総務省 戦略的情報通信研究開発推進制度SCOPE
国際競争力強化型研究開発
4-4 ユビキタス・プラットフォーム統合化技術

ユビキタスID技術の相互運用性に関する研究開発

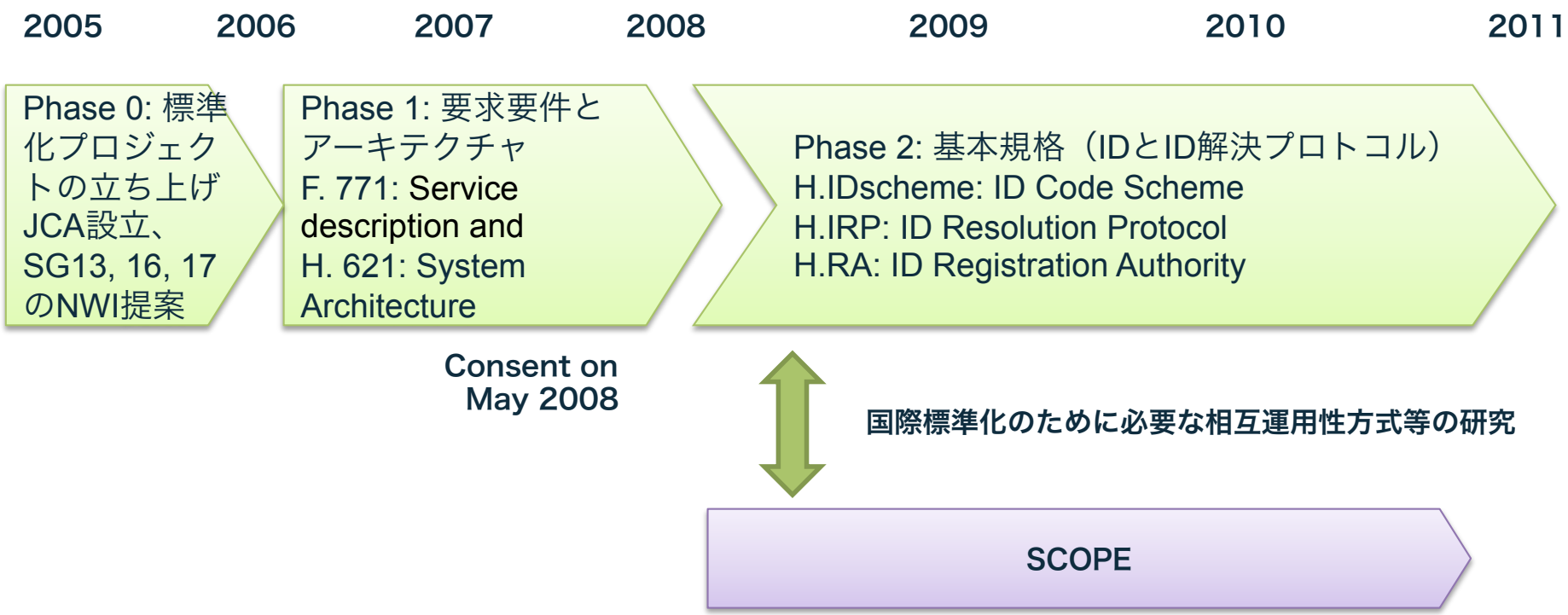
㈱横須賀テレコムリサーチパーク
東京大学
法政大学
研究代表者：越塚　登（YRP UNL）

事業概要

- **種別**
  - 国際競争力強化型研究開発
- **研究開発分野**
  - 4-4 ユビキタス・プラットフォーム統合化技術
- **概要**
  - ユビキタスIDアーキテクチャをITU-Tにおいて国際標準化させるための研究開発を行う。
  - その際、国内外で広範に利用されるユビキタスプラットフォームとするために、ISO/IEC JTC1で標準化されているRFID標準等の他の規格群との相互運用性を確保するためのインタフェース仕様を確立する。
  - 想定する標準群
    - ISO/IEC JTC1 SC31におけるRFIDタグ標準
    - ISO TC211におけるUBGI、PI (Place Identifier) の地理情報標準
    - EPCGlobal (GS1) におけるRFIDタグや情報システム標準
- **期間**
  - 平成20～22年度（2008～2010年度、3年間）
- **研究体制**
  - 研究代表者：越塚登（株式会社横須賀テレコムリサーチパーク、YRPユビキタスネットワーキング研究所副所長、東京大学教授）
  - 実施者：株式会社横須賀テレコムリサーチパーク、東京大学、法政大学

