Building a national Secure Wi-Fi infrastructure with international roaming

– Supporting the society and education in the digital era –

Hideaki Goto   Tohoku University, Japan
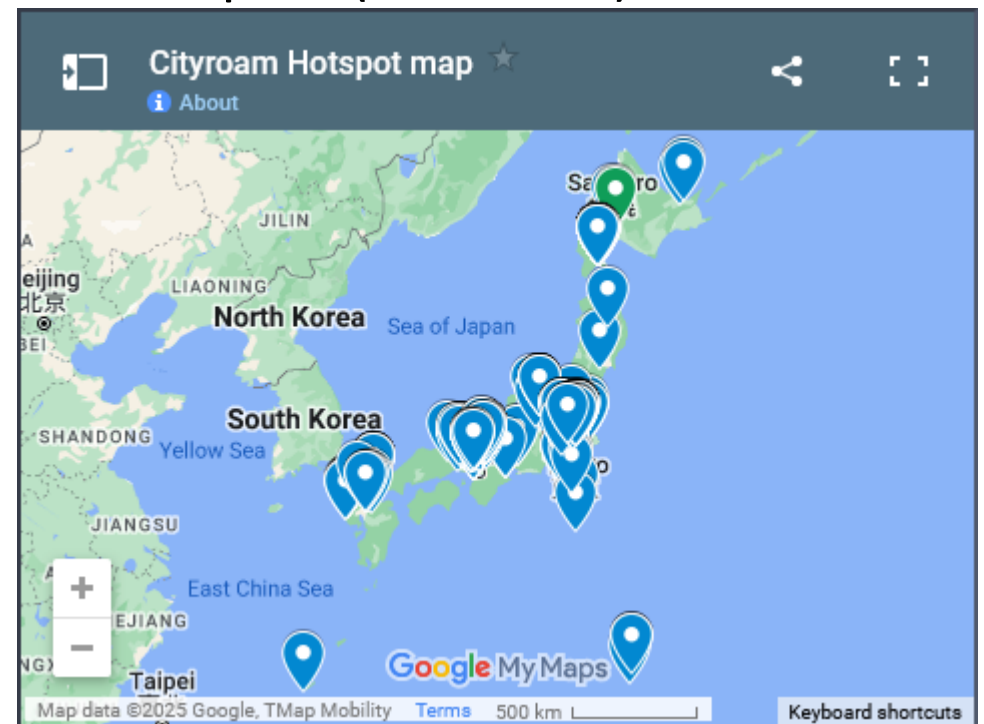
Nationwide Cityroam deployment in Japan

Your countries can have a similar one !

- Cityroam, a federation providing secure roaming system for Public Wi-Fi since 2018.

- All sites provide both eduroam and OpenRoaming (2020-).

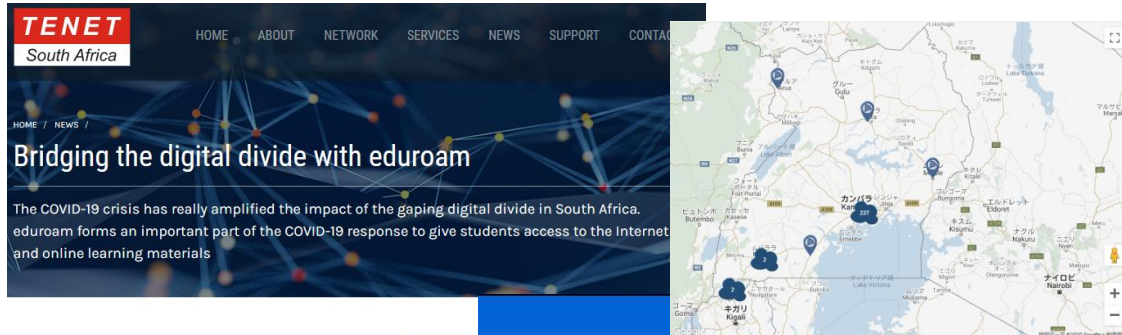- Unique sites across the nation.

cityroam
1000+ spots (Jan. 2025)

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Off-campus eduroam as a digital infrastructure

South Africa:
eduroam at most universities, addressing digital divides and COVID-19 (July 2020)

TENET — South Africa
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Bridging the digital divide with eduroam

The COVID-19 crisis has really amplified the impact of the gaping digital divide in South Africa. eduroam forms an important part of the COVID-19 response to give students access to the Internet and online learning materials

Today a University of Cape Town student living in Khayelitsha can access eduroam, the high-speed Internet offered by nearly all South African universities and an additional 105 countries around the world, at their local library. A University of Witwatersrand (Wits) student living in Sebokeng needs only to travel 30 minutes to North-West University's Vaal Triangle Campus to download their course content and videos quickly and for free on the eduroam network, while a University of South Africa (UNISA) student anywhere can check the eduroam interactive map to see where their closest internet access point is.

eduroam
Are you a Student, Researcher or University Staff?

Covid-19 has pushed us off campus, and **reliable** off-campus connectivity is a problem.

eduroam has now gone beyond your campus borders.

Look out for the **eduroam WI-FI** network in your neighborhood.

