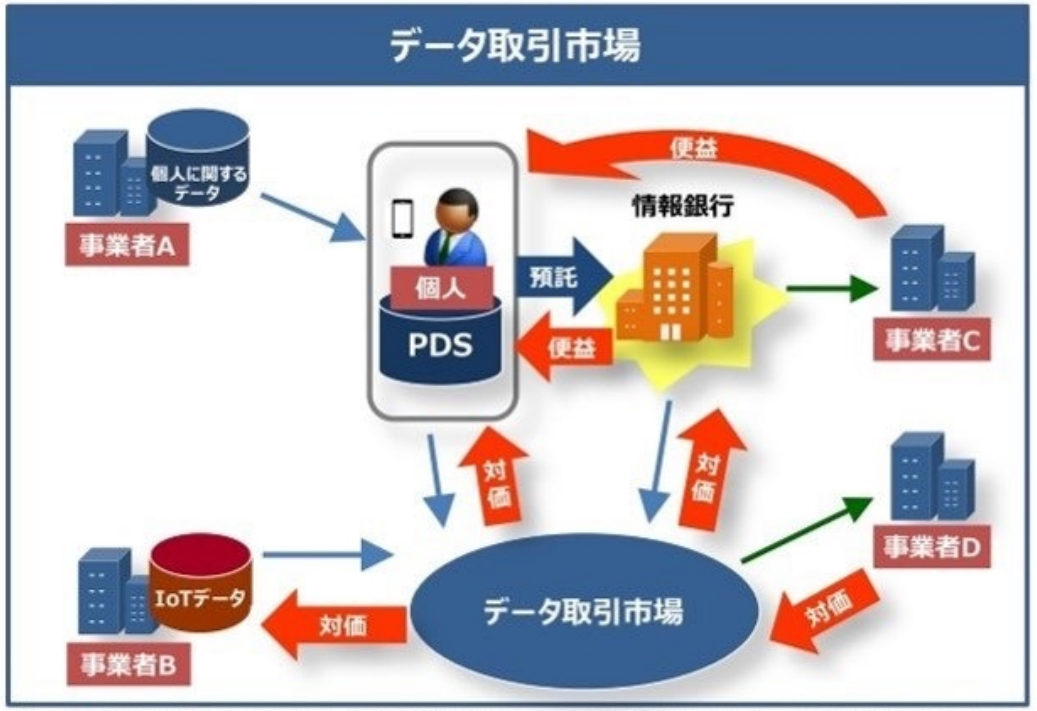
High-Level Functional Architecture of DATA-EX



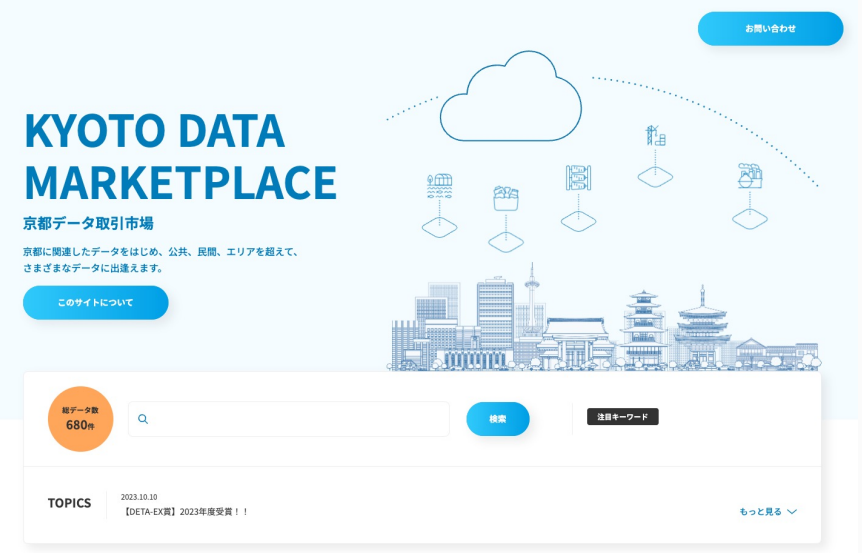
2-4
External Services Collaborated with Data Sharing Platform
Data Marketplaces



Data Marketplace: Initiatives to Transform Data into Value



Data market place is an open platform for data exchange(sell and buy) operated by trusted operators. Just as a variety of stocks are bought and sold by market participants in the securities market, data exchanges allow users to purchase data held by companies and local governments.