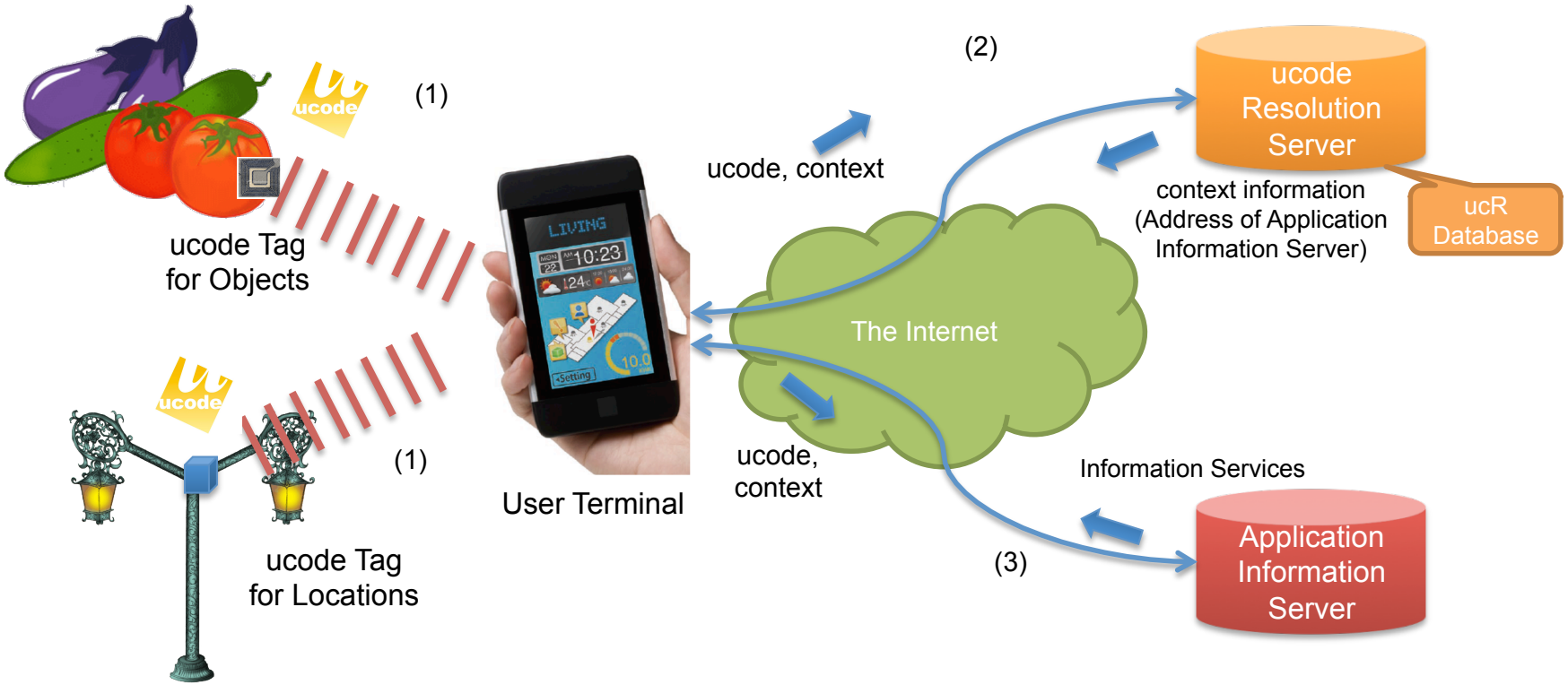
背景
Background

ITU-Tにおけるユビキタスネットワーク標準化の経緯



uIDアーキテクチャ標準
uID Architecture Standard

Ubiquitous ID Architecture

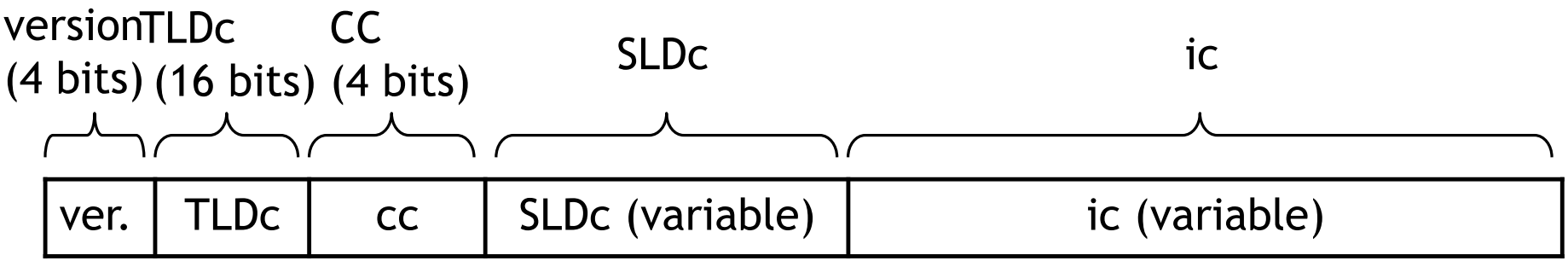


Workflow
(1) User terminal obtains ucode from ucode tags
(2) User terminal retrieves context-information including address information of Application Information Server
(3) User terminal receives context-aware information services from application information servers

ucode

- Definition
  - What is ucode?
    - Numbering scheme to identify that “one object is different from another object.”
    - Numbering scheme to identify objects, places, and concepts as sole thing.
  - The name of “ucode” comes from
    - “unique, uniform, and universal id-code used for ubiquitous computing.
  - Classification of ucode
    - Physical ucode: identifies tangible objects
    - Logical ucode: identifies intangible objects
- Features
  - Fixed length: 128-bit length code
    - 2128 ≒ 3.4×1038 (340,282,366,920,938,463,463,374,607,431,768,211,456)
    - The code can also be extended in 128 bits units.
  - Able to identify individual “things”
  - Tag-agnostic
    - Barcode, 2D barcode, passive RFID, active RFID, IR beacon, …
  - Can be issued by anyone
    - Decentralized governance
  - The ucode number itself contains no semantic information
  - Possible to embed existing codes

ucode: Numbering Structure

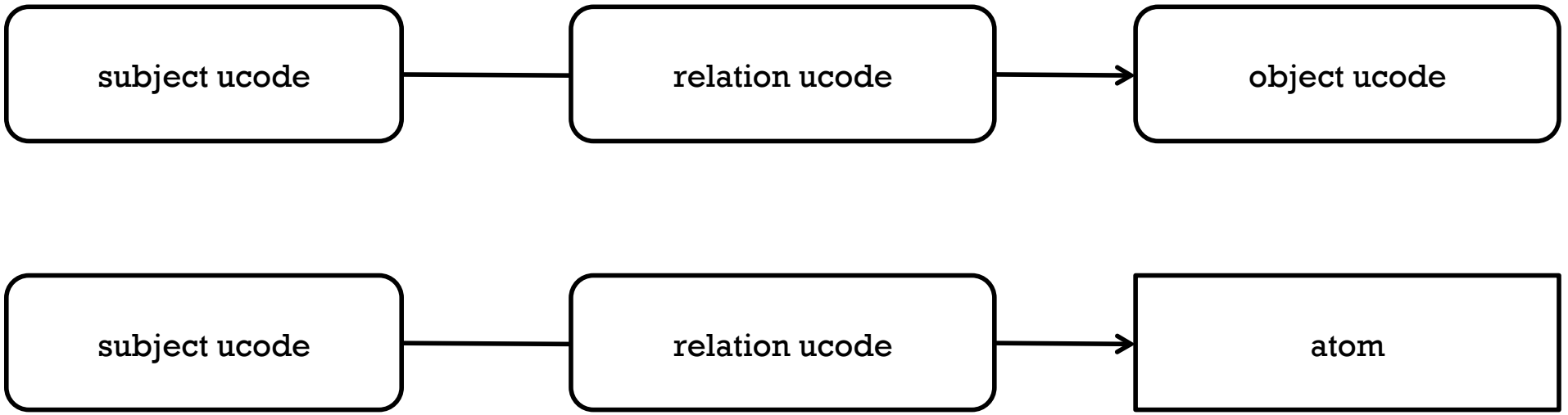


name	meaning
version	Indicating the version of ucode
TLDc: Top Level Domain Code	Upper level domain code
cc: Class Code	Specifying the boundary of SLDc and ic
SLDc: Second Level Domain Code	Lower level domain code
ic: Identification Code	Rest field of ucode

ucode Relation Model (Definition)

- ucR (ucode Relation) Model is a representation model of real-world context in which information on real-world object, place, and concept are modeled as a collection of triples of ucodes and atoms.
- ucR is a kind of three-valued logics based on the ontology model.

