Linking the Real World to the Virtual World –

Atoms, Bits and Smart Objects

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Smart Objects? Atoms? Bits?

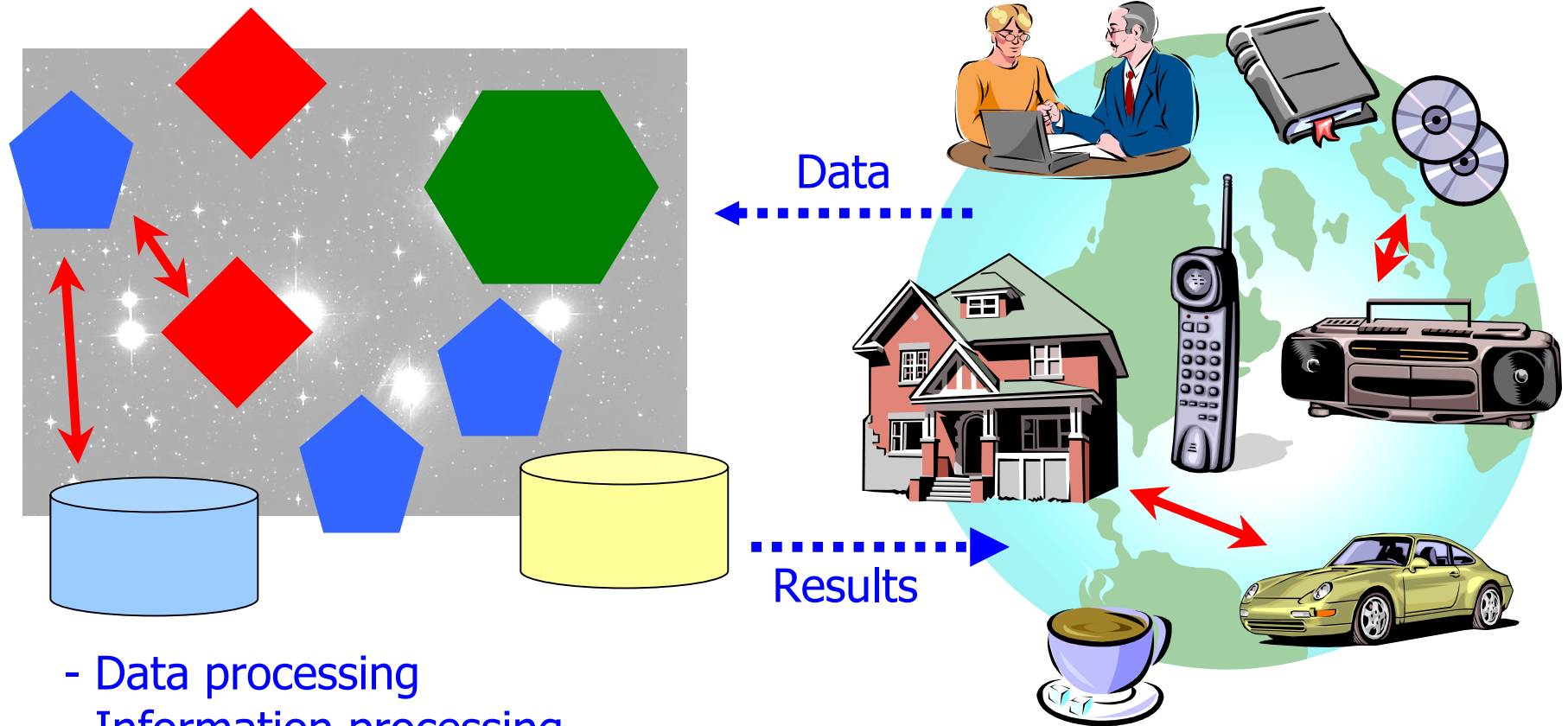- What if all things were smart?

  but what does „smart" mean?

- What if every object had its Internet home page?