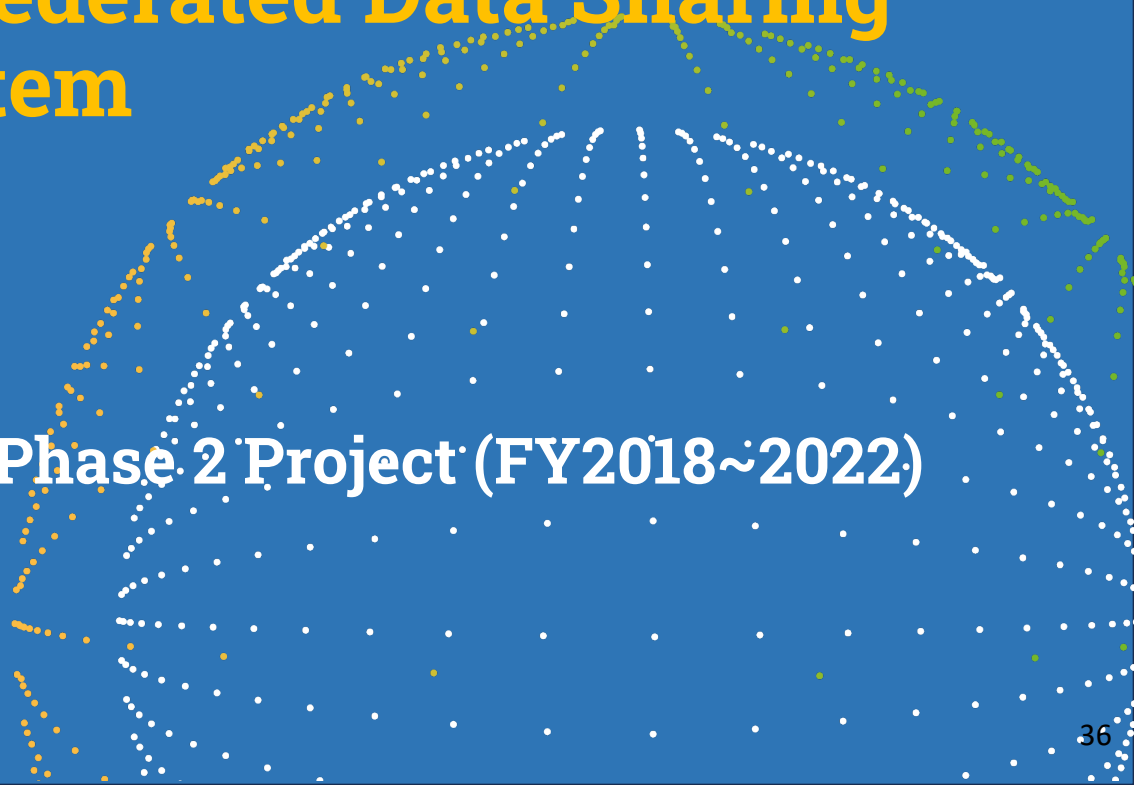


Kyoto Data Marketplace
https://data-market.smart-kyoto.or.jp/

Sapporo Data Marketplace
https://ui.apimarket-sapporo.jp/

PART 3
SIP CADDE: Federated Data Sharing Platform System

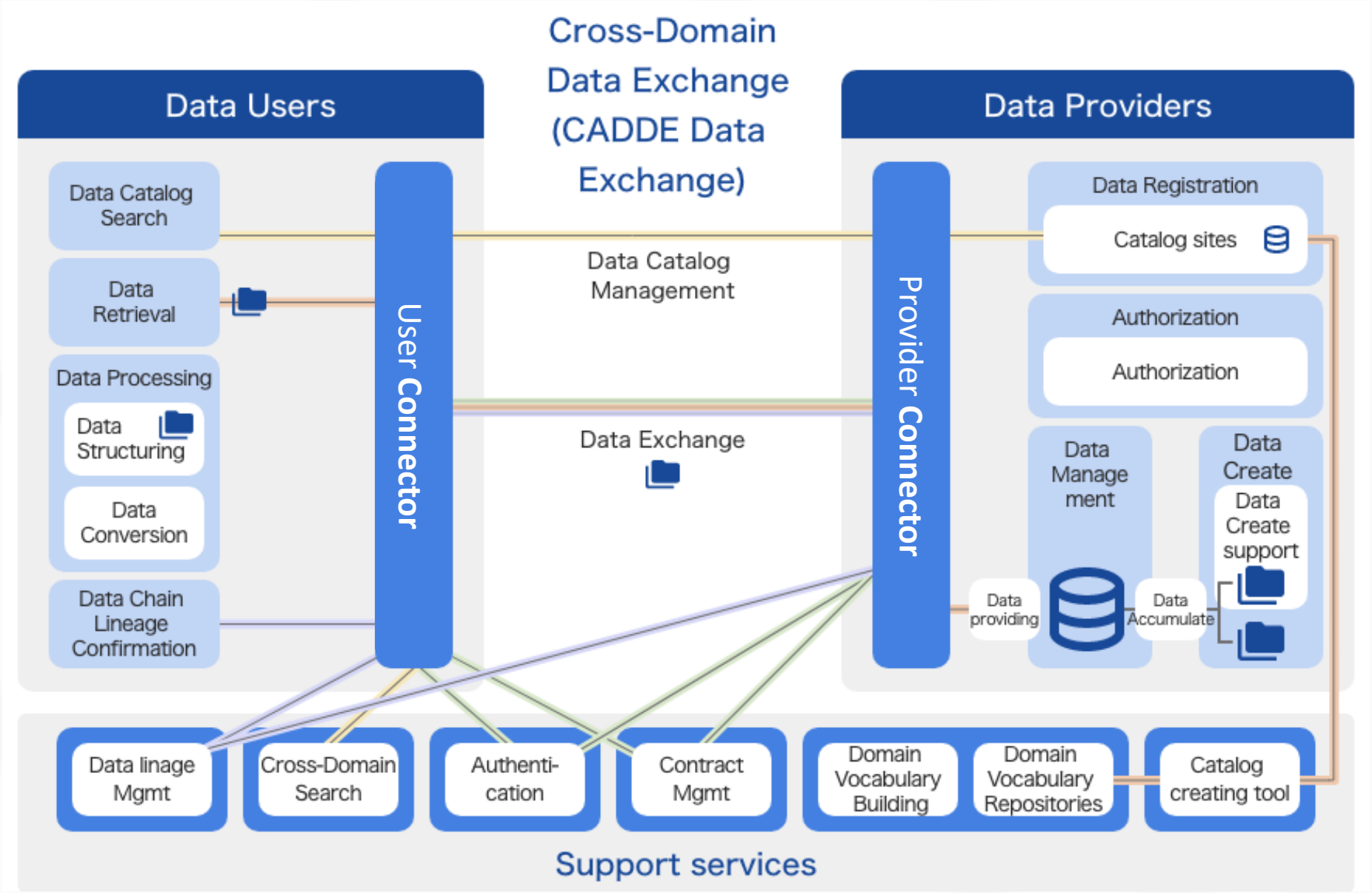
Developed by SIP Phase 2 Project (FY2018~2022)



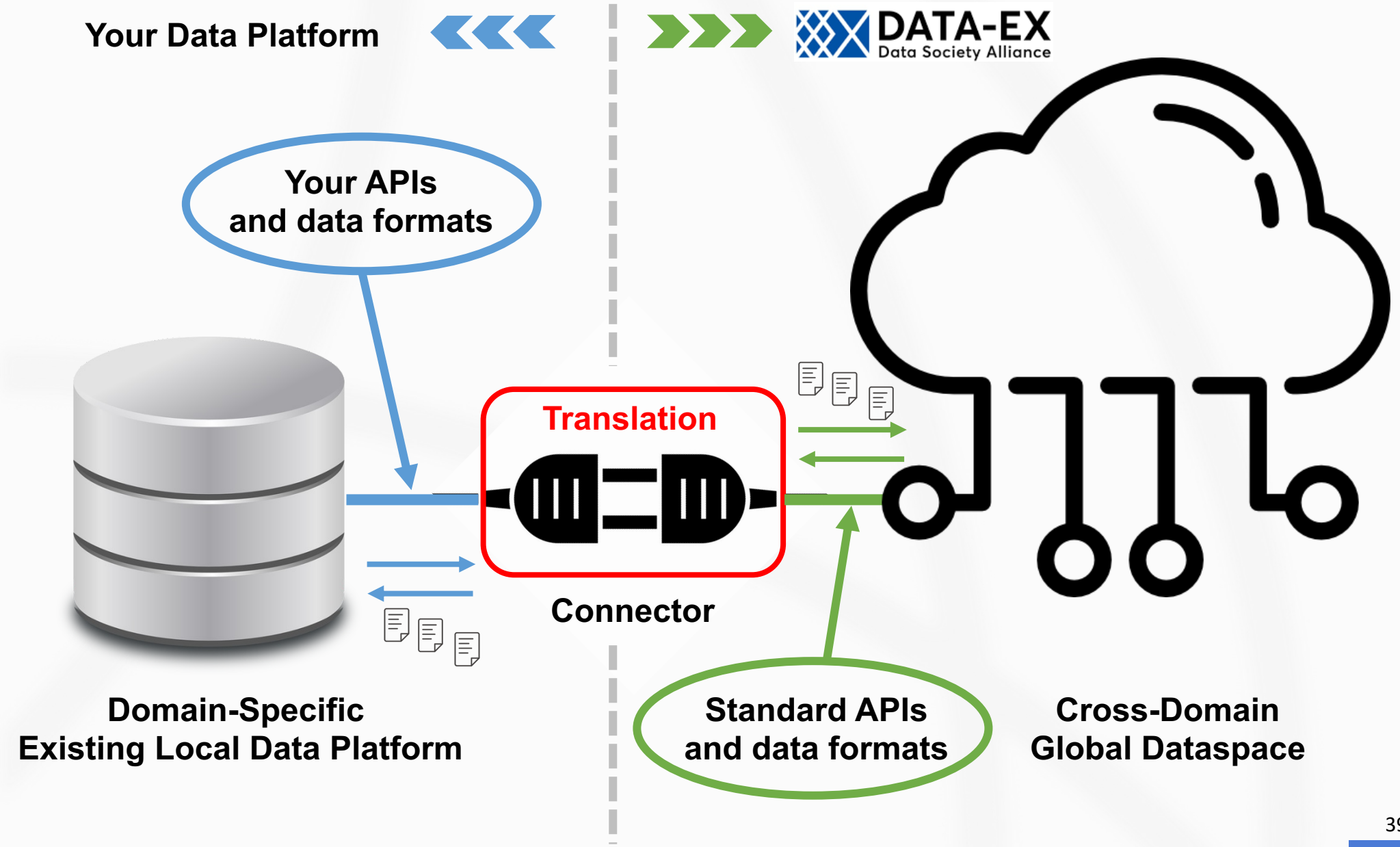
Technologies of Cross-Domain Data Exchange