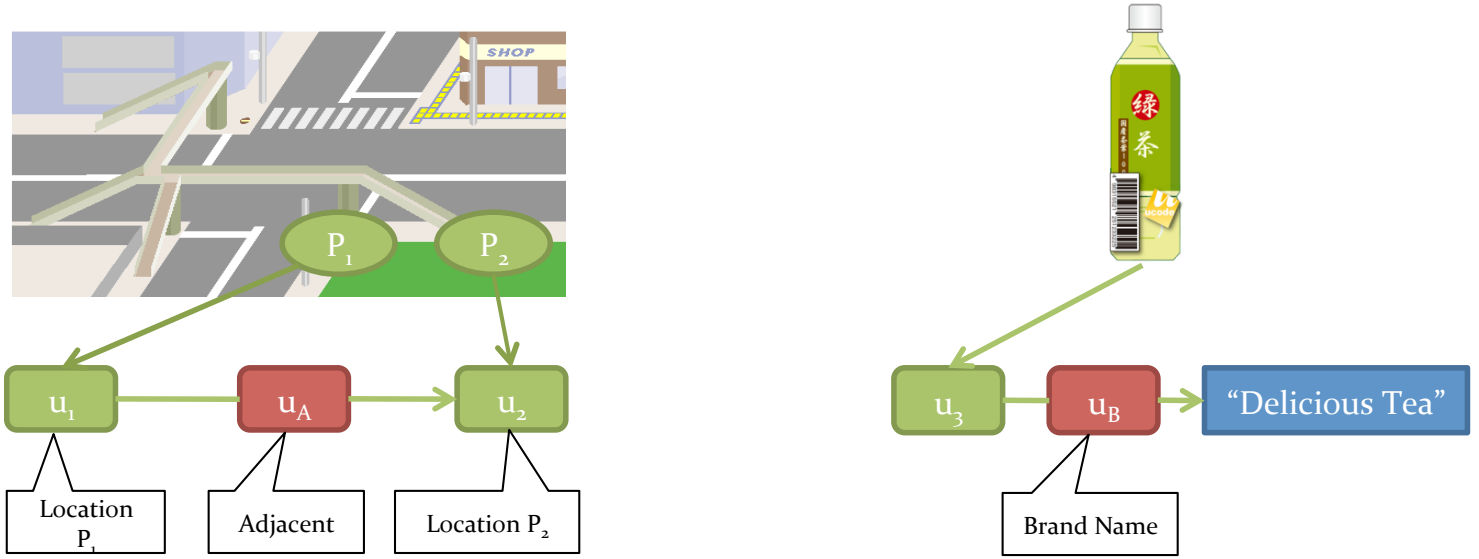
UCR unit



- UCR unit is defined as the following triple
  - A triple of ucodes = (ucode, relation ucode, ucode)
  - A pair of ucodes and an atom = (ucode, relation ucode, atom)

- UCR unit is the basic unit for describing real-world context information.

ucR units: Examples



ID Resolution

ucode解決要求①
0x0-0001-c-00000000000003-0123456789ab

ucodeRS for TLD 0x0001のアドレス

Root ucodeRS

vers.(4)	TLDc (16)	cc (4)	SLDc (56)	ic (48)
0x0	0x0001	0x#	0x###############	0x############

ucodeRS for TLD 0x0001のアドレス

ucode解決要求②
0x0-0001-c-00000000000003-0123456789ab

ucodeRS for SLD 0x00.....03のアドレス

ucodeRS
for TLD 0x0001

vers.(4)	TLDc (16)	cc (4)	SLDc (56)	ic (48)
0x0	0x0001	0xc	0x00000000000003	0x############

ucodeRS for SLD 0x00.....03のアドレス

ucode解決要求③
0x0-0001-c-00000000000003-0123456789ab

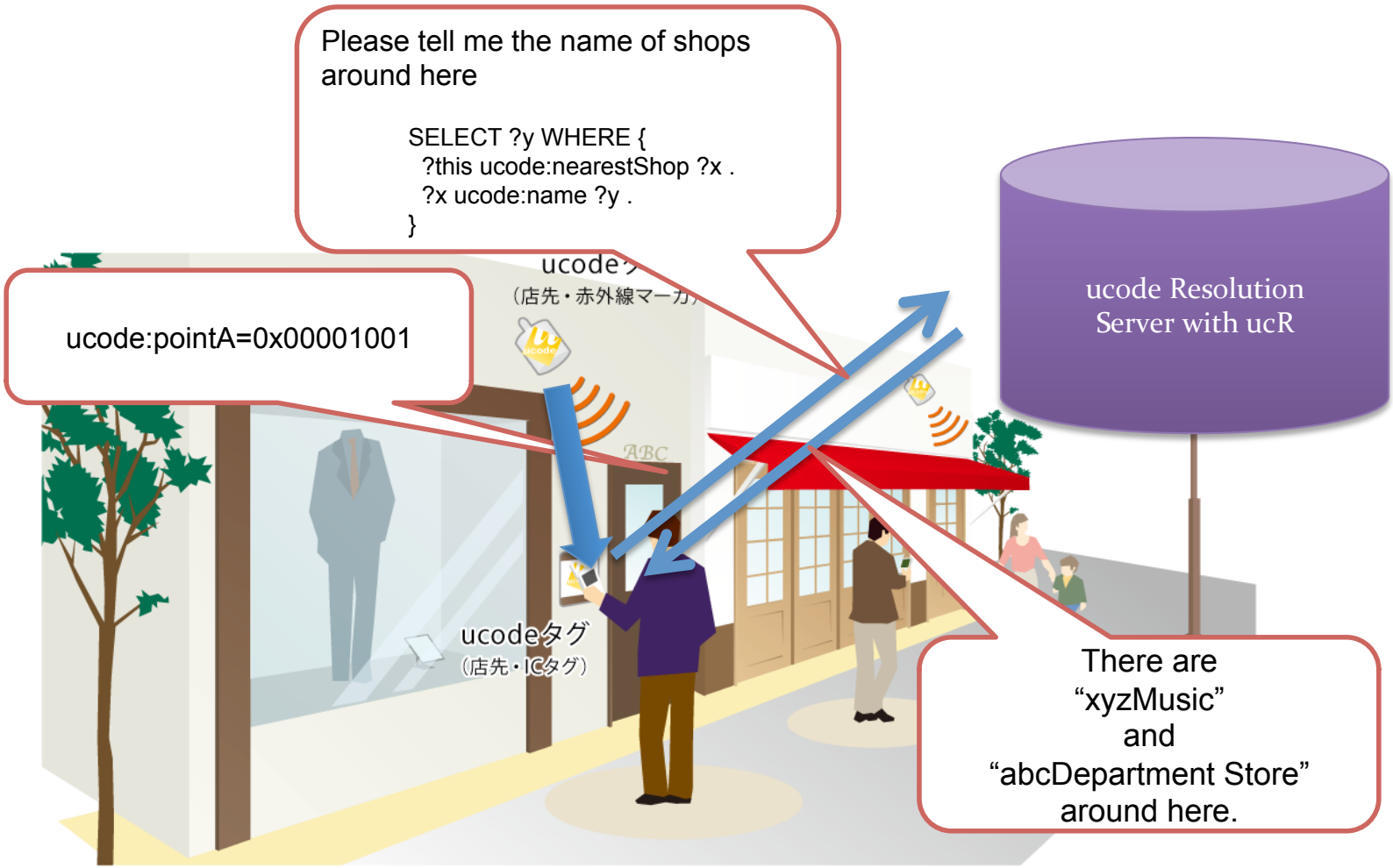
アプリケーション情報サーバーへのリンク
http://demo.demo.org/query.cgi&
ucode=0x0-0001-c-00000000000003-0123456789ab

ucodeRS
for SLD
0x00.....03

vers.(4)	TLDc (16)	cc (4)	SLDc (56)	ic (48)
0x0	0x0001	0xc	0x00000000000003	0x0123456789ab