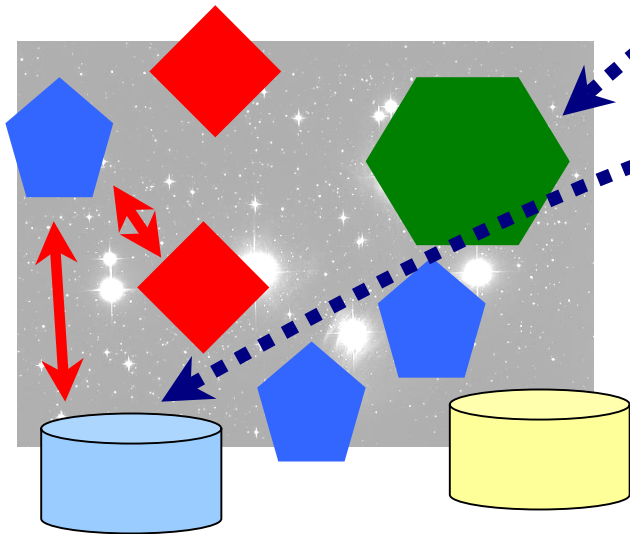 atoms

  bits

- What if every object had a smart proxy?
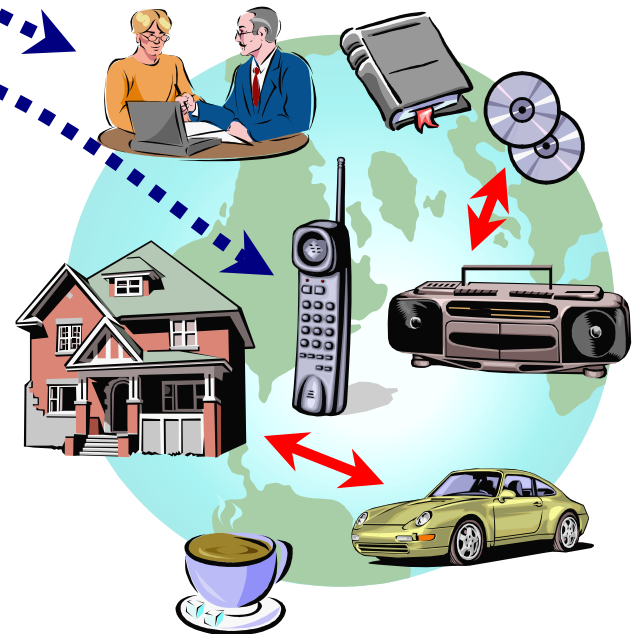
Virtual Worlds - It All Started with Data Processing

Data

Results

- Data processing
- Information processing
- Simulation
- Virtual Reality
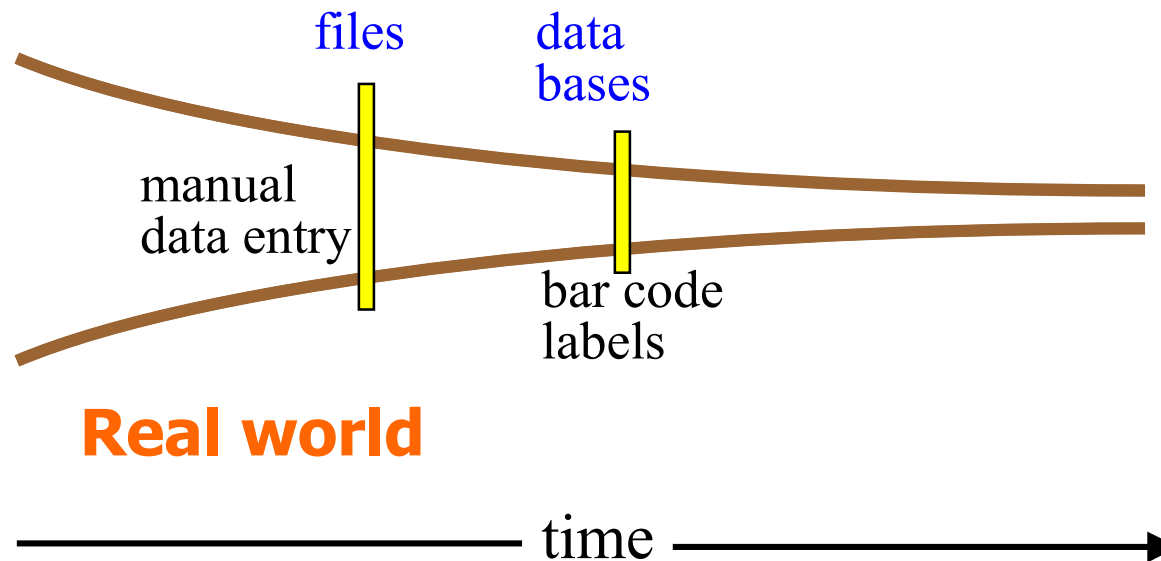
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How to Bridge the Gap?