Free, simple, seamless connection at your convenience.

www.renu.ac.ug   SECURE & TRUSTED

RENU in Uganda:
Town-wide eduroam
to help students
learning under COVID-19 (Oct. 2020)

ut NEWS ▾ IN FOCUS ▾ OPINION ▾ SPORT ▾ MAGAZINE ▾ RADIUS   ☰ SECTIONS   Search 🔍

NEWS JAN 5, 2021

Government to Extend WiFi Initiative for Students to 90 New Locations

Difficulty accessing the internet in rural communities has become a major talking point in higher education circles since the outbreak of the pandemic.
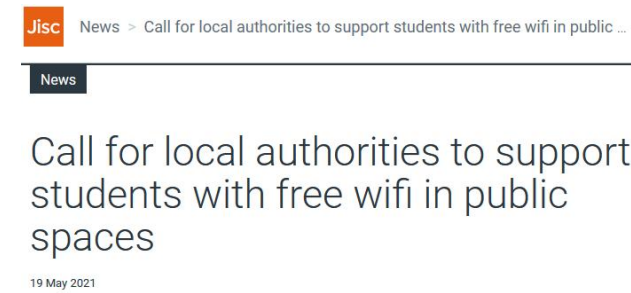
Cormac Watson
EDITOR

The government will extend internet access for students to 90 new locations across the country in order to create "extended virtual campuses", Higher Education Minister Simon Harris announced today.

HEAnet will lead the initiative, rolling out eduroam – a WiFi connection that students can automatically connect to – to locations accessible to students, such as libraries, museums, public offices, coffee shops and shopping centres.

Eduroam is already available to students in a number of locations, including libraries in Longford and Galway, the Convention Centre and Custom House Quay in Dublin.

"Extended virtual campuses" in Ireland (Jan. 2021)
http://www.universitytimes.ie/2021/01/heanet-to-extend-wifi-initiative-for-students-to-90-new-locations/

Jisc News > Call for local authorities to support students with free wifi in public ...

News

Call for local authorities to support students with free wifi in public spaces

19 May 2021

Building on efforts to tackle digital poverty, Jisc has written to the Local Government Association, urging authorities to provide free internet access to students in public spaces via our eduroam connectivity service.

Jisc, UK (May, 2021)

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Wi-Fi Security is not only for end-users…

- Security for Wi-Fi operators:
  - Make clear the responsible bodies.
  - Keep user traceability in case of network abuse or crime.
    User Verification is important.

- Security for the society:
  - Suppress crimes such as fraud.
  - Suppress organized crimes and terrorisms.
  - Disaster prevention and mitigation utilizing user activity analysis.
  - Smart City design through data analysis.
  - Securing people's communication means under disasters.

AFP

28 JUNE 2024, 7:34AM

Media Release

Man charged over creation of 'evil twin' free WiFi networks to access personal data

Editor's note: Footage of the man's arrest and on camera grabs by AFP Det-Insp Coleman available via Hightail

The AFP has charged a West Australian man who allegedly established fake free WiFi access points, which mimicked legitimate networks, to capture personal data from unsuspecting victims who mistakenly connected to them.

The man, 42, is expected to appear in Perth Magistrates Court today

WBA OpenRoaming

- **Seamless & secure connection experience for everyone.** eduroam-like, but not limited to Research&Education community.
  - eduroam since 2003, now 100+ countries/territories.

- **Advanced and multipurpose** than eduroam (RFC 7593).

- Based on Passpoint and WRIX framework.

- PKI and RadSec + Dynamic Peer Discovery
  - Similar to eduroam, but in larger scale.

- Two policies using different RCOIs
  - Settled: Accounting and intermediary are required.
  - Settlement-free: No roaming fee. Much easier adoption.

Fit with our purposes.

RCOI: Roaming Consortium Organization Identifier

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Cityroam's rapid growth – why?

- Organized a Roaming Federation
  - **Community supports** (seminars, tech tests & discussions, etc.)
  - → **Wireless Identity Federation Association** (est. Apr. 2024)
- Affordable roaming platform with Simplified inter-connections (central hub).
  - IdP: eduroam, Cityroam Cloud IdP, operators in Japan, telcos/ISPs and cities overseas via **OPENROAMING** WIRELESS BROADBAND ALLIANCE
- eduroam/OpenRoaming combined architecture
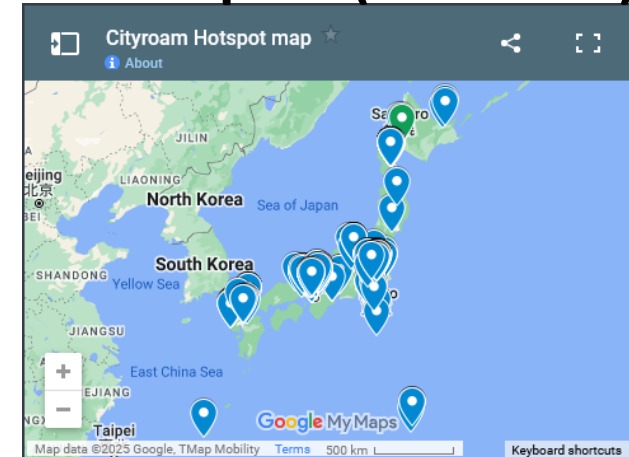- Involvement of Municipal Wi-Fi (multi-vendor, multi-operator scheme)

WBA OpenRoaming

90+ spots (Jan. 2023)

1000+ spots (Jan. 2025)