アプリケーション情報サーバーへのリンク
http://demo.demo.org/query.cgi&
ucode=0x0-0001-c-00000000000003-0123456789ab

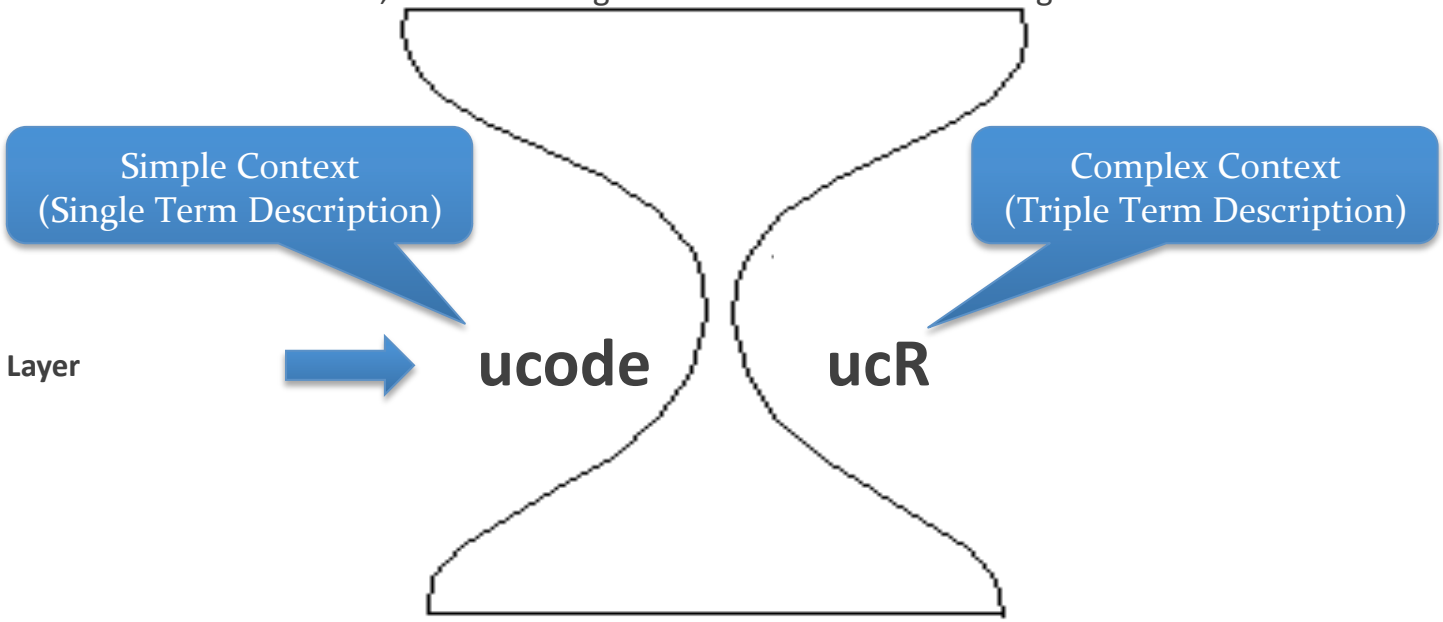
Ex: Location-aware Resolution



Hourglass model of uID Architecture

Applications and services

Location-aware information services Supply Chain Management Food Traceability
Product Certification Logistics Certification e-health Smart Grid
Smart House, Smart Building Critical Infrastructure Management



Context Representation Layer

Sensor Network Techs.	**Auto ID Techs.**	**User Terminals**	**Networks**
Sensor Network	Passive RFIDs Smart Cards	Mobile Phones PDAs	TCP/IP IPv6
	Active RFIDs Barcodes	Smart Phones PCs	3G, 4G Mobile Phone Networks
	IR Beacons 2D Barcodes	e-Book Terminals	NGN Overlay Networks
	RF Beacons	Pad Computers	WLANS ……

What are standardized ? What are NOT?

Standardized

- IDs for real-world entities
  - ucode
- Context representation format
  - ucode Relation (ucR)
- Service Finding Protocols
  - ucode Resolution Protocol

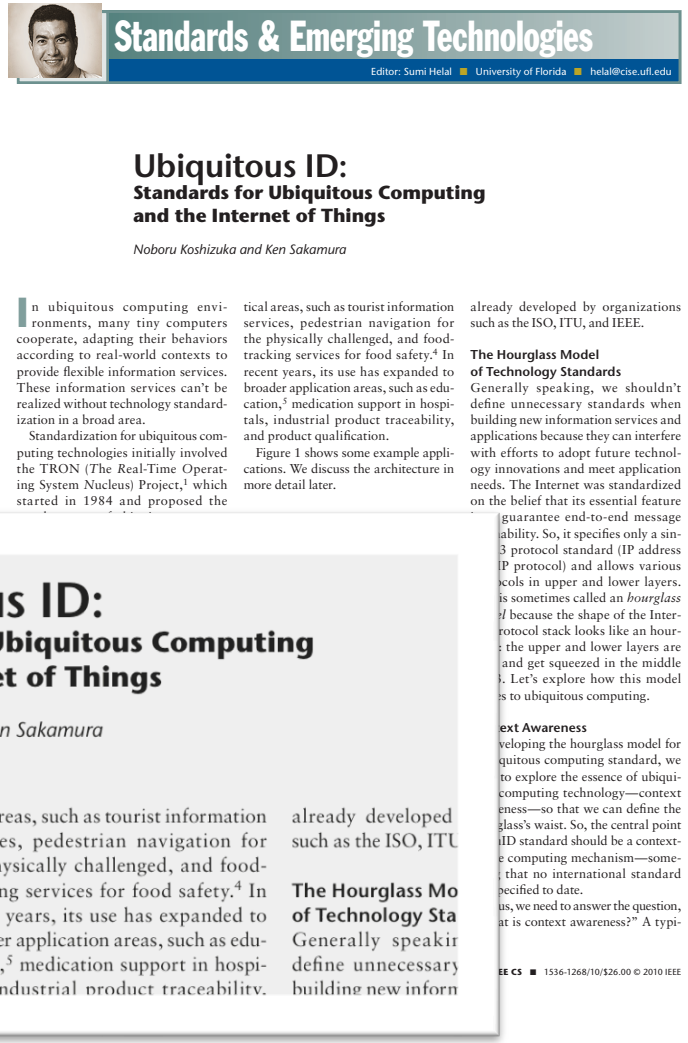
- All standard documents can be obtained from the following web page:
  - http://www.uidcenter.org/

NOT

- Tags (RFIDs, barcodes, …)
  - Any tags can be used
  - Tag-agnostic architecture
- Application service protocol
  - Any applications and services can be used.