Virtual world

Real world

Narrowing the Gap

Virtual world

files   data bases

manual data entry

bar code labels

Real world

time

Narrowing the Gap

Virtual world

files

data bases

virtual counterparts

manual data entry

bar code labels

RFID tags

Real world

time
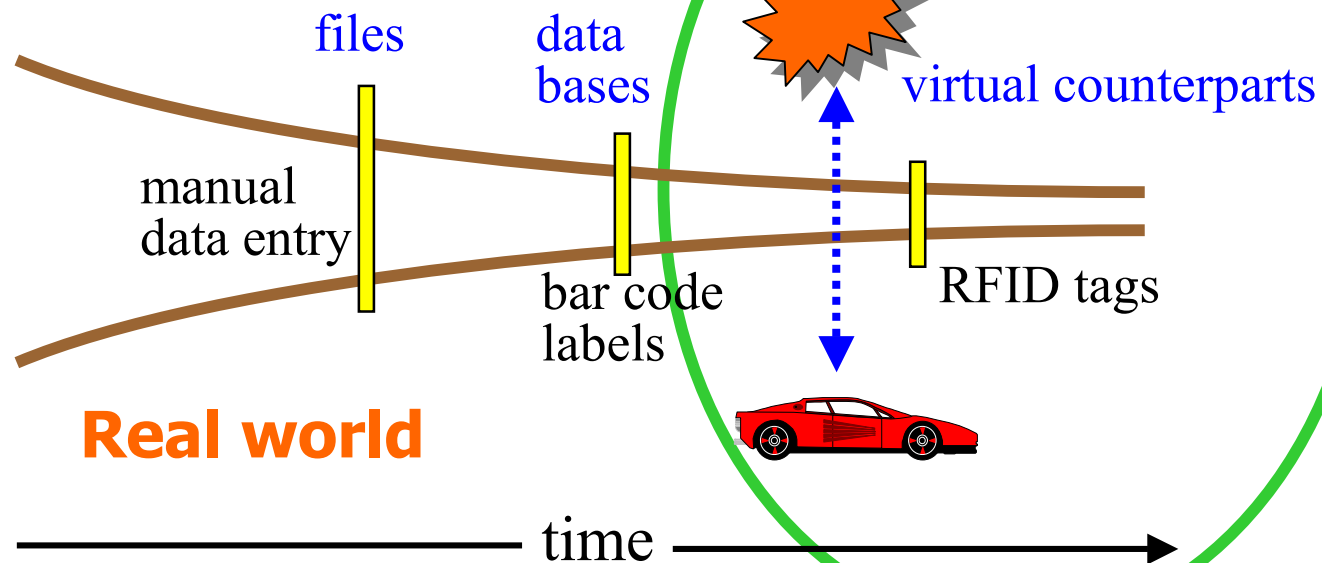
- Why not attribute every object a unique representation in cyberspace?
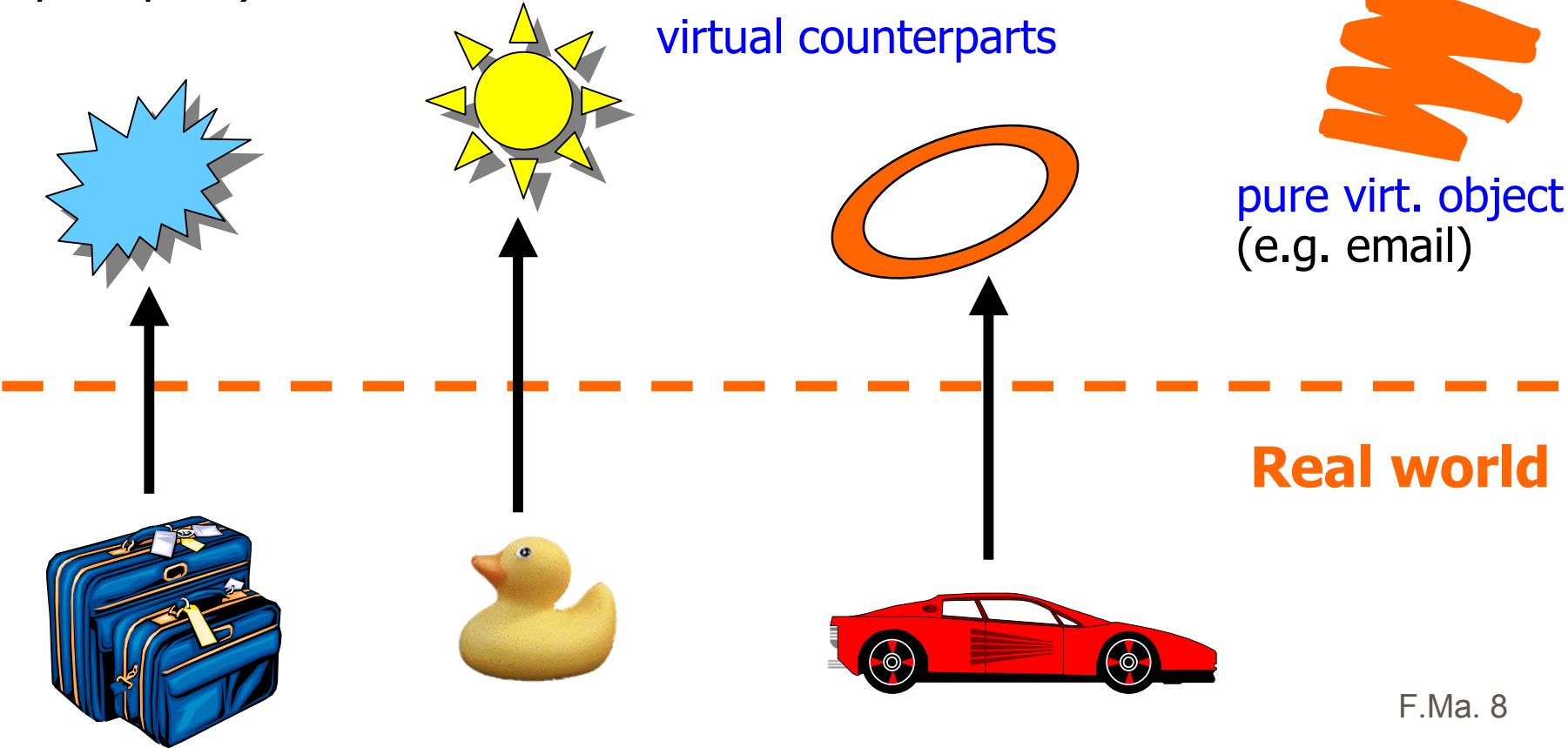 - „virtual counterpart"