- The objective of the SIP Phase 2 development of infrastructure Technologies of Cross-Domain Data Exchange is to establish a mechanism that enables the discovery and use of data beyond the boundaries of disciplines. To this end, we are proceeding with development based on the following principles
- Approach
  - To provide a basic venue and a variety of tools that can be used in order to enable the exchange of safe and secure data in an open and unrestricted manner.
    - Distributed federal architecture to connect data distribution in the field.
    - Designed for compatibility with existing technologies
    - Highly versatile function-specific hierarchical structure that can handle everything from open data to business data
    - A variety of services and tools to support various stages of data use, from data generation to discovery, contracting, exchange, and history management
    - Linkage with trust infrastructure to facilitate international collaboration
    - Simple architecture for easy implementation
- Architecture
  - This project proposes a mechanism for data discovery and use across disciplines as CADDE (Connector Architecture for Decentralized Data Exchange; CADDE).
  - In CADDE, data exchange is realized through a network of connectors. Distributed data providers and data users participate in this network by providing connectors that serve as contact points for each other. In the data exchange between connectors, functions such as authentication and authorization, contract management, and history management are invoked and used as needed.
  - CADDE provides tools and services to support not only the process of data exchange, but also the functions required in a series of phases of data utilization, such as data description vocabulary sharing, data discovery, and data transformation

Cross Domain Data Exchange (CADDE Data Exchange)



“Connector”-based Federation Architecture (Data Federation Mechanism)



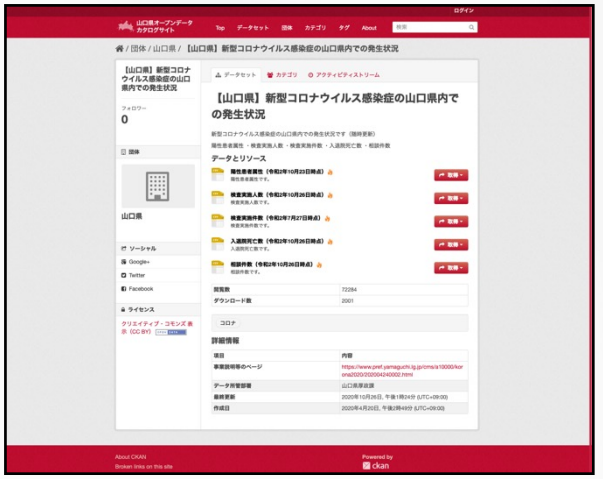
Federated Data Catalog (Metadata Federation Mechanism) …More than 150,000 open datasets are collected

Searching datasets by “COVID 19”

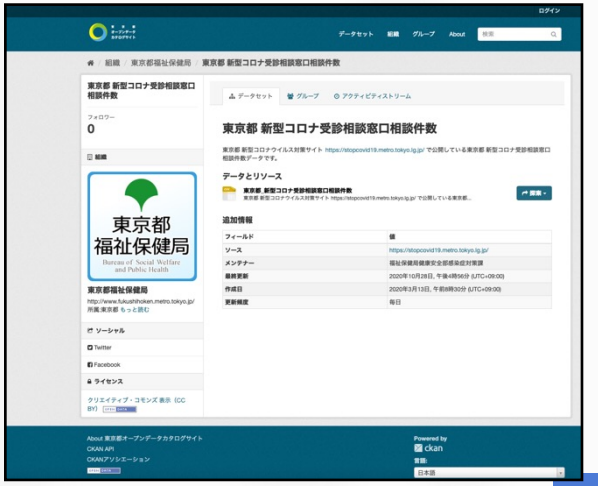
Many metadata are obtained by searching open data catalogues managed by city governments in Japan in a federated manner.