For more info. on uID Center Standardization

- Noboru Koshizuka, and Ken Sakamura: “Ubiquitous ID: Standards for Ubiquitous Computing and the Internet of Things”, IEEE Pervasive Computing, Vol. 9, No. 4, Oct.-Nov., 2010, pp. 98-101.
  - Published by the latest IEEE Pervasive Computing Magazine.



Standards & Emerging Technologies

Editor: Sumi Helal ■ University of Florida ■ helal@cise.ufl.edu

Ubiquitous ID:
Standards for Ubiquitous Computing and the Internet of Things

Noboru Koshizuka and Ken Sakamura

In ubiquitous computing environments, many tiny computers cooperate, adapting their behaviors according to real-world contexts to provide flexible information services. These information services can't be realized without technology standardization in a broad area.

Standardization for ubiquitous computing technologies initially involved the TRON (The Real-Time Operating System Nucleus) Project,[1] which started in 1984 and proposed the

tical areas, such as tourist information services, pedestrian navigation for the physically challenged, and food-tracking services for food safety.[4] In recent years, its use has expanded to broader application areas, such as education,[5] medication support in hospitals, industrial product traceability, and product qualification.

Figure 1 shows some example applications. We discuss the architecture in more detail later.

already developed by organizations such as the ISO, ITU, and IEEE.

The Hourglass Model of Technology Standards

Generally speaking, we shouldn't define unnecessary standards when building new information services and applications because they can interfere with efforts to adopt future technology innovations and meet application needs. The Internet was standardized on the belief that its essential feature

guarantee end-to-end message
ability. So, it specifies only a sin-
3 protocol standard (IP address
IP protocol) and allows various
ocols in upper and lower layers.
is sometimes called an *hourglass*
l because the shape of the Inter-
rotocol stack looks like an hour-
the upper and lower layers are
and get squeezed in the middle
. Let's explore how this model
s to ubiquitous computing.

ext Awareness

veloping the hourglass model for
quitous computing standard, we
to explore the essence of ubiqui-
computing technology—context
eness—so that we can define the
glass's waist. So, the central point
ID standard should be a context-
e computing mechanism—some-
that no international standard
pecified to date.
us, we need to answer the question,
at is context awareness?" A typi-

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国際標準化への取組み
International Standardization Activities

Standardization Issues in ITU-T in Relation with Ubiquitous Networks

- Study Group 16 “Multimedia and New Applications”
  - Chair: Mr. Naito (Japan)

- Networked ID (Q21, 22/SG16)
  - “Multimedia information accessing services and applications triggered by tag-based identification”
  - Main Contributors: Japan
- Visual Surveillance (Q21, 22/SG16)
  - Main Contributors: China
- Ubiquitous Sensor Networks (Q25/SG16)
  - Mail Contributors: Korea

Standardization on Networked ID in SG16, ITU-T

- ITU-T Rec. F.771 Requirement standard
  - Formal Title: "Service description and requirements for multimedia information access triggered by tag-based identification"
  - Editor: Y. Takashima (YRP UNL, Japan)
- ITU-T Rec. H.621 Architecture standard
  - Formal Title: "Tag-based ID triggered multimedia information access system architecture"
  - Editor: Y. Takashima (YRP UNL, Japan)

- Approved in August, 2008

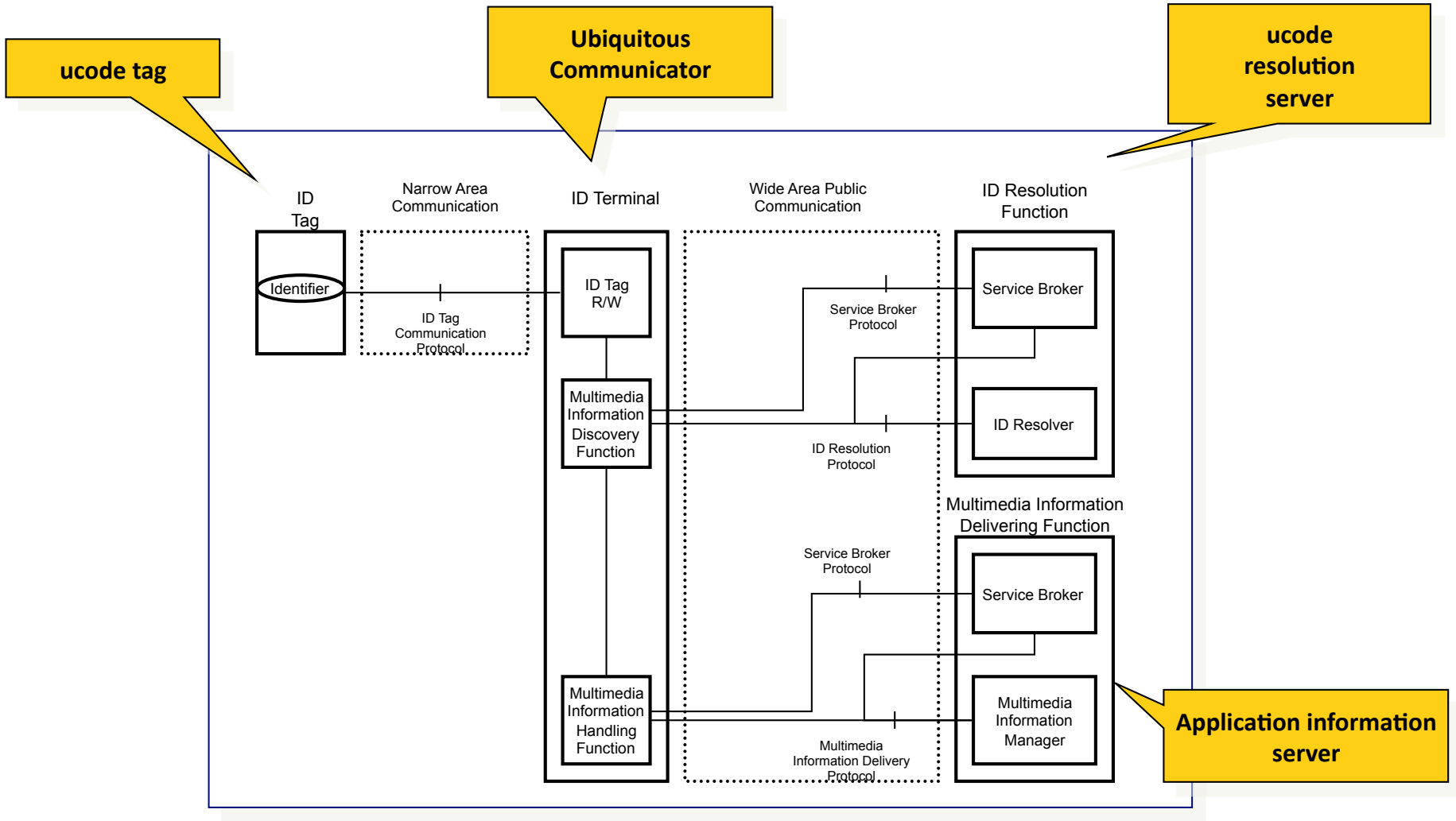
F. 771: サービス記述と要求要件

- タイトル（英語）
  - Service description and requirements for multimedia information access triggered by tag-based identification
- タイトル（日本語）
  - （RFID 等の）タグ情報の読込みをきっかけとして提供される複合メディア情報サービスのための サービス記述と要求要件
- エディタ
  - Yoichi Takashima (YRP UNL)
  - Jun Soeb Lee (ETRI, Korea)
- 成立
  - 2008年5月（consent）、2008年8月（成立）