Virtual Counterparts

Virtual world
(Internet,
Cyberspace)

virtual counterparts

pure virt. object
(e.g. email)

Real world

Making Things Smart with Virtual Counterparts

- Extend artifacts by information processing facilities and enable interaction between artifacts, e.g. by:
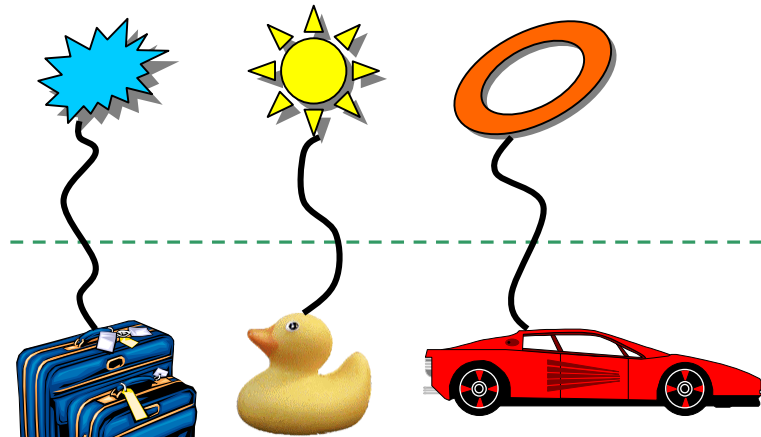 - embedded processors
  - sensors (e.g., computer vision)
  - ➡ tagging (barcode, RFID tags)

- Virtual counterparts represent their real-world artifacts in a virtual world
  - coupled to artifact
  - passive („homepage") or
  - active („proxy") or
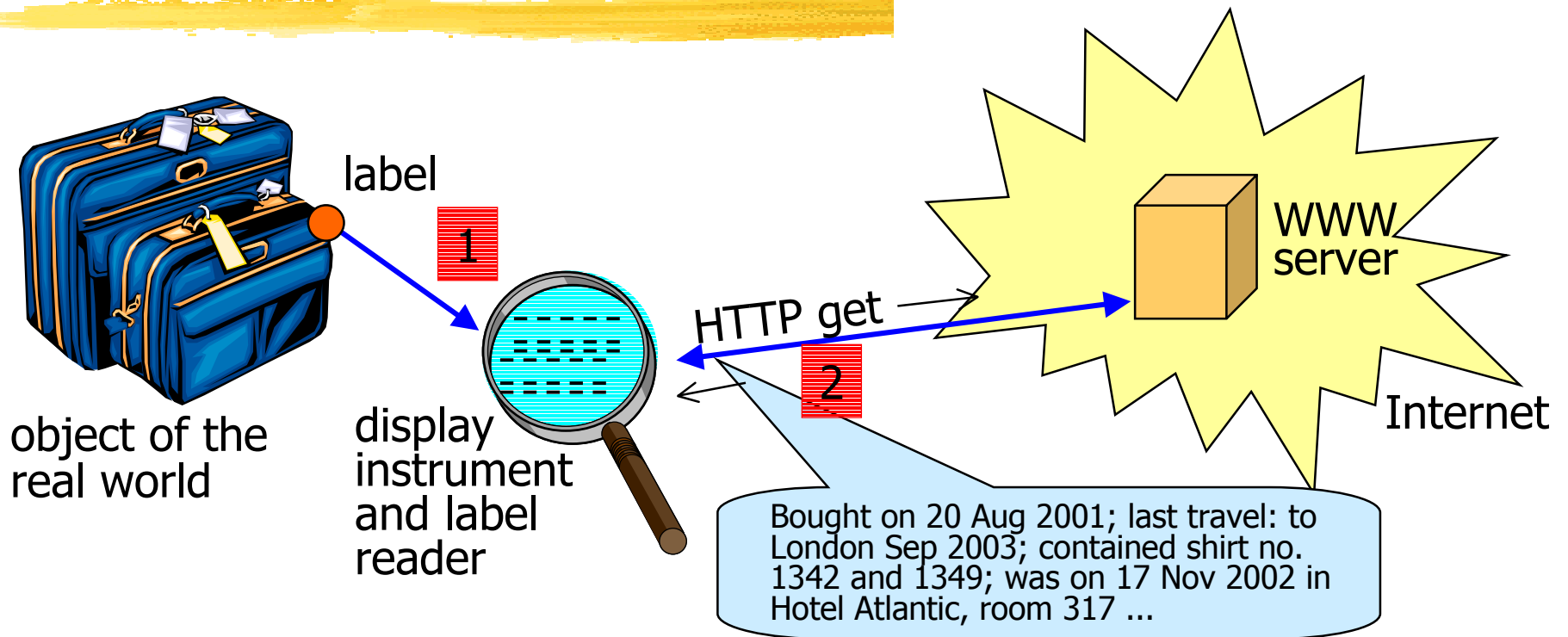 - service interface („portal")

Virtual world

Real world

e.g., HP's Cooltown project

Display Virtual Counterparts of Labeled Artifacts

label

1

object of the real world

display instrument and label reader

HTTP get

2

WWW server

Internet

Bought on 20 Aug 2001; last travel: to London Sep 2003; contained shirt no. 1342 and 1349; was on 17 Nov 2002 in Hotel Atlantic, room 317 ...