6
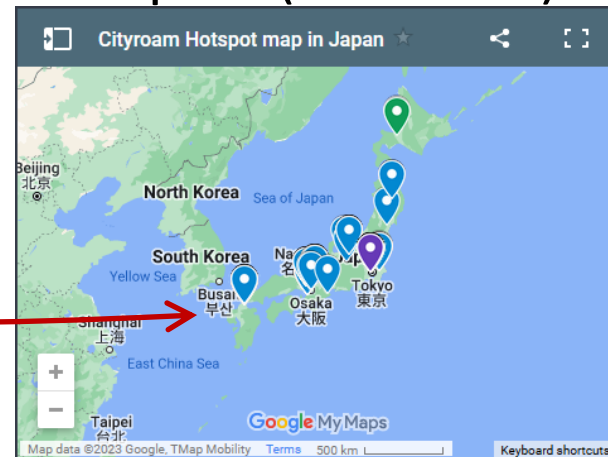
Cityroam sites – early adopters of OpenRoaming

Co-working space in Morioka
(OpenRoaming was added
 in 2020)

Conference Center in Nagano
(May 2021)

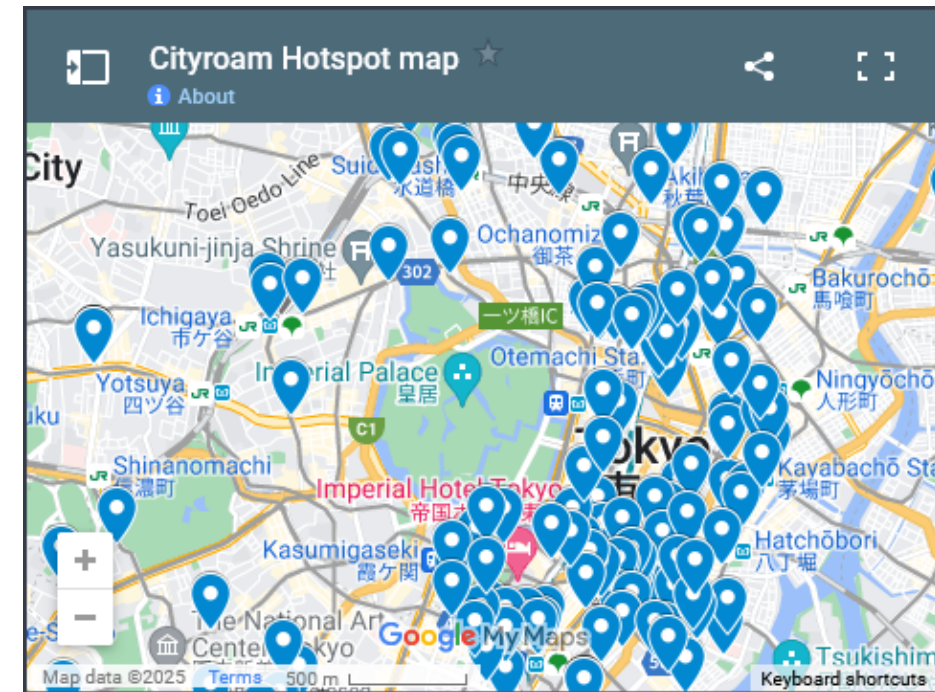Hot Spring facility in Nagano
(May 2021)

Resort Hotel & Complex in Ise
(Feb. 2022)

Vending machines in
Kyoto City Parks
(May 2020)
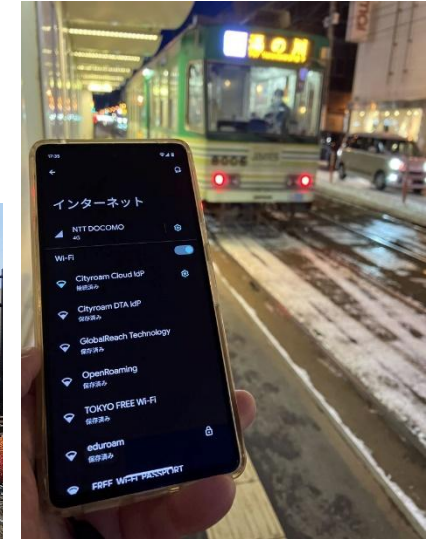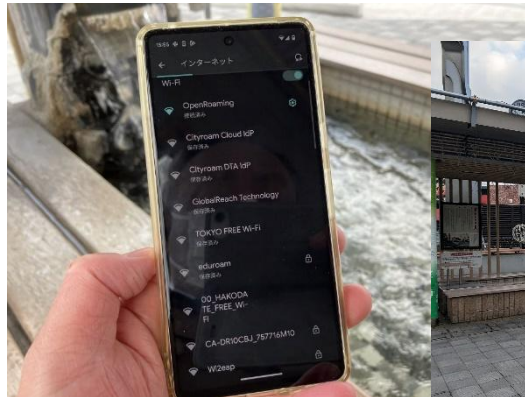
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TOKYO FREE Wi-Fi supports OpenRoaming

- Released on Mar. 31, 2023
- Tokyo Metropolitan Government + KDDI / Wire & Wireless (Wi2)
- Enhanced security, safety, and usability. ☺