H. 621: アーキテクチャ

- タイトル（英語）
  - Tag-based ID triggered multimedia information access system architecture
- タイトル（日本語）
  - （RFID 等の）（RFID 等の）タグ情報の読込みをきっかけとして提供される複合メディア情報システムアーキテクチャ
- エディタ
  - Yoichi Takashima (YRP UNL)
  - Jun Soeb Lee (ETRI, Korea)
- 成立
  - 2008年5月（consent）、2008年8月（成立）

ITU H.621 Architecture Based on uID Architecture



Standardization on Networked ID in SG16, ITU-T

- H.IDscheme: ID Standard
  - Formal Title: “ID schemes for multimedia information access triggered by tag-based identification”
  - Editor: N. Koshizuka (YRP UNL, Japan), J. Lee (ETRI, Korea)
  - Current draft adopts “ucode”
- H.IRP: Service Finding Protocol Standard
  - Formal Title: “ID resolution protocols for multimedia information access triggered by tag-based identification”
  - Editor: N. Koshizuka (YRP UNL, Japan), J. Lee (ETRI, Korea)

- Work in progress

H.IDscheme

- タイトル（英語）
  - ID schemes for multimedia information access triggered by tag-based identification
- タイトル（日本語）
  - （RFID 等の）タグ情報の読込みをきっかけとして提供される複合メディア情報サービスのための ID スキーム
- エディタ
  - Noboru Koshizuka (YRP UNL)
  - Jun Soeb Lee (ETRI, Korea)

H.IRP

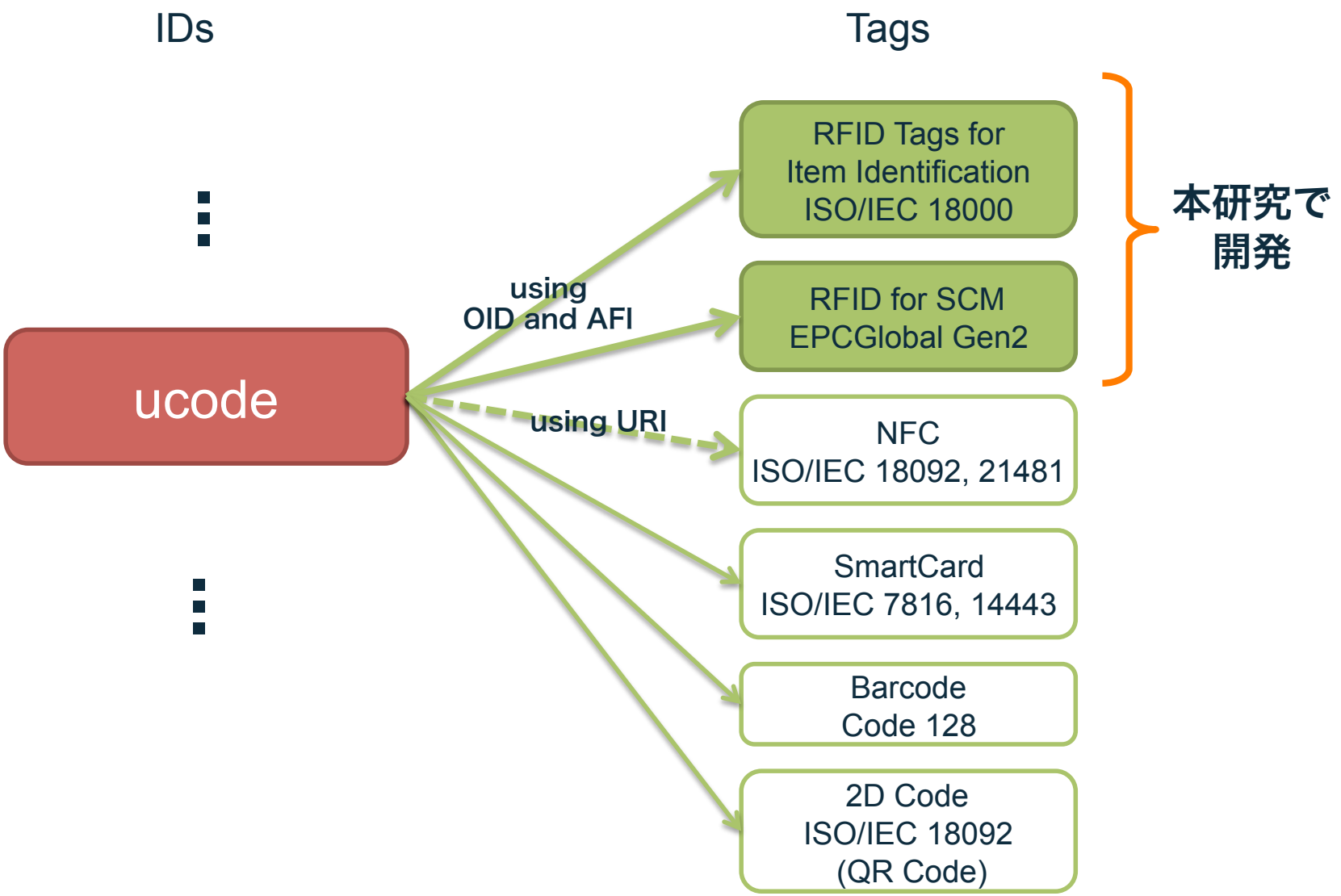
- タイトル（英語）
  - ID resolution protocols for multimedia information access triggered by tag-based identification
- タイトル（日本語）
  - （RFID 等の）タグ情報の読込みをきっかけとして提供される複合メディア情報サービスのための ID 解決プロトコル
- エディタ
  - Noboru Koshizuka (YRP UNL)
  - Jun Soeb Lee (ETRI, Korea)

本事業の研究開発
R&D Results of this Project

注目する３種類の相互運用性

- **タグの相互運用性**
  - 国際標準のRFIDタグに、ucodeを搭載する方法
- **ID解決プロトコルの相互運用性**
  - ucodeから関連する情報へのポインタを取り出すプロトコル
- **セマンティックス、実世界記述データの相互運用性**
  - 場所やモノの属性情報記述（本研究開発では、特に場所の属性情報記述に着目）