- Label = Internet-URL (pointing to the bag's „home page")
  - e.g., recipe „on" food for microwave oven (passive parameters or active code)

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Artifact Memory
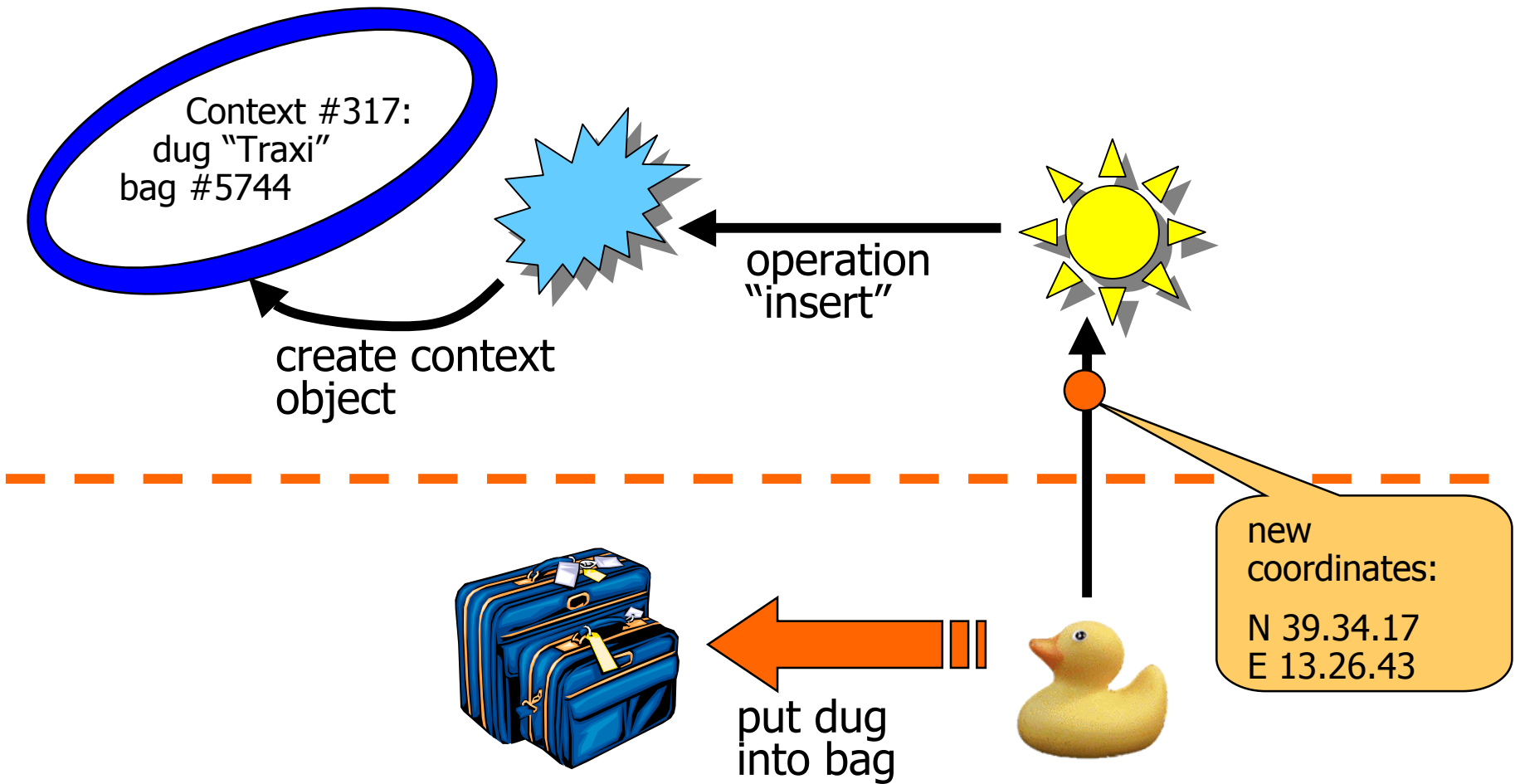
1) Aug. 3rd, 2001: ....
2) Aug. 5th, 2001, 10:34 .....
3) Aug. 5th, 2001 10:37 ...
4) ...

Proxies act as memories for their artifacts

Updates triggered by events

Queries from the real world return memory content

Arrived in room 564 Bayview Hotel

10:34, Sue K. opens bag

who? where? when?