Kobe City

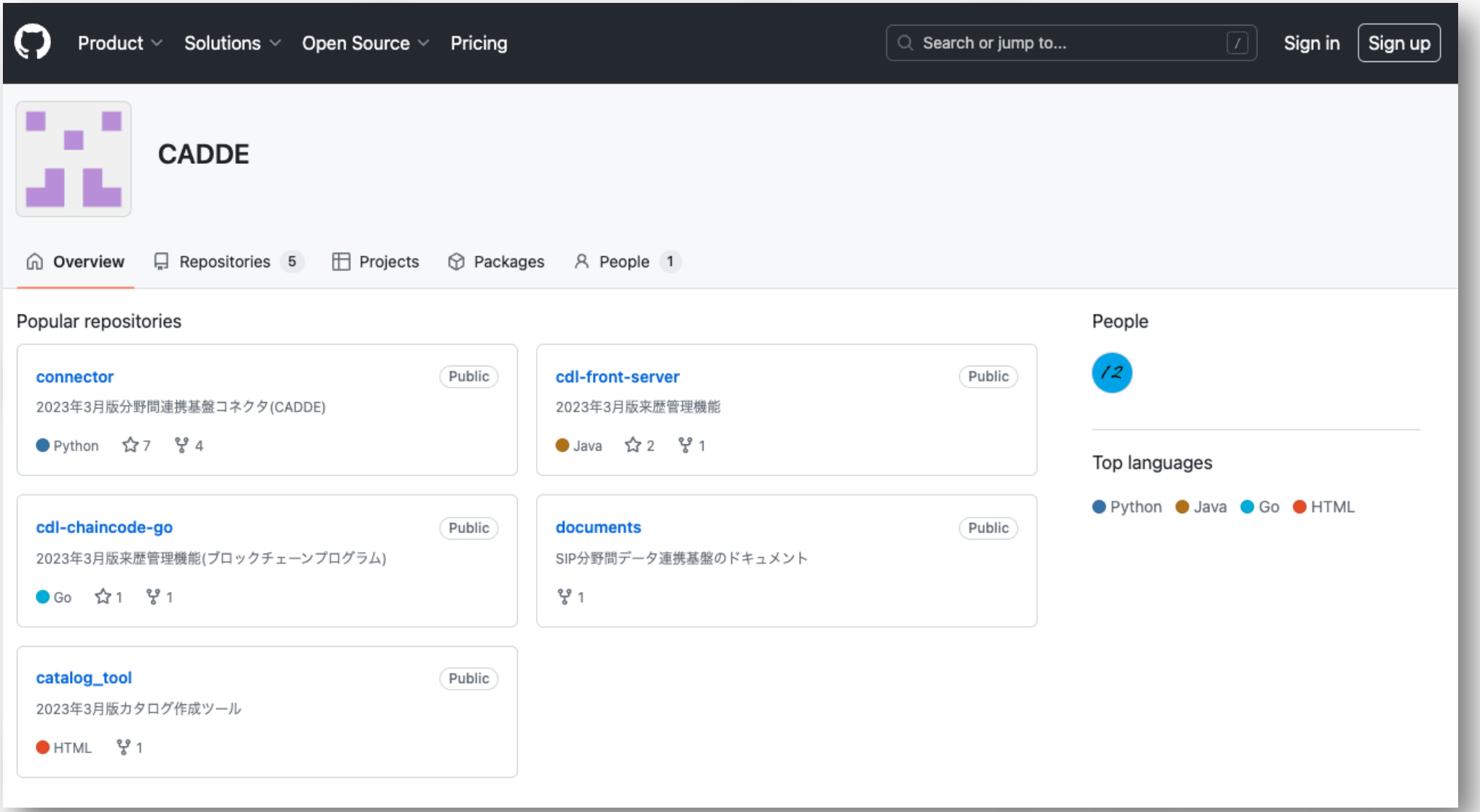
Yamguchi City



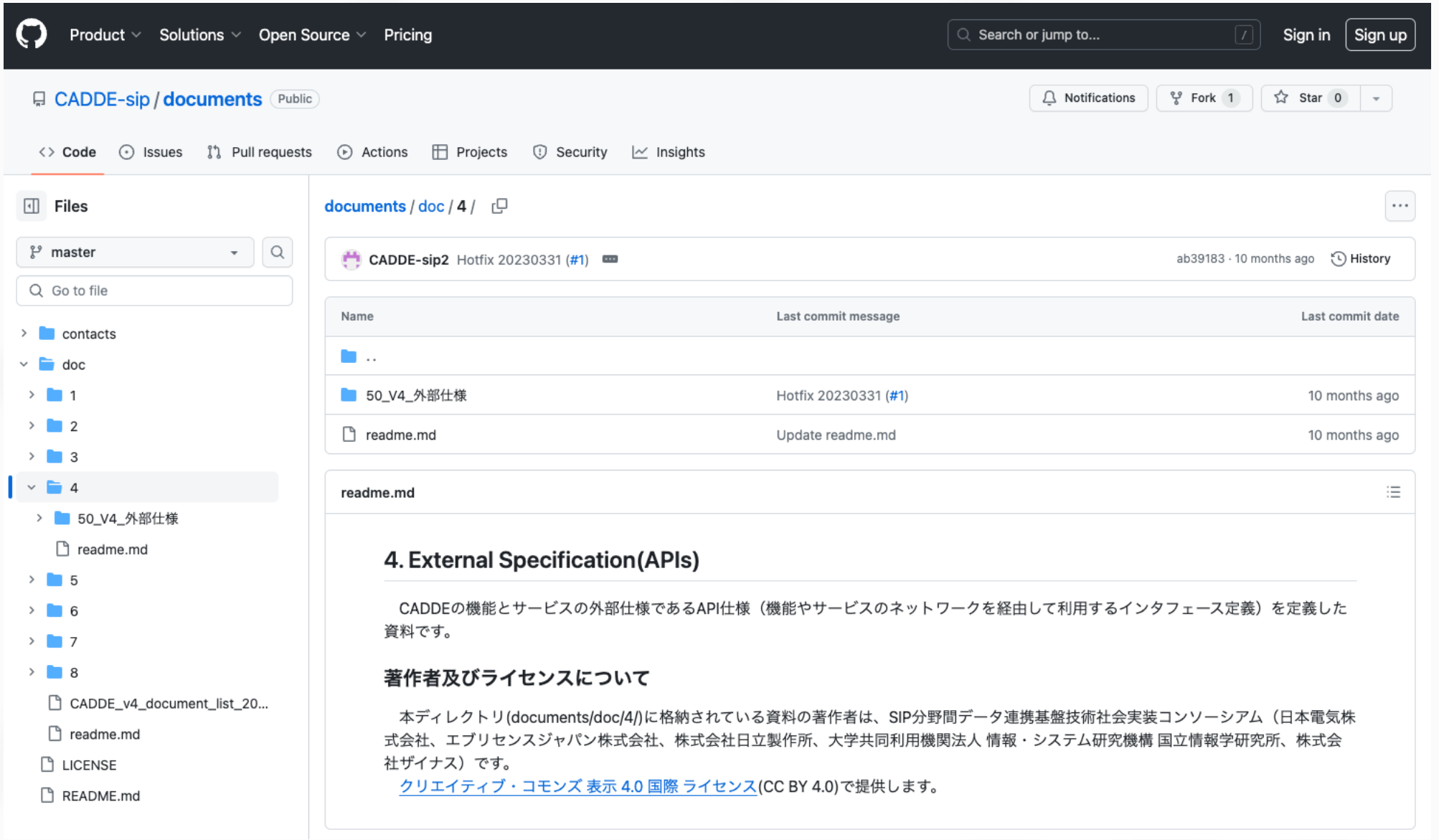
Tokyo Metropolitan Gov.



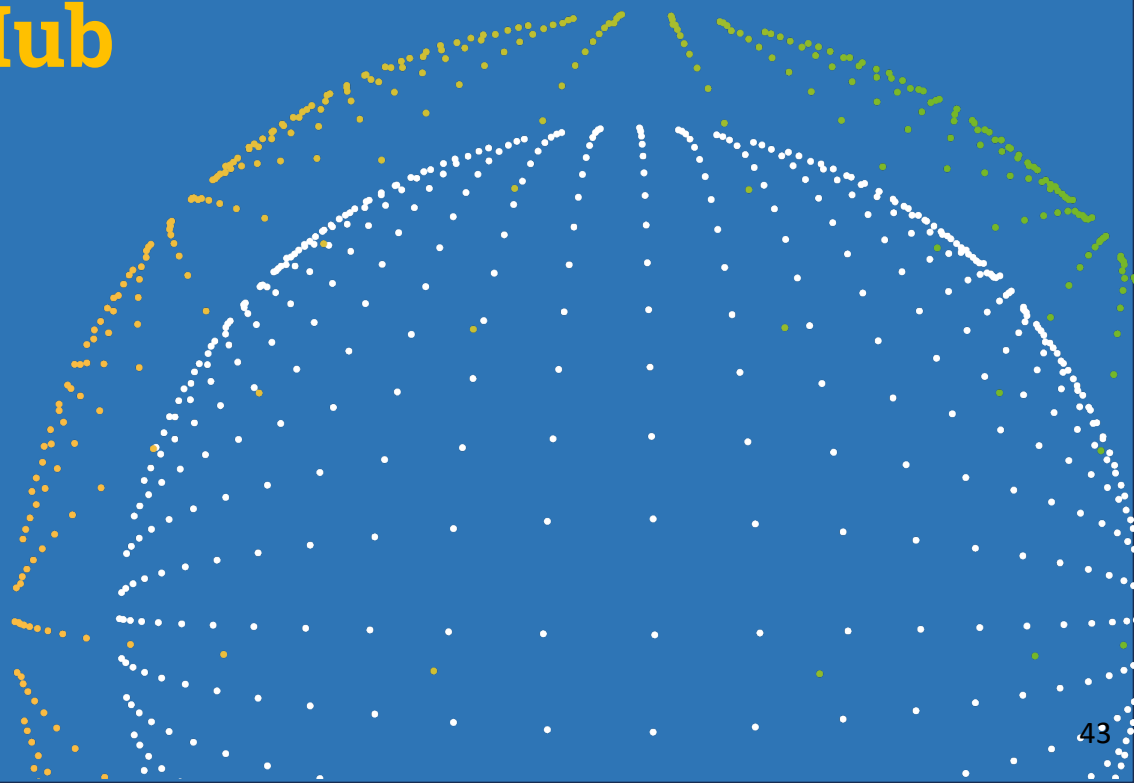
CADDE: OSS for Dataspaces in Federated Architecture
https://github.com/CADDE-sip