タグの相互運用性

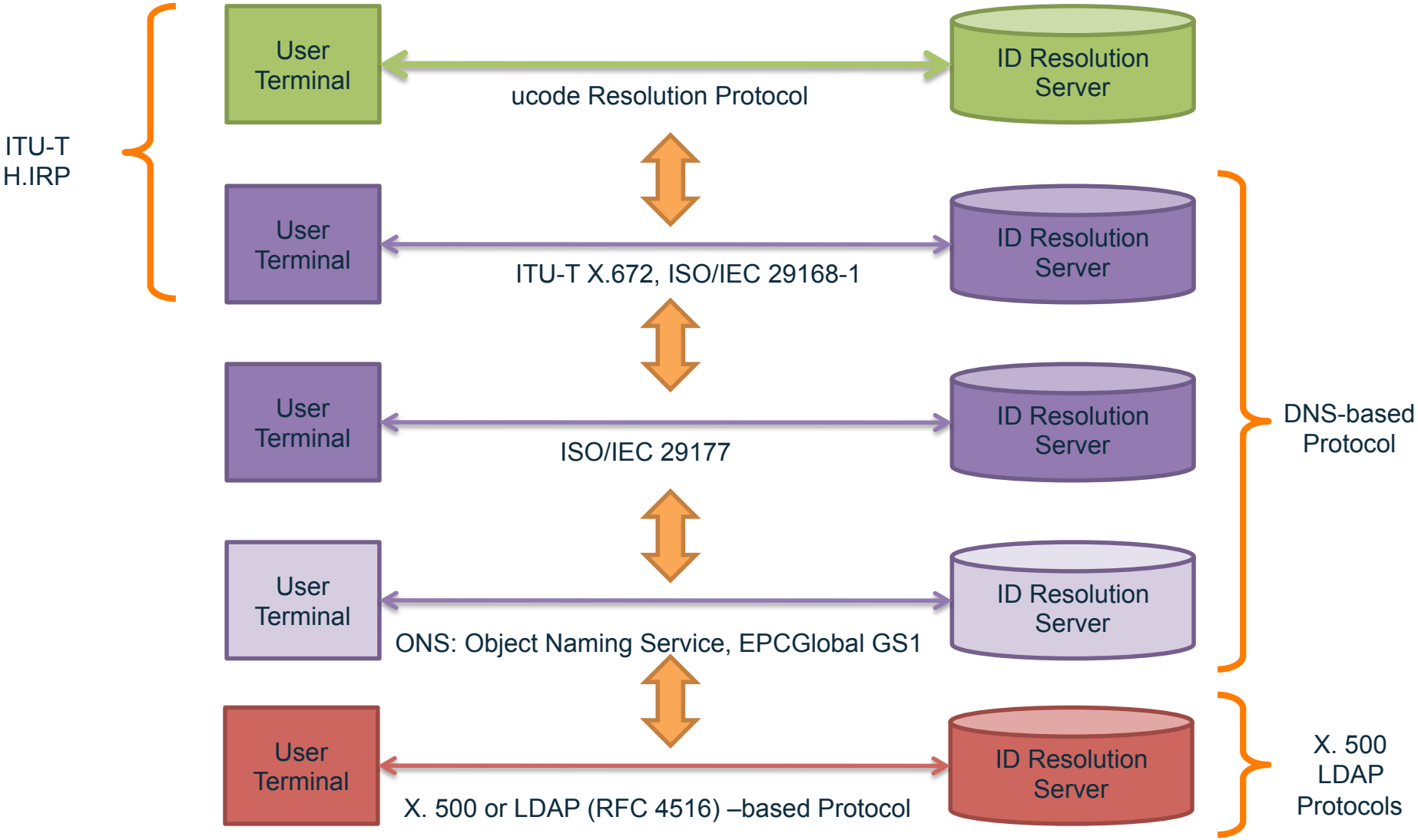


ID解決プロトコル

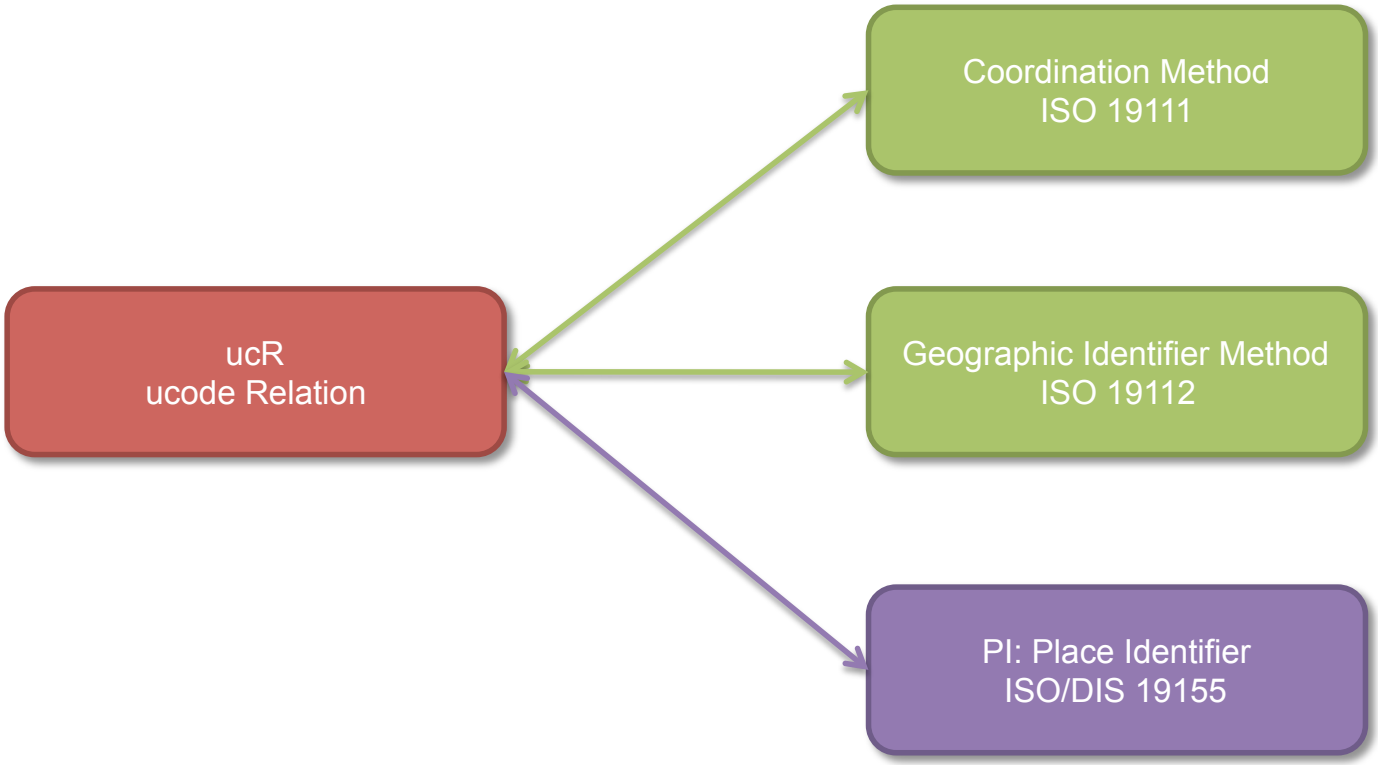
- ID解決プロトコル
  - Key (= input): ID, Context Data
  - Value (= output): Pointer/Address of Information/Services