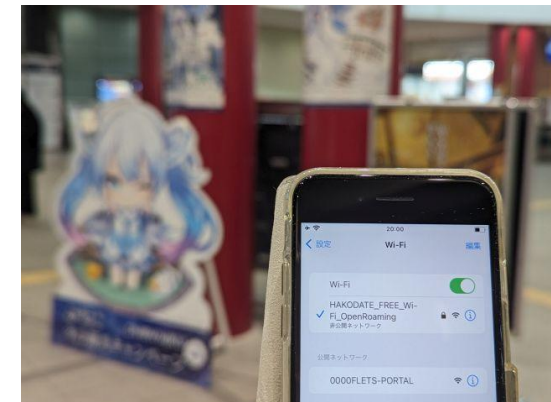https://wi-fi.metro.tokyo.lg.jp/en/

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HAKODATE FREE Wi-Fi

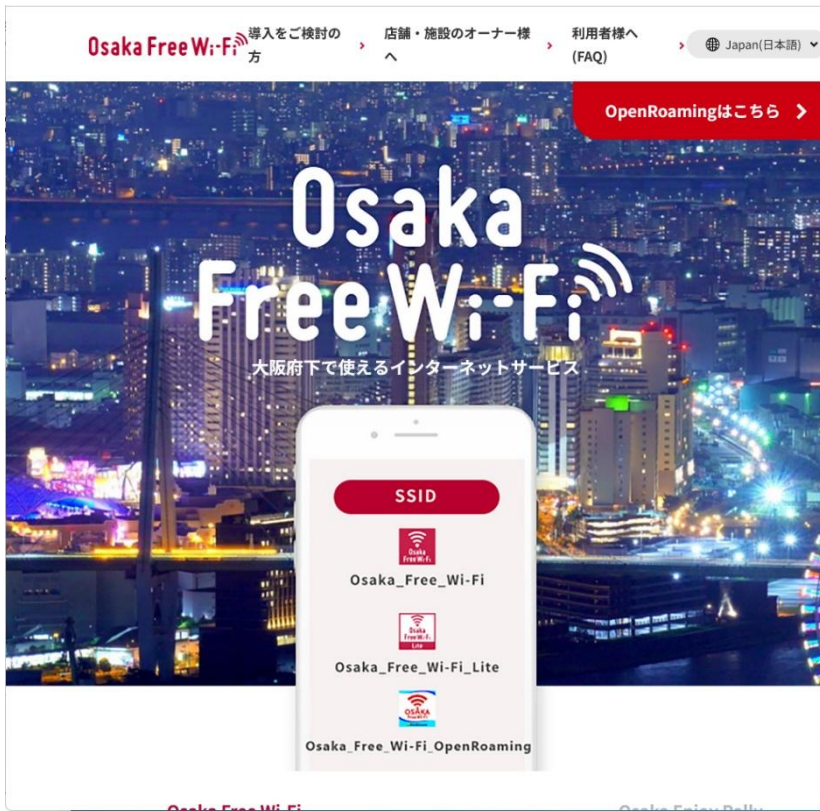- Nov. 30, 2023 –
- eduroam and OpenRoaming become available.

Enjoy eduroam / OpenRoaming
at the footbath (hot spa), airport, trams !

https://wi2.co.jp/release/press/2023/2023
1130-hakodate_openroaming.html

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Osaka Free Wi-Fi

- Oct. 10, 2024 –
- Initial deployment focuses on Public Transport. (for EXPO 2025)
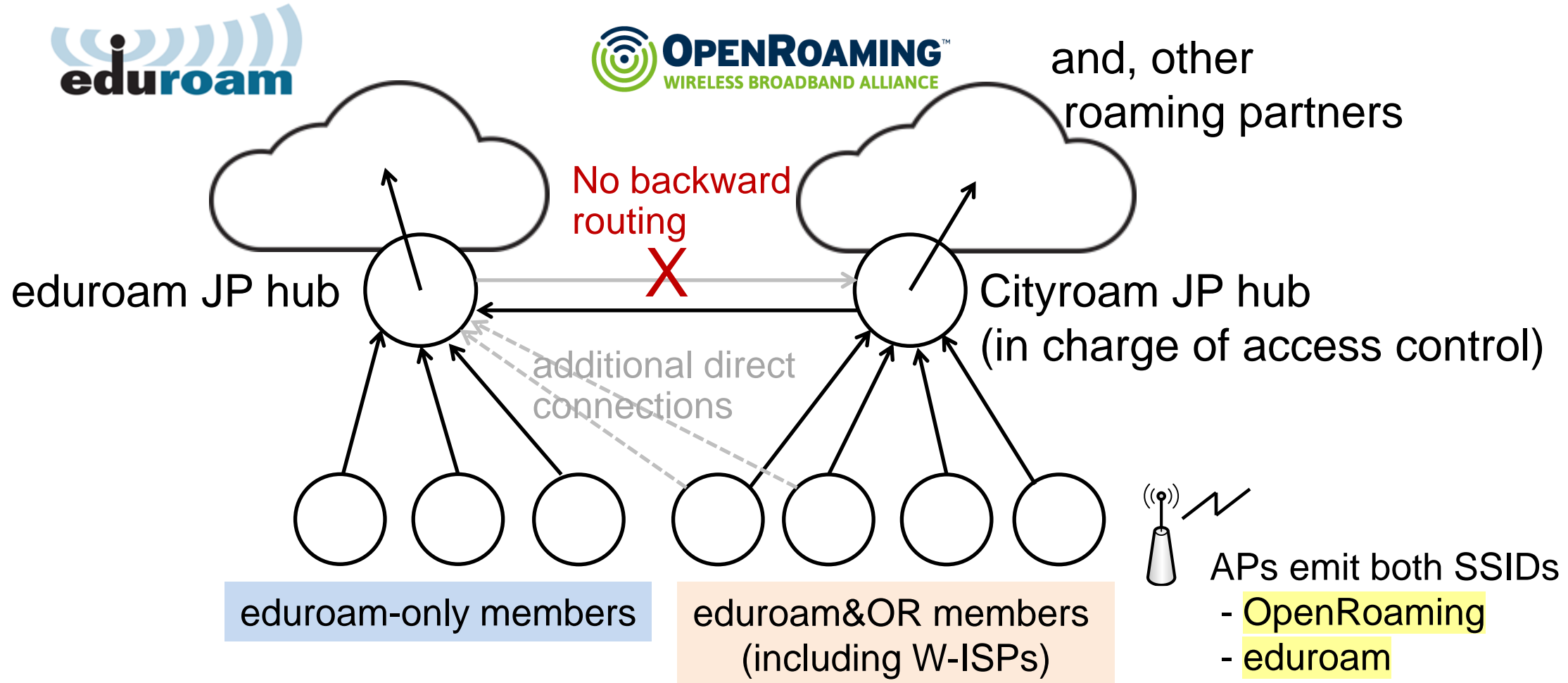

https://ofw-oer.com/

Why eduroam/OpenRoaming combination?