Sensors generate events

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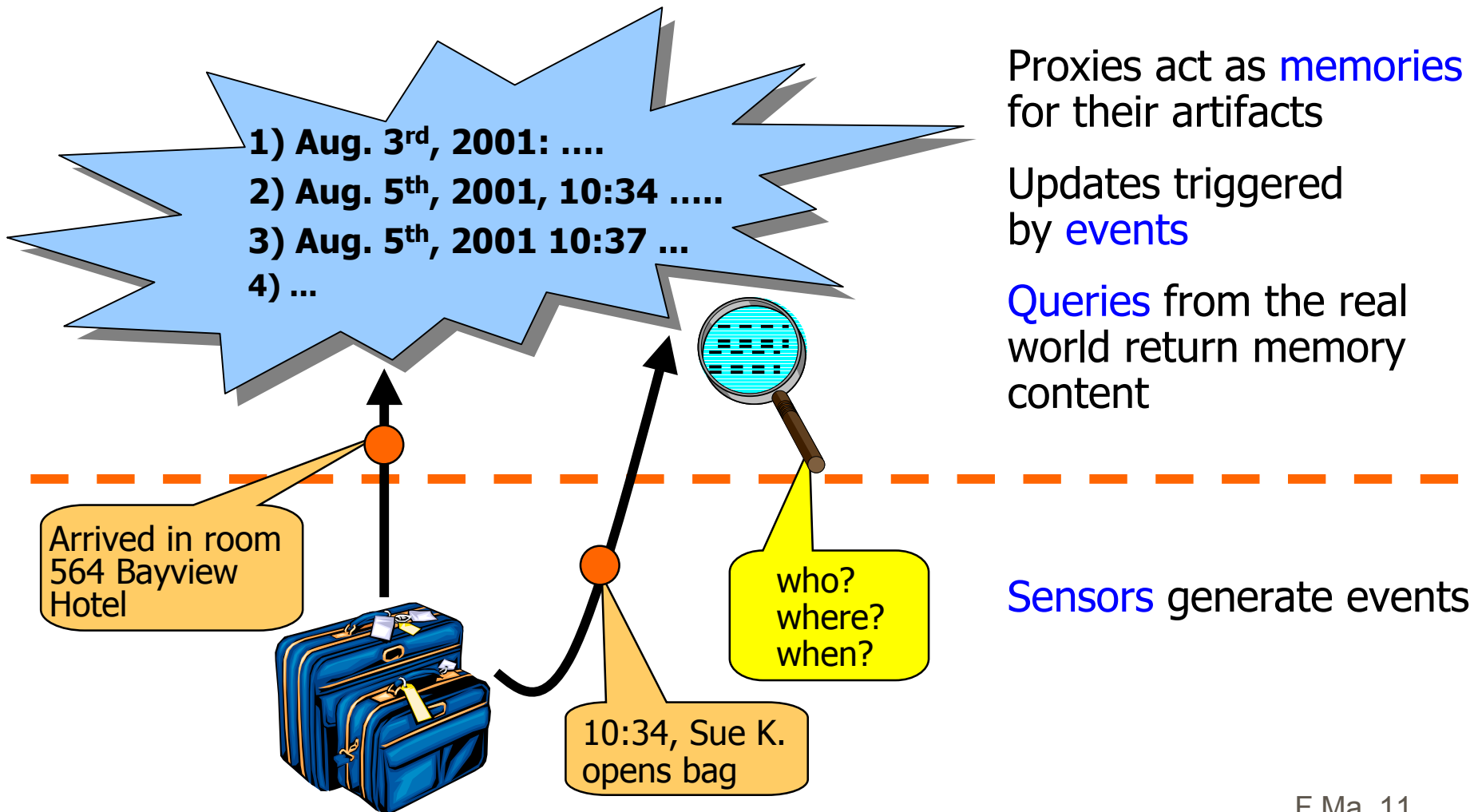
Active Proxies Replay Real-World Manipulations

Context #317:
dug "Traxi"
bag #5744

create context
object

operation
"insert"

put dug
into bag

new
coordinates:

N 39.34.17
E 13.26.43

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A New Paragidm?
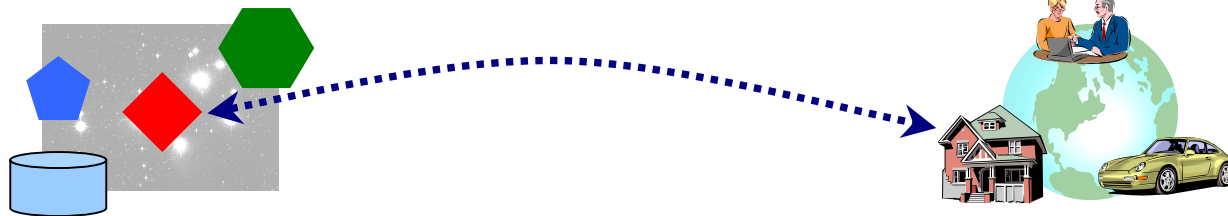
- Real-world objects have virtual peers
  - which record a state (sensor data, history, location, ...) and
  - meta-information (type, owner, references, ...)

- Actions in one world are reflected in the other
  - real transactions manipulate virtual objects
  - virtual actions trigger real-world actors

- Meta-objects collect & process data
  - infer knowledge, take appropriate actions

An Old Paradigm, But a New View

- **Classical paradigm**: mapping the real world through thoughts, ideas, data collections, bookkeeping, simulation, factory automatization...