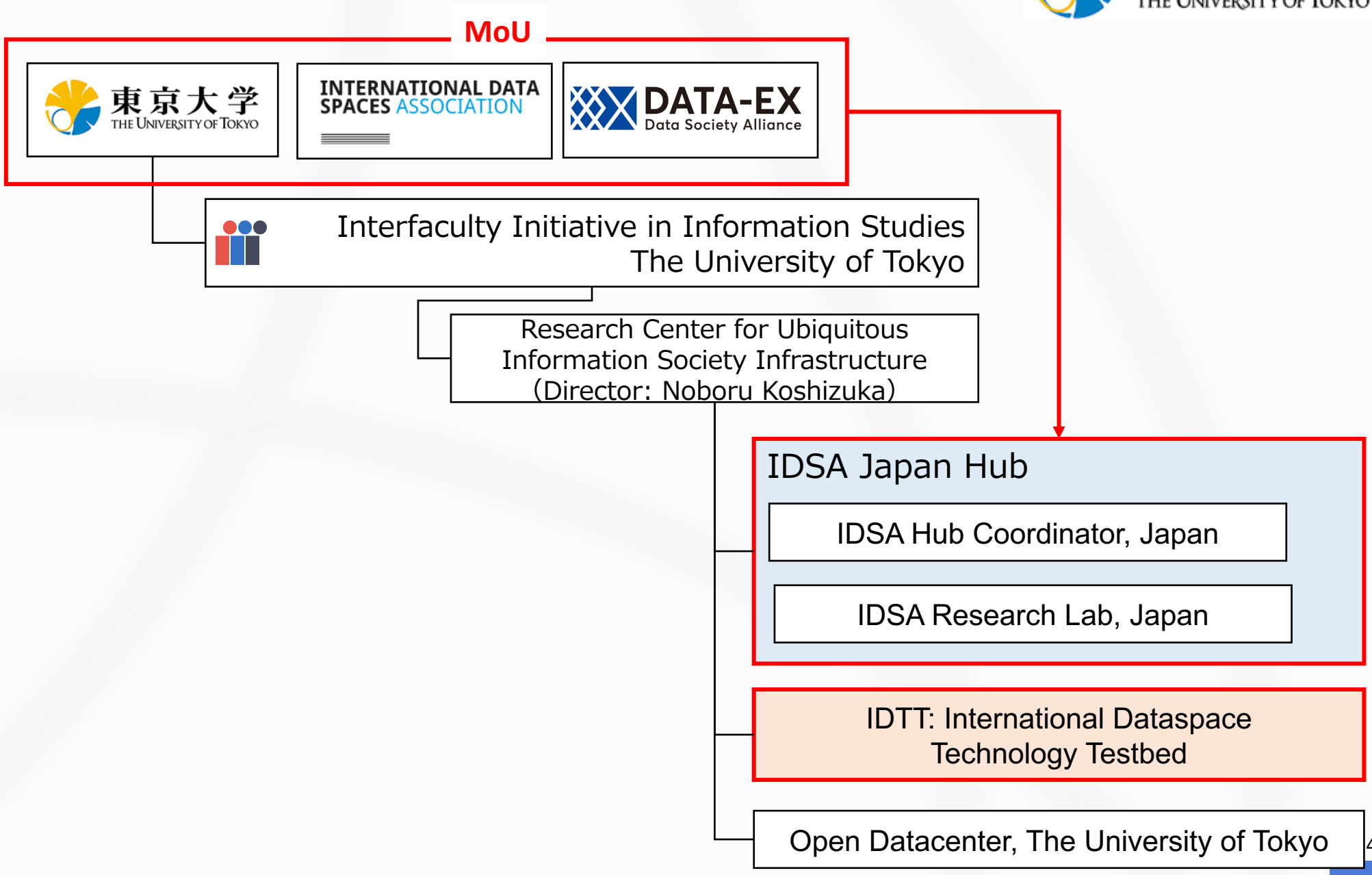
External Specifications of CADDE 4.0
https://github.com/CADDE-sip/documents/tree/master/doc/4



PART 4
IDSA Japan Hub



IDSA Japan Hub, Nov. 2023



Data Spaces Discovery Day Tokyo, Nov. 22, 2023

Data Spaces Discovery Day Tokyo, Nov. 22, 2023

PART 5
International Dataspace Technology Testbed

Data Space Technology International Testbed: An Overview

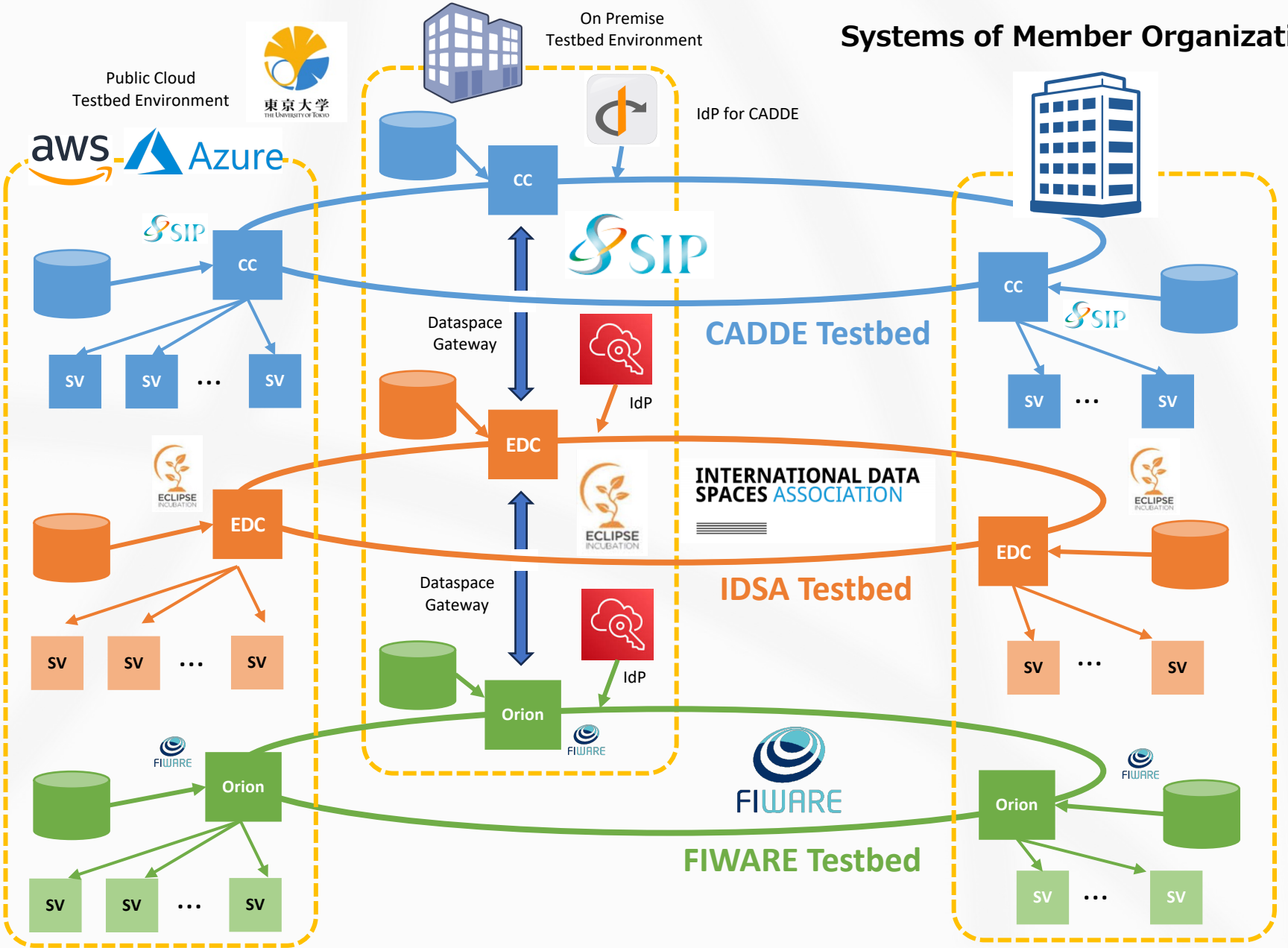
Background

- The distributed systems required to build a data spaces are huge systems.
- For individual companies and individuals (companies, universities, research institutes, students, engineers...) , there have been great difficulties in testing these.
- Even if you say, "I want to touch the data space right now," you cannot touch it.