- eduroam has a matured **autonomy**.
  - Virtually monolithic.
    If you see "eduroam" SSID, **the service is always there**.
  - Single basic policy + minor variants.
    (won't bother users so much)
  - eduroam can be "**a group of reliable IdPs**"
    that provides <u>good credentials with strict user verification</u>,
    probably accompanied with enlightenment.

- Many students and staff are <u>carrying devices already
  configured with eduroam</u>.

Great
advantage

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eduroam/OpenRoaming combined architecture

eduroam

OPENROAMING
WIRELESS BROADBAND ALLIANCE

and, other
roaming partners

No backward
routing
X

eduroam JP hub

Cityroam JP hub
(in charge of access control)

additional direct
connections

APs emit both SSIDs
- OpenRoaming
- eduroam

eduroam-only members

eduroam&OR members
(including W-ISPs)

Forward to eduroam if ("%{Called-Station-Id}" =~ /:eduroam/)
(e.g. Called-Station-Id = de-ad-be-ef-01-23:eduroam)

Access analysis in the eduroam/OpenRoaming combined deployment

It is quite important to lower onboarding hurdles.

- **Municipal Wi-Fi profiles have become popular.** (>50%)
- SIM-based authentication is second popular.
  - User authentication is quite stable, with few errors.
- **eduroam accesses account for 10%.** (as of 2024)

Embedded profiles work quite well.

Summary

- eduroam / OpenRoaming combined deployment is quite useful for the societies in the digital era,
  supporting education, lifelong learning, tourism, and economy.

- Many municipalities in Japan (Kyoto, Tokyo, Hakodate, Kobe, Himeji, Osaka, etc.) have already deployed Cityroam.

- Why don't you deploy OpenRoaming together with eduroam? Cityroam architecture is open. You can do the same. 👍

On-going work

- **User activity analysis, data acquisition and sharing, under users' consent**. (currently, in a commissioned research program at NICT)

- eduroam for K-12, IoT, and some other applications.

Development of a user data sharing system

- Owners want to know / do …
  - ☐ Age group
  - ☐ Gender
  - ☐ Nationality
  - ☐ Language (browser setting)
  - ☐ Device/OS (for app development)
  - ☐ Wi-Fi usage location and staying time
  - ☐ Travel routes (e.g. shop-hopping in a mall, tourist sites), etc.

- Especially, municipalities want to know / do …
  - ☐ Travel routes
  - ☐ Analysis of tourist sites
  - ☐ Analysis for disaster response / mitigation, and urban design

Important data for businesses

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- Supplementary slides

Public Wi-Fi as an infrastructure

- WiFi4EU's case
  - Project for EU-wide Free Wi-Fi deployment
  - Public Wi-Fi is a society infrastructure like water and electricity.
  - Provide network access means to everyone including those who cannot have a DSL at home.
  - Access to digital government services is crucial.

> "Everyone benefiting from connectivity means that it should not matter where you live or how much you earn. So we propose today to equip every European village and every city with free wireless internet access around the main centres of public life by 2020.
> **Jean-Claude Juncker - State of the Union speech, September 2016**"

Why Public Wi-Fi?