- But provide a new view:
  - everything has a unique virtual counterpart
  - bridges are ubiquitous
  - interactions are immediate

- Required: an adequate model of the real world and techniques for bridging the gap

  e.g., RFIDs

RFID:
„Radio Frequency Identification"

- IC with RF-transponder

- Wireless energy supply
  - ~ 1 m
  - magnetic field (induction)

- ROM or EEPROM (writable)
  - ~ 100 Byte
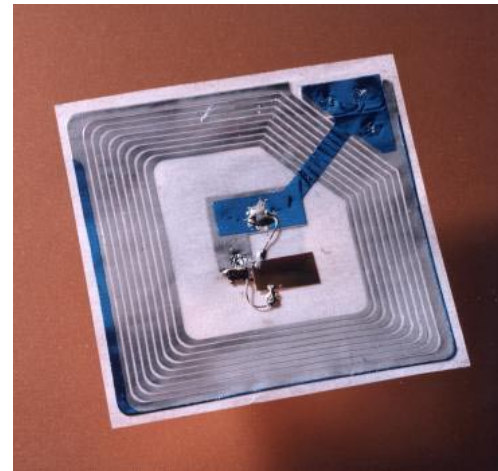
- Price ~ 0.1 $ ... 1 $
  - consumable and disposable

image source: Portolano project
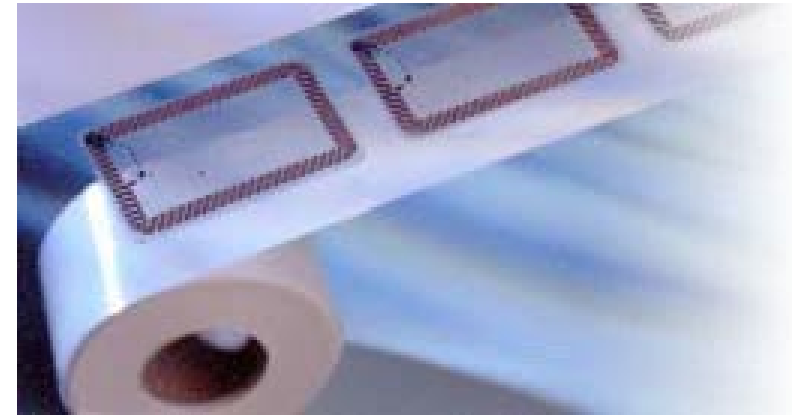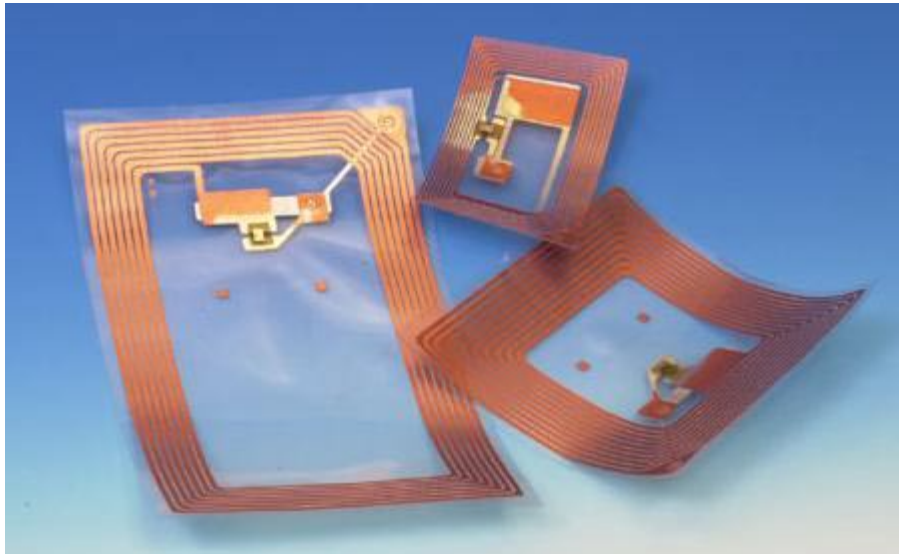
RFIDs as „Smart Labels"

- **Flexible tags**
  - laminated with paper
  - self-adhesive
  - printable (e.g., barcode)