- ID解決プロトコルの種類
  - Simple Key-Value型
    - keyとして、ID（とAttribute）のみを与える
    - いわゆるディレクトリサービス型
    - 複数種類の標準プロトコルが提案されている。
  - Semantic Database型
    - RDF Queryのように、知識データベース検索のクエリとして実行する
    - 確立した国際標準はない

ID解決プロトコルの相互運用性



セマンティックス、実世界記述データの相互運用性
特に…場所情報記述の相互運用性



国際標準化活動の現状
Current Status of International Standardization in ITU-T

国際標準化活動の現状

- ISO/IEC JTC1/SC31 WG6 “Mobile RFID”の取組みとの連携
  - 主に携帯電話のような端末を使って、RFIDから情報を読み出し、その情報をもとにネットワーク情報サービスを受け取るための標準規格
  - ITU-Tにおける標準化の後に起きたが、似た部分があるため、連携することを求める国があった。

  - 共通化できる部分は共通化する方向で作業がすすむ

- 連携の現状
  - ID Scheme
    - ISO/IEC側とITU側のscopeが異なるため、IDの共通化はしない
  - ID Resolution Protocol
    - 技術的に共通のものでカバーできるため、DNSベースのプロトコルでコモンテキスト化する

まとめと今後の展開
Summary and Future Works

まとめと今後の課題

まとめ

- 関連する主要な国際規格との連携手法を考案、実証
  - 他標準規格との連携は解決済
  - 論理的にも性能的にも解決
- scopeの研究開発成果が、国際標準規格の技術的裏付けの役割を果たす
  - 特に他規格とのハーモナイズしている状況を技術的に示したことは大きい。
- 日本がイニシアチブをとって、国際標準化を推進
  - 現在、IDとID解決プロトコルの標準規格については、最終ドラフト段階に

今後の課題

- ITU-Tの国際標準の成立（H.IDscheme、H.IRP、H.RA）
  - 早ければ、次回SG16会合（2011年11～12月）
- ucRの国際標準化
  - 国際的にも、この部分の標準化は手つかず状態
  - 情報流通連携基盤のためには、不可欠な標準規格

成果リスト
List of Works

受賞リスト

- **越塚登, 第37回日本ITU協会賞・国際活動奨励賞**, 2009年5月.
- Best Paper Award, The 34th Annual IEEE Computer Software and Application Conference (COMPSAC 2010), July 2010.

紙上発表リスト（平成20～22年度）

論文

- Yukihiko Shigesada, Shinsuke Kobayashi, Noboru Koshizuka, Ken Sakamura: “ucR Based Interoperable Spatial Information Model for Realizing Ubiquitous Spatial Infrastructure,” in Proc. 34th Annual IEEE Computer Software and Application Conference (COMPSAC2010), July 19, 2010, *Best Paper Award*.
- Shinsuke Kobayashi, Yukihiko Shigesada, Noboru Koshizuka, and Ken Sakamura: “Interoperable Spatial Information System Architecture Based on Ubiquitous ID Infrastructure,” in Proc. 4th IEEE International Workshop on Service Science and Systems (SSS2011) .
- Yukihiko Shigesada, Shinsuke Kobayashi, Noboru Koshizuka, and Ken Sakamura: “Interoperable Spatial Information Model and Design Environment Based on ucR Technology,” IEEE Transactions on Computer, *in submitting*.

書籍

- 越塚登：「ユビキタスIDセンターの技術と活動」, RFIDタグの開発技術 II（普及版）, シーエムシー出版, 2009年, pp. 211～219.

口頭発表リスト（平成20年度）

- NoboruKoshizuka: “UbiquitousID Architecture: Its Technologies and Applications”, Panel Sesion#2 “Can smart cards and tags create Ubiquitous Network Society?”, the 8th IFIP Conference on e-Business, e-Services, and e-Society (I3E 2008) , Tokyo, Sept. 24-26, 2008.
- Noboru Koshizuka: “Ubiquitous Computing Technologies for Product Qualification”, Workshop on Identification of Automation Components, Karlsruhe, Germany, Oct. 27, 2008
- 新堂克徳: “はじめての ucode”, TRONSHOW 2009 (東京)(2008 年 12 月 10 日)
- 小林真輔、“ucode を RFID で使う”、TRONSHOW 2009 (東京)(2008 年 12 月 11 日)
- 新堂克徳、紙名哲生、”ucode 基盤システムのすべて”、 TRONSHOW 2009 (東京)(2008 年 12 月12 日)
- 越塚登、“ユビキタス ID 技術の国際標準化:イントロダクション”、 パネルセッション「進むユビキタス ID 技術の国際標準化」, TRONSHOW 2009 (東京)(2008 年 12 月 12 日)
- 越塚登:「ITU Recommendation/ITU 勧告 F.621 and H.771」, パネルセッション「進むユビキタス ID 技術の国際標準化」, TRONSHOW 2009(東京)(2008 年 12 月 12 日)

口頭発表リスト（平成21年度-1）

- Noboru Koshizuka, Tetsuo Kamina: “Survey on ID code schemes for NID applications and services”, NID-WG, the 9th CJK meeting, **中国張家界市**, April 8–10, 2009.
- Noboru Koshizuka, Tetsuo Kamina: “Current status on NID and USN applications and services in Japan.”, NID-WG, the 9th CJK meeting（**中国張家界市**）,（April 8-10, 2009）
- Noboru Koshizuka, Tetsuo Kamina: ” Evidence that combination of multiple existing international IDschemes is insufficient”, The 9th CJK N-ID-WG meeting(Beijing)、（July 22 2009）
- Noboru Koshizuka, Tetsuo Kamina: ”Evidence that multiple general purpose ID schemes are required”, The 9th CJK N-ID-WG meeting (Beijing), July 22 2009.
- Noboru Koshizuka, Tetsuo Kamina: ” Current status of N-ID related activities on ITU-T SG16”、The 10th CJK N-ID-WG meeting （**中国　三亜**)、(Nov. 16 – 18, 2009)
- Noboru Koshizuka, Tetsuo Kamina: ”Modification Plan for H.IDscheme”、The 10th CJK N-ID-WG meeting （**中国　三亜**)、(Nov. 16 – 18, 2009)
- “UNL**における国際標準化の紹介**”、TRONSHOW2010(**東京**)、（2009年12月9-11日）

口頭発表リスト（平成21年度-2）

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- Liaison Officer (Noboru Koshizuka)
  - ISO/IEC JTC1/SC31 WG6 Liaison Officer (from ITU-T SG16)
- Chair (Noboru Koshizuka)
  - CJK NID WG Chair (2008)
  - CJK NID WG Vice Chair (2009, 2010)

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