Pros

- Higher bandwidth than cellular networks
- Autonomy
- Easier deployment with freedom
- Less expensive deployment and operation
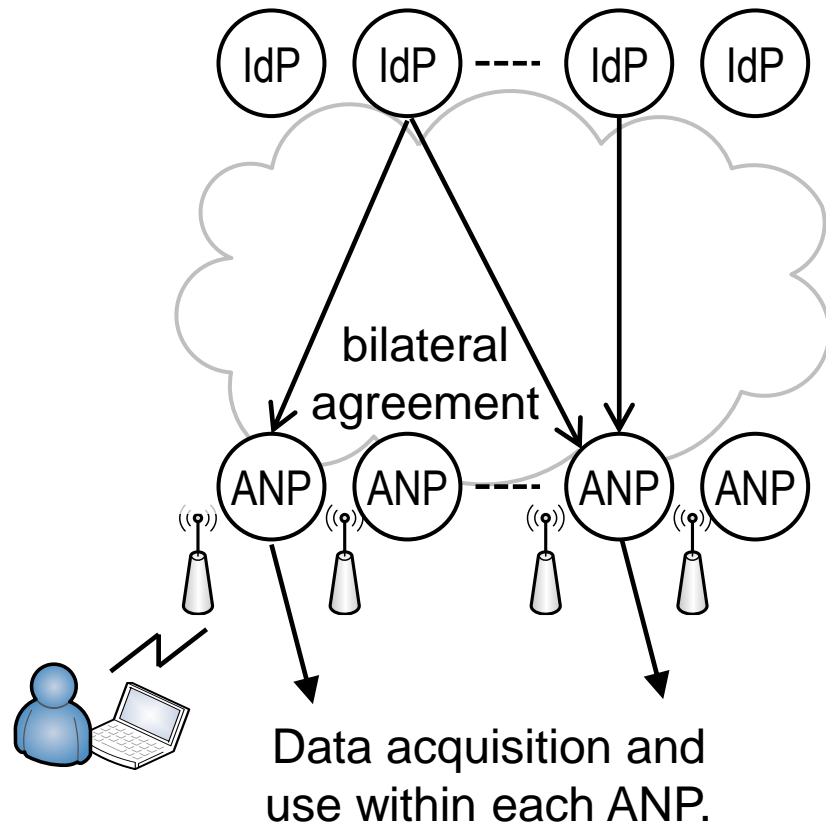- Less technical knowledge
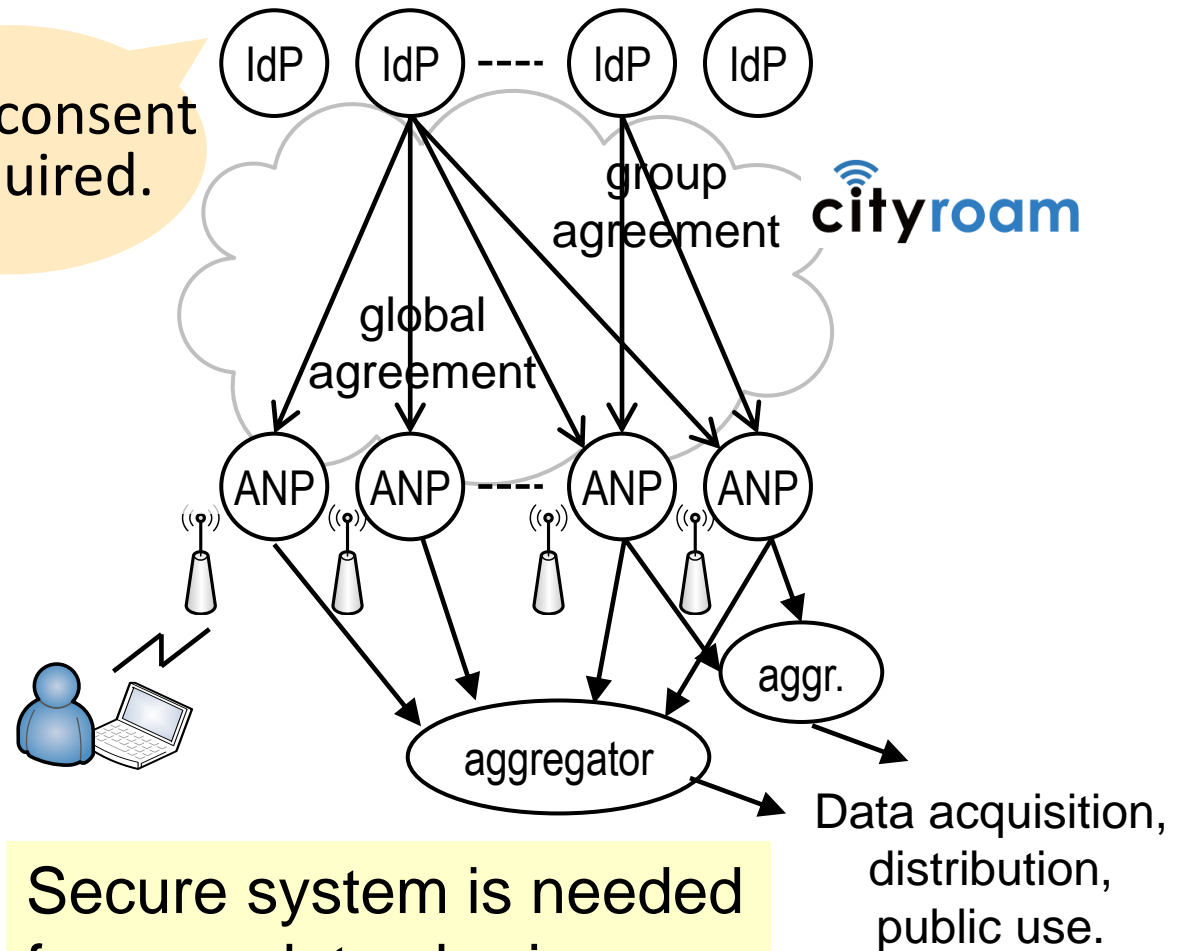
Cons   -> can be overcome

- Low (or no) security in the legacy Free Wi-Fi systems
  - Many people say "security is a concern".
    They are still using it or won't use it at all !
- Cumbersome registrations here and there
- Unclear privacy protection measures

Cellular network isn't enough ?

Development of a user data sharing system

User's consent is required.

bilateral agreement

ANP ANP ---- ANP ANP

Data acquisition and use within each ANP.

Bilateral agreements lead to low scalability.

IdP IdP ---- IdP IdP

group agreement

cityroam

global agreement

ANP ANP ---- ANP ANP

aggregator

aggr.

Data acquisition, distribution, public use.