Activities

- Build an open testbed for data space technologies.
  - The test environment is built in the computer system environment of the University of Tokyo.
  - The test environment is positioned as an experimental environment that can be used freely.
  - Using the test environment, learn how to use, implement, and manage and operate the data space system
  - R&D of technologies related to data space infrastructure and data linkage infrastructure
  - R&D of interoperability between various data space infrastructure and data linkage infrastructure related technologies
  - Once the development of DATA-EX is completed (currently in progress), we will put a new component of DATA-EX into operation
- Formation of a "technical community" for data space technology
  - Publication of online magazines
  - Holding training courses and hands-on workshops
  - Collaboration with overseas data space technology communities
  - In the future, we want to establish academic society for data spaces.

International Dataspace Technology Testbed



CADDE 4.0 Testbed in ITDT at U-Tokyo

CADDE 4.0 Federated Data Catalog

Authentication Server **Open ID Server**

CADDE 4.0 Data User **Connector**

Sample Web App Developed by Koshizuka-lab

CADDE 4.0 Transaction Log Server

DATA-EX Operator

Private network in U-Tokyo

Data User

Authorization (Access Control) **Keycloak**

Data Catalog **cKAN**

Authorization (Access Control) **Keycloak**

Data Catalog **cKAN**

File Server **Google Drive**

CADDE 4.0 Data Provider **Connector**

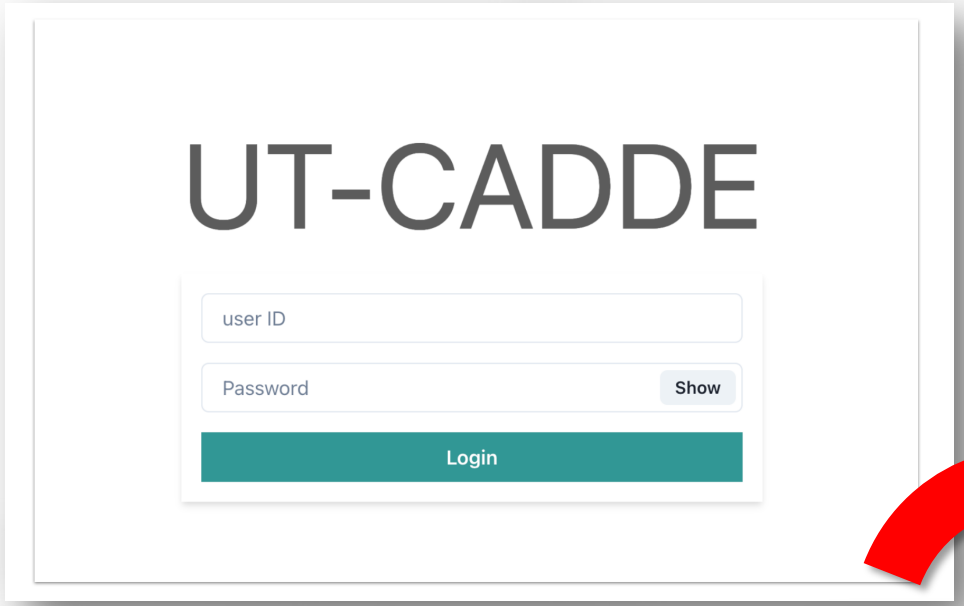
Data Provider

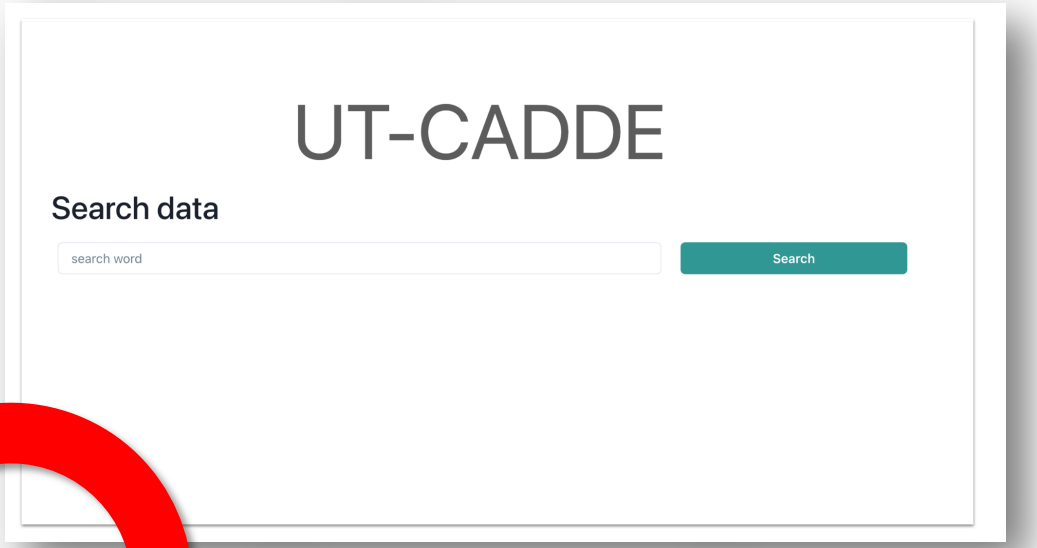
CADDE 4.0 Data Provider **Connector**

Data Provider

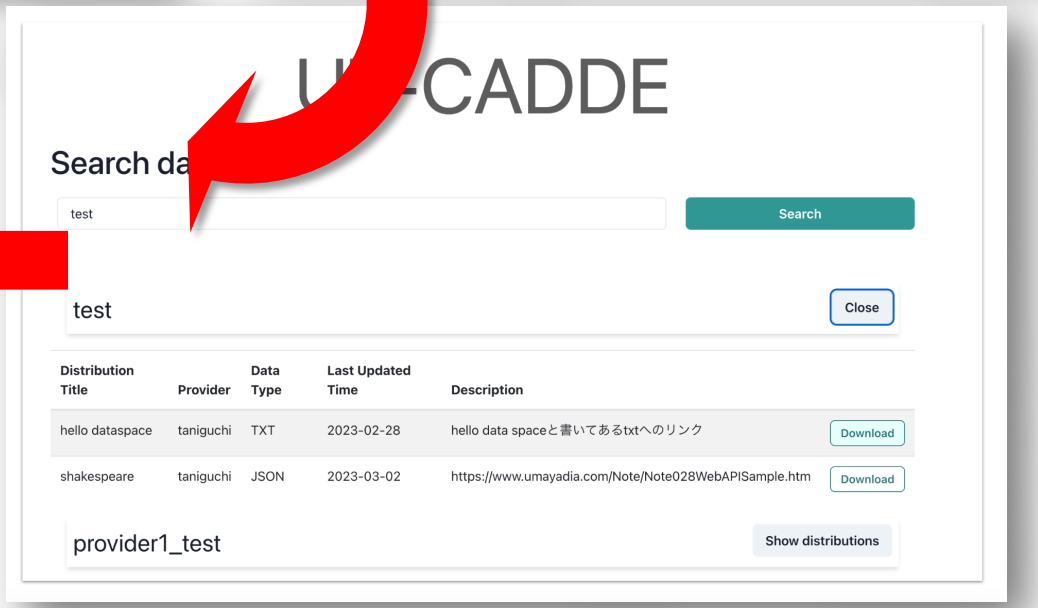
File Server **NAS**

CADDE 4.0 in International Dataspace Technology Testbed

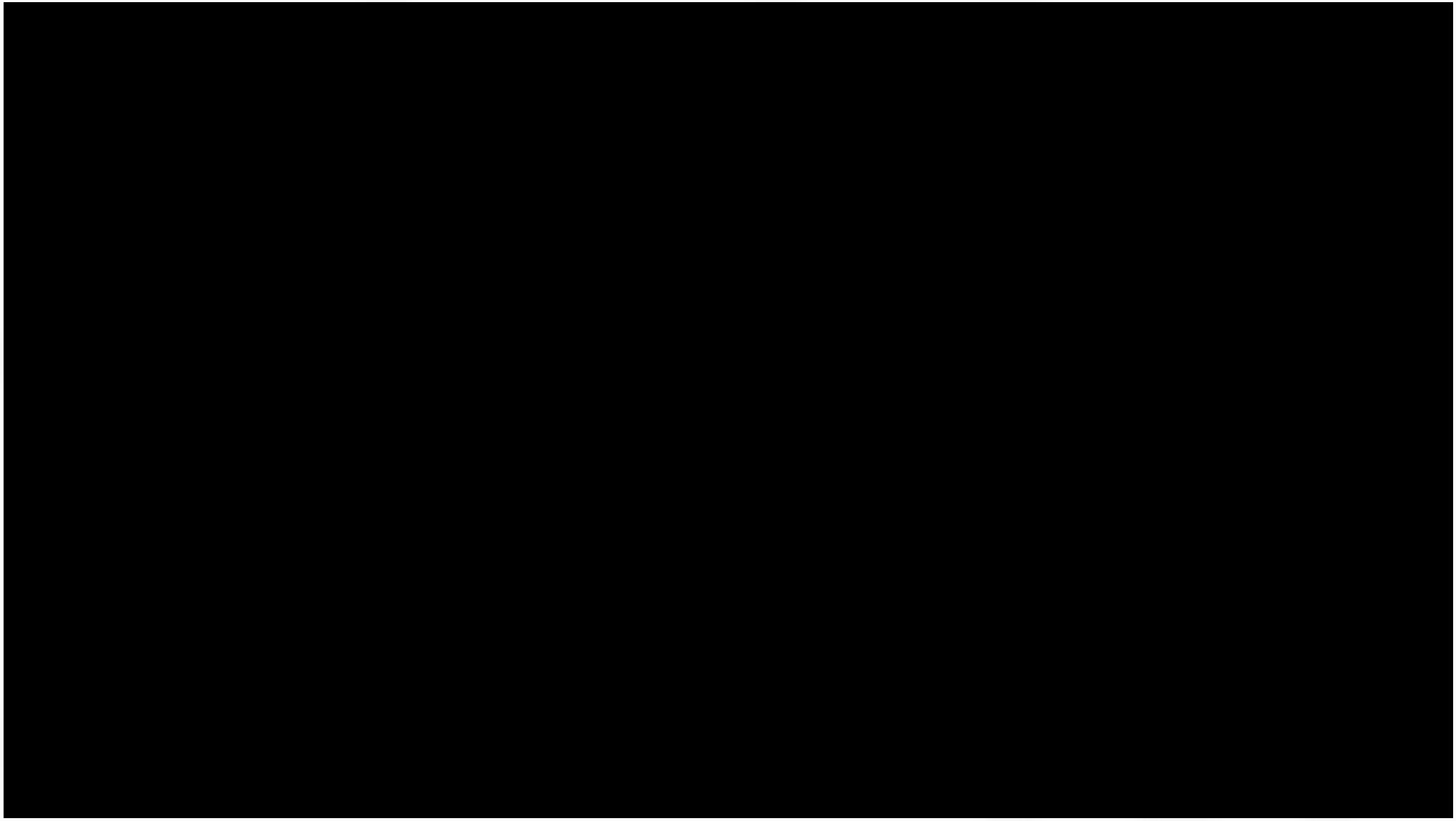




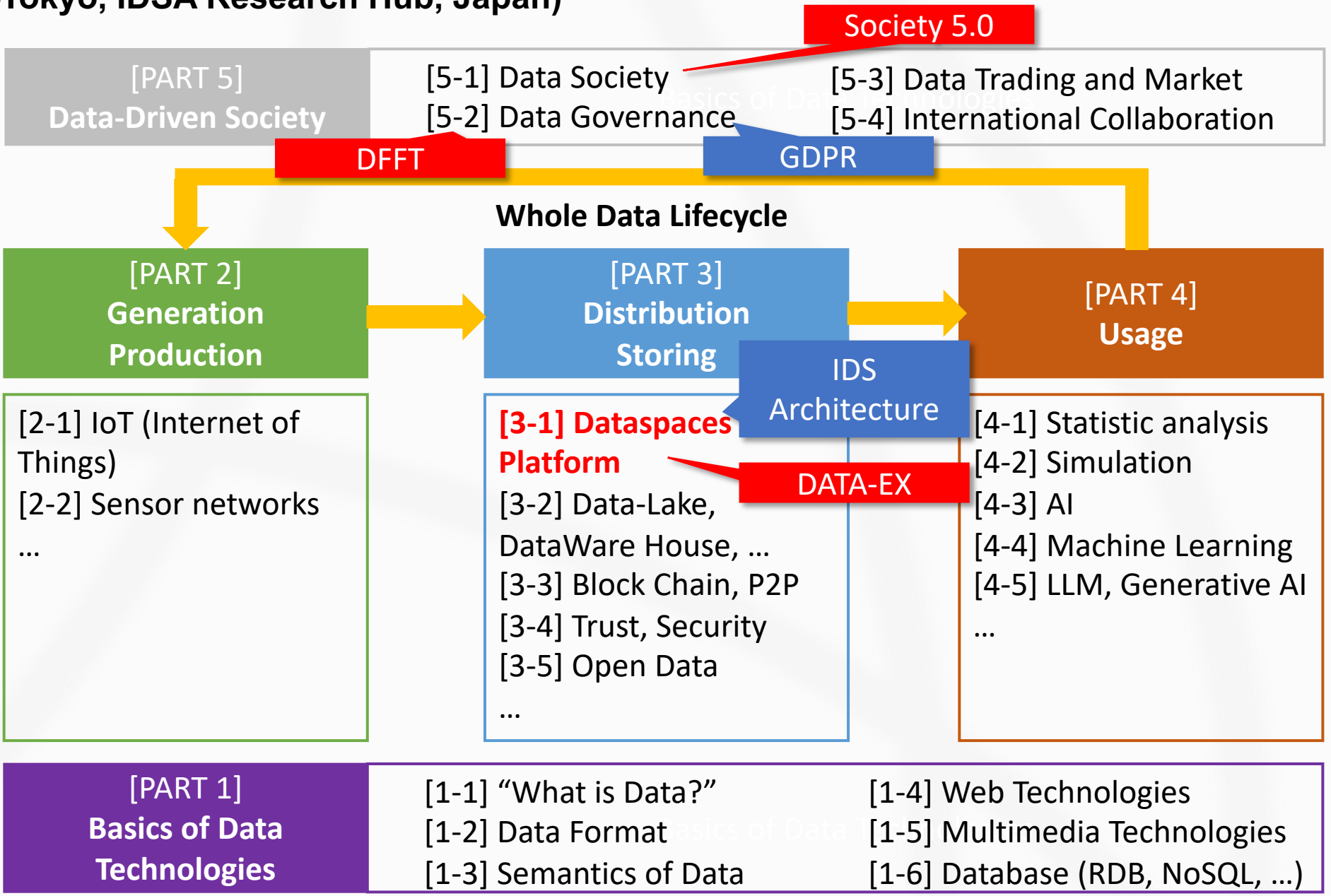
Data Download



UT CADDE Demo Video



Data Science Training Program (U-Tokyo, IDSA Research Hub, Japan)