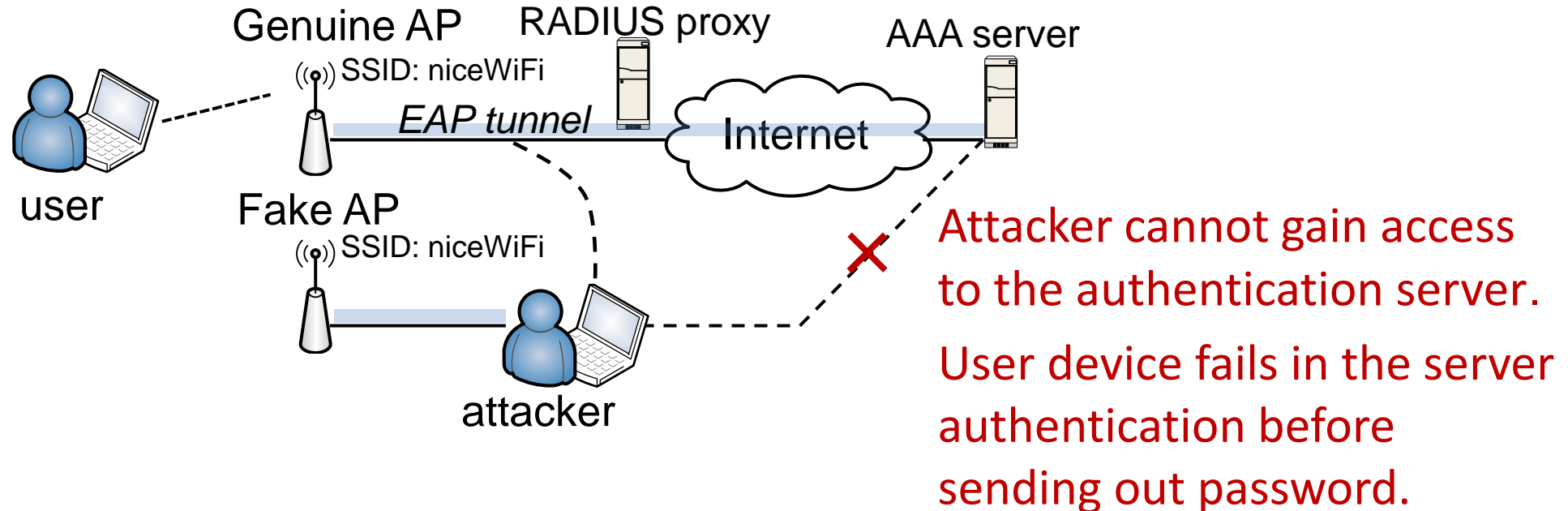Secure system is needed for user data sharing.

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Evil Twin Access Points

- If *open Wi-Fi* is used, there's no security or privacy. Anyone can plant an Evil Twin AP.

- If many people are using *WPA Personal*, sharing a *Pre-Shared Key* (PSK), the network is also unsecure.

- If you have joined a fake network, many attacks become possible. E.g., MITM, eavesdropping, malware injection, and active attacks.
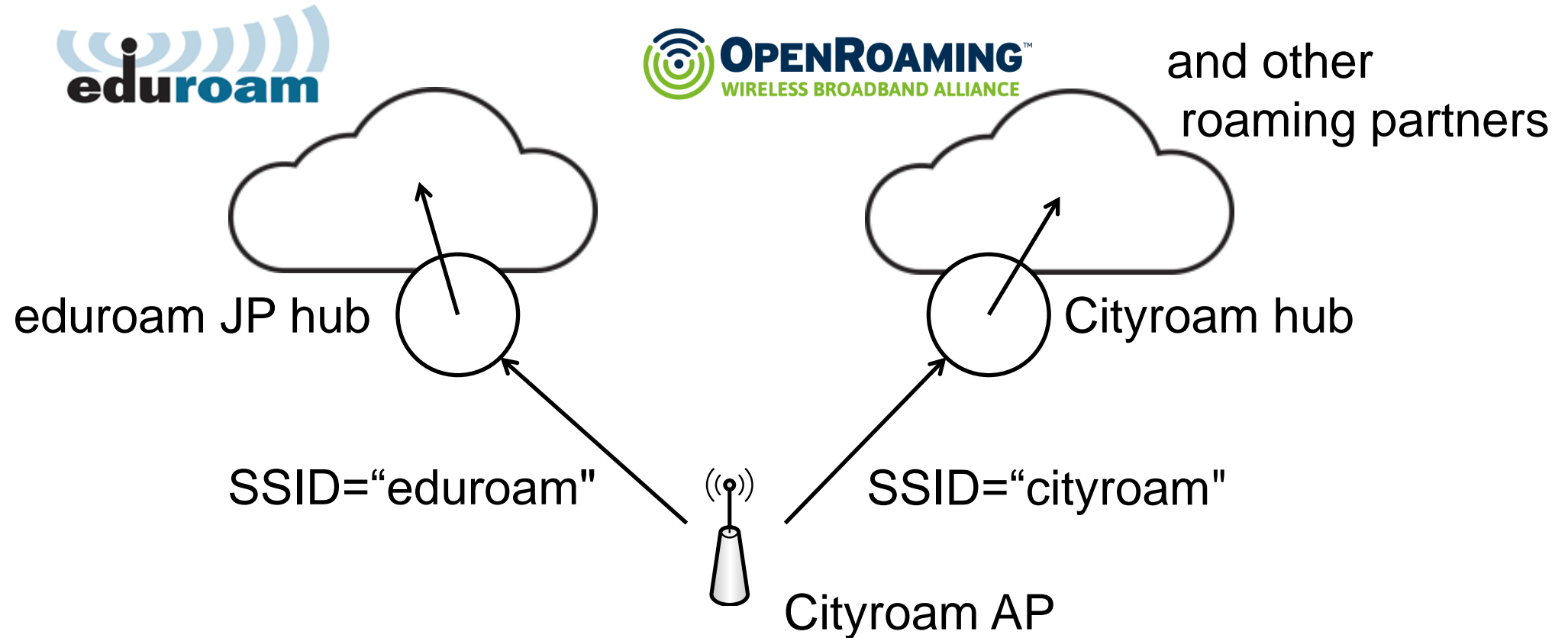
Genuine AP

SSID: niceWiFi

tapping

Internet

user

Fake AP

SSID: niceWiFi

Internet'

attacker

Behind the fake AP, everything could be fake.
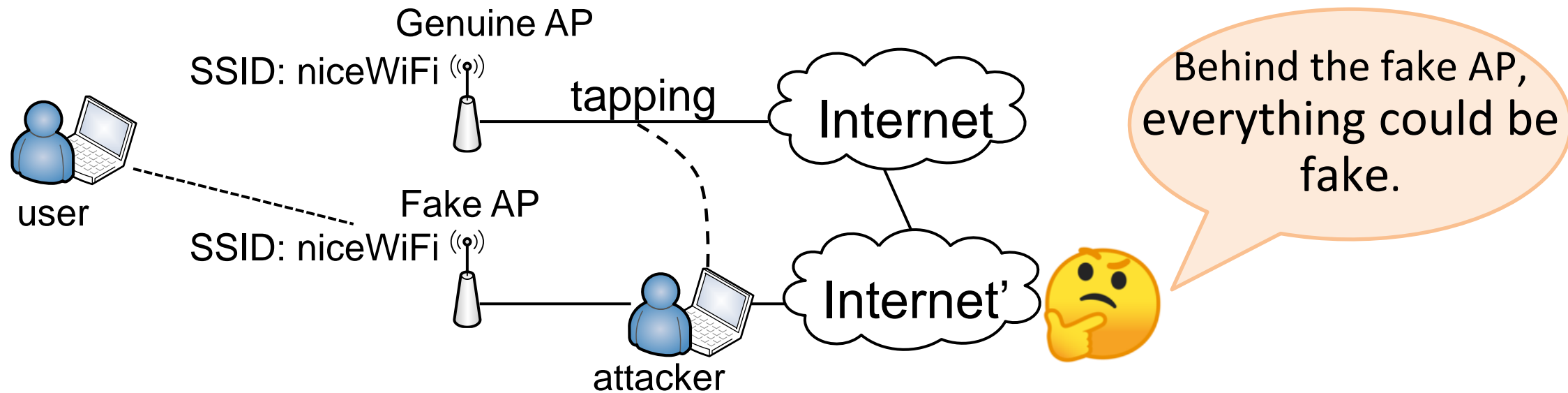
Secure Public Wi-Fi Using WPA2/WPA3 Enterprise

- Users should check whether the AP is a genuine one provided by an authorized operator.
  Server authentication in 802.1X makes it possible.

- Password protection as well as privacy protection is needed.
  EAP (Extensible Authentication Protocol) can provide protection.

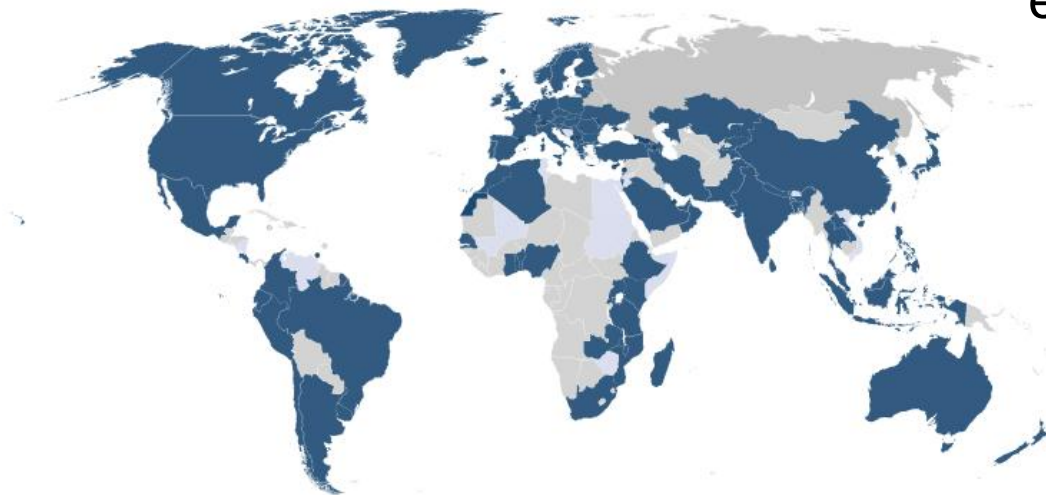Genuine AP RADIUS proxy AAA server
SSID: niceWiFi
EAP tunnel
Internet
user
Fake AP
SSID: niceWiFi
attacker

Attacker cannot gain access to the authentication server.

User device fails in the server authentication before sending out password.

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eduroam traffic separation – basic (but complex) implementation

eduroam JP hub

Cityroam hub

and other
roaming partners

SSID="eduroam"

SSID="cityroam"

Cityroam AP

- Require multiple RADIUS connections
- Complex AP configuration

eduroam (RFC 7593)

- **Secure Wi-Fi Roaming system for Research & Education**
  - Started as a pilot at TERENA (now GÉANT).
  - 104 countries/territories worldwide (as of 2025)
  - De facto standard of campus Wi-Fi in the world.
  - Mutual benefit system.
  - High security and usability based on 802.1X.

eduroam Companion (Android, iOS)