Example of Web-based “Data Science Training Program”

ホーム » EnPiT Pro 2022 IoT技術者のためのデータ活用論（東京大学）

EnPiT Pro 2022 IoT技術者のためのデータ活用論（東京大学）

■科目名

IoT技術者のためのデータ活用論

■担当教員・連絡先

越塚登（noboru@koshizuka-lab.org）
葛杭麗（hangli.ge@koshizuka-lab.org）

■講義の目的

IoTシステムでは、センサー等から得られたデータを分析・解析を行い、その結果をアクチュエーターなどを通して機器や設備の自動制御に役立てたりする。本講義では、IoTでデータを扱うために必要な基礎知識を習得することを目的とする。

■講義の実施方法

オンライン教育システム上で、講義資料と課題を週2回のペースで公開します。受講生の方には、それぞれのペースで講義資料を閲覧しながら課題を進めて頂きます。質問等がある場合には、Slackのチャンネル上に書き込んで頂ければ、担当教員が回答いたします。

■教材について

各自のPC等を利用し、講義を受講して下さい。

■講義計画（9月～11月）

- 第１講（9/17）　ガイダンス＋データ活用論イントロダクション
- 第２講（9/21）　実習環境Jupyter
- 第３講（9/24）　様々な情報 (1) 数値データと文字データ
- 第４講（9/28）　様々な情報 (2) 画像、音声、動画などのマルチメディアデータ
- 第５講（10/01）　Python入門
- 第６講（10/05）　データの圧縮と暗号化とPython演習
- 第７講（10/08）　Pythonの重要なライブラリ：Numpy、 Pandas、matplotlib
- 第８講（10/12）　Pythonで時系列データの扱い
- 第９講（10/15）　Pythonで試すマルチメディアデータ処理
- 第10講（10/19）　Pythonで画像データの取り扱い
- 第11講（10/22）　ucodeとucode実習
- 第12講（10/26）　Web時代のデータ形式とデータベース論
- 第13講（10/29）　Web形式のデータ形式＋データベースの扱い_Python練習
- 第14講（11/02）　データの統計分析と可視化
- 第15講（11/05）　Open Data 概論と技術
- 第16講（11/09）　IoT、データと法制度

※　教材は、Google Colaboratoryの講義資料配布ページに、notebook形式で掲載されます。

Lecture 12 データベース

本講の目的

本講では、データベースの概要、特に関係データベースについて学習します。

想定履修時間

90分

授業アンケートと練習問題の提出

以下のURLにあるGoogle Formにアンケートと練習問題を回答して送ってください、。

https://goo.gl/forms/MJtNCEj0ddBJEJ0S2
(https://goo.gl/forms/MJtNCEj0ddBJEJ0S2)

1. はじめに

データを格納するためには、まずはプログラム言語の変数を用います。 変数は、主記憶上に実装されますので、そのプログラム言語で書いたプログラムが動いている時はデータを保持しますが、 プログラムが終了すればデータは保持されません（***揮発性記憶***）。そこで、プログラムが終了しでもデータを保持するためには、 一般的にはファイルがよく使われます（***不揮発性記憶***）。ただ、このファイルも小さなプログラムならこれで充分ですが、 データが大規模で複雑なものになると、様々な方法で、 データを検索でき、データの読み書きが可能で、データが正しい形式になっていることを保証する仕組みが必要になります。 これが***データベース（database）***です。

データベースには、様々な種類のものがあります。 現在、一般的に使われており、しっかりとした理論的背景をもっているものが、***関係データベース（relational database）***です。

関係データベースのコンセプトは、1970年6月に IBMサンノゼ研究所のコッド博士が発表した 「大規模な共有データバンクのためのリレーショナル・モデル」という論文で提唱されました。 当初は、学術的な世界でのみ取り扱われましたが、80年代に入ると、ハードウェアの進化に伴って商用に使える関係データベース用のソフトウェアが徐々に登場してきました。 そして1990年代以降になってくると、UNIXやWindowsといったオープン系テクノロジーが、 また最近ではLINUX系のサーバーで動く関係データベースが増えてきました。 関係データベースを用いて大規模な商用システムや科学ソフトウェアの心臓部が構成されています。 現在の商用データベースの約80%はリレーショナル・データベースが占めています。 IoTで扱う、大量のセンサーデータなどを扱う基本的な仕組みにすることもできます。

そこで、今回は、この関係データベースの基本概念を紹介します。

2. 関係データベース（Relational Database）とは？

関係データベース（Relational Database）は、データを行と列から構成される2次元の表形式で表します。 列は各項目を表し、行はデータのエントリー（レコード）を表します。 データ同士は複数の表と表の関係によって関連付けられ、 SQL（問い合わせ言語）により ユーザーの目的に応じて自由な形式で簡単に操作できます。

2.1 利点

- プログラムとデータの分離
  - プログラムとデータの独立性が高いため、データ構造に修正が入ったとしてもプログラムへの影響は極めて小さい
- 柔軟かつ容易なデータの取り出しが可能
- データベース操作の容易化
  - SQLにより、データベースの構築や問合せが簡単になりました。

2.2 関係モデル

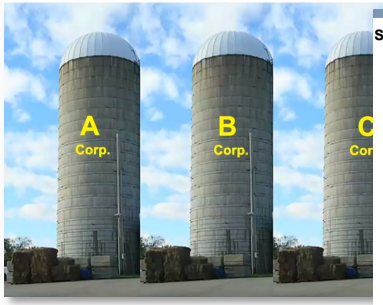
関係データベースにおけるデータは表に似た構造で管理されるが、 ***関係（Relation）***と呼ぶ概念でモデル化される。

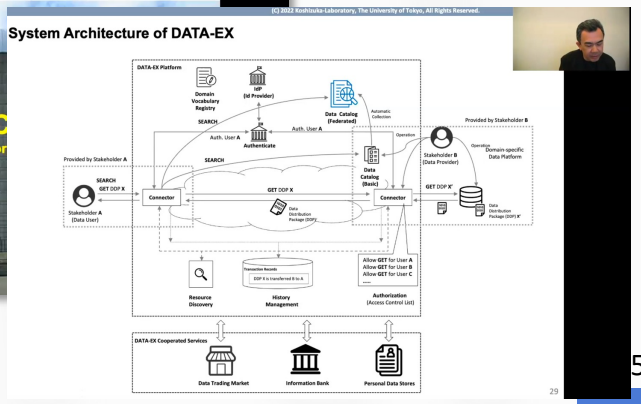
関係は以下などの要素が必要である。

- 組（タプル、Tuple）表における行に相当する
- 属性（アトリビュート、Attribute）表における列に相当する
- 定義域（インスタンス、Instance）またはドメイン（Domain）：データの型（Type）に相当する
- 候補キー（主キー、Main key）
- 外部キー

具体的に***関係（Relation）***は、以下のように構成される。

- 関係は、組の集まりで、組には、見出しの組（一つ）と本体の組（一つ以上）から構成される。
- 組には、いくつかの属性から構成される。
- 属性は、属性名と定義域から構成される。（例：属性A1 = （住所、文字列）、属性A2=（電話番号、数字列）、など）





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