image source: Portolano project

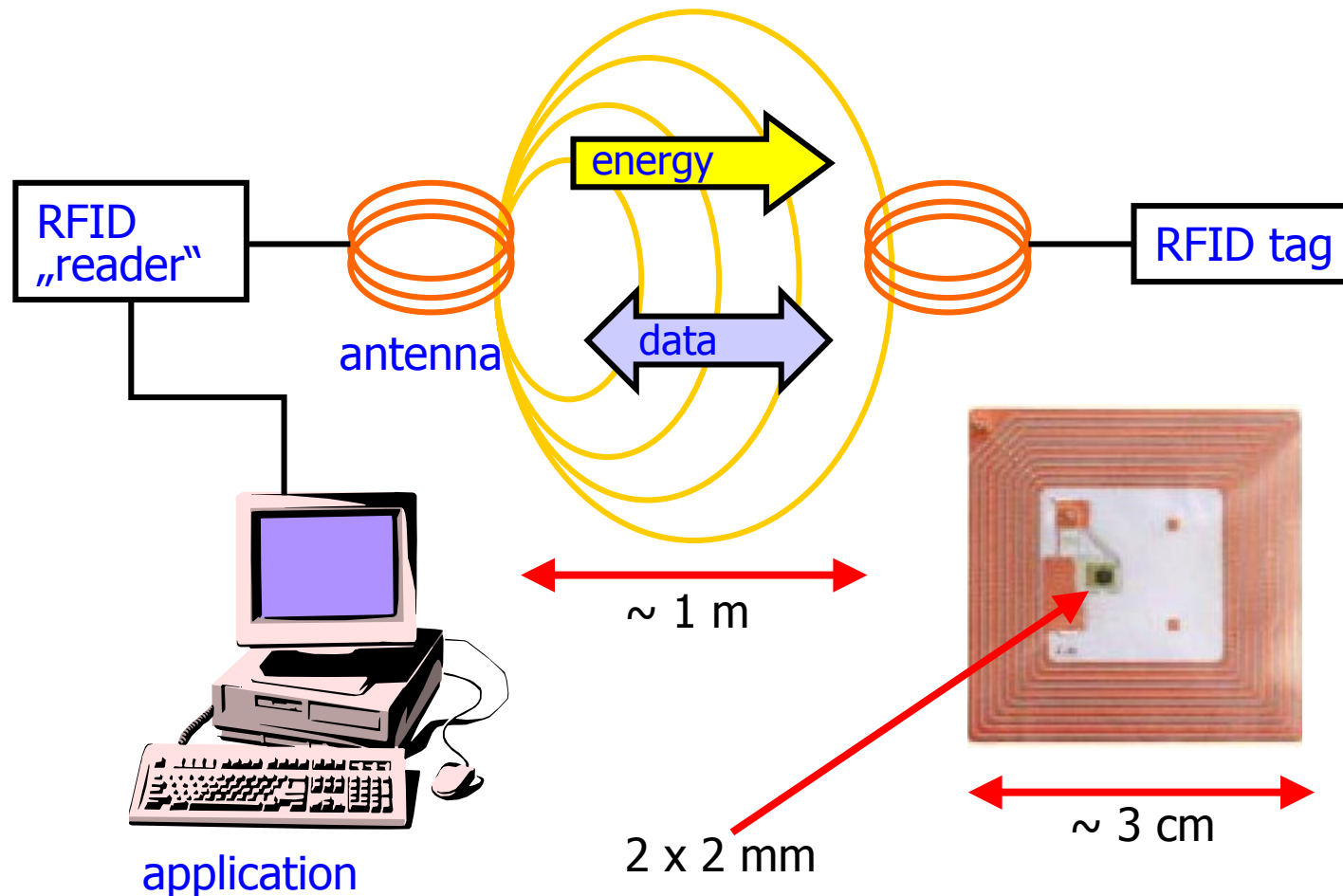# Smart Labels

- Chip (without antenna):
  ~ 2 mm x 2 mm x 10 μm
  - fits into 80 μm thick paper!

- Antenna:
  - copper, or
  - printed with conductive ink, or
  - on CMOS waver (micro galvanic „coil on chip")

Components of an RFID System

energy

data

RFID „reader"

antenna

RFID tag

~ 1 m

~ 3 cm

2 x 2 mm

application

Patent US06018299

Radio frequency identification tag having a printed antenna and method

Motorola Inc, issued 01/25/2000

„A radio frequency identification tag includes a radio frequency identification tag circuit chip coupled to an antenna including a conductive pattern printed onto a substrate. The substrate may form a portion of an article, a package, a package container, a ticket, a waybill, a label and/or an identification badge…"
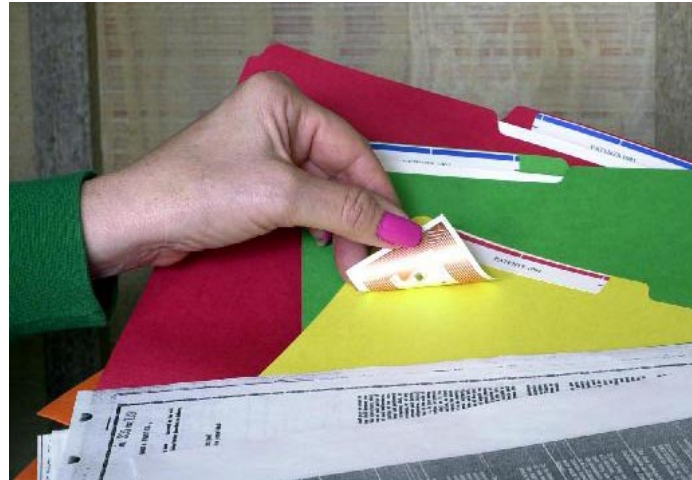
Application Domains for RFIDs

- Electronic article surveillance (EAS - anti-theft functionality)
- Inventory control
  - shops or mini bar in hotel rooms
- Libraries, video rental
- Baggage labels

Application Domains for RFIDs

- Ski passes
- Ear clips for animals
- Transport of mail and parcels
- Tracking of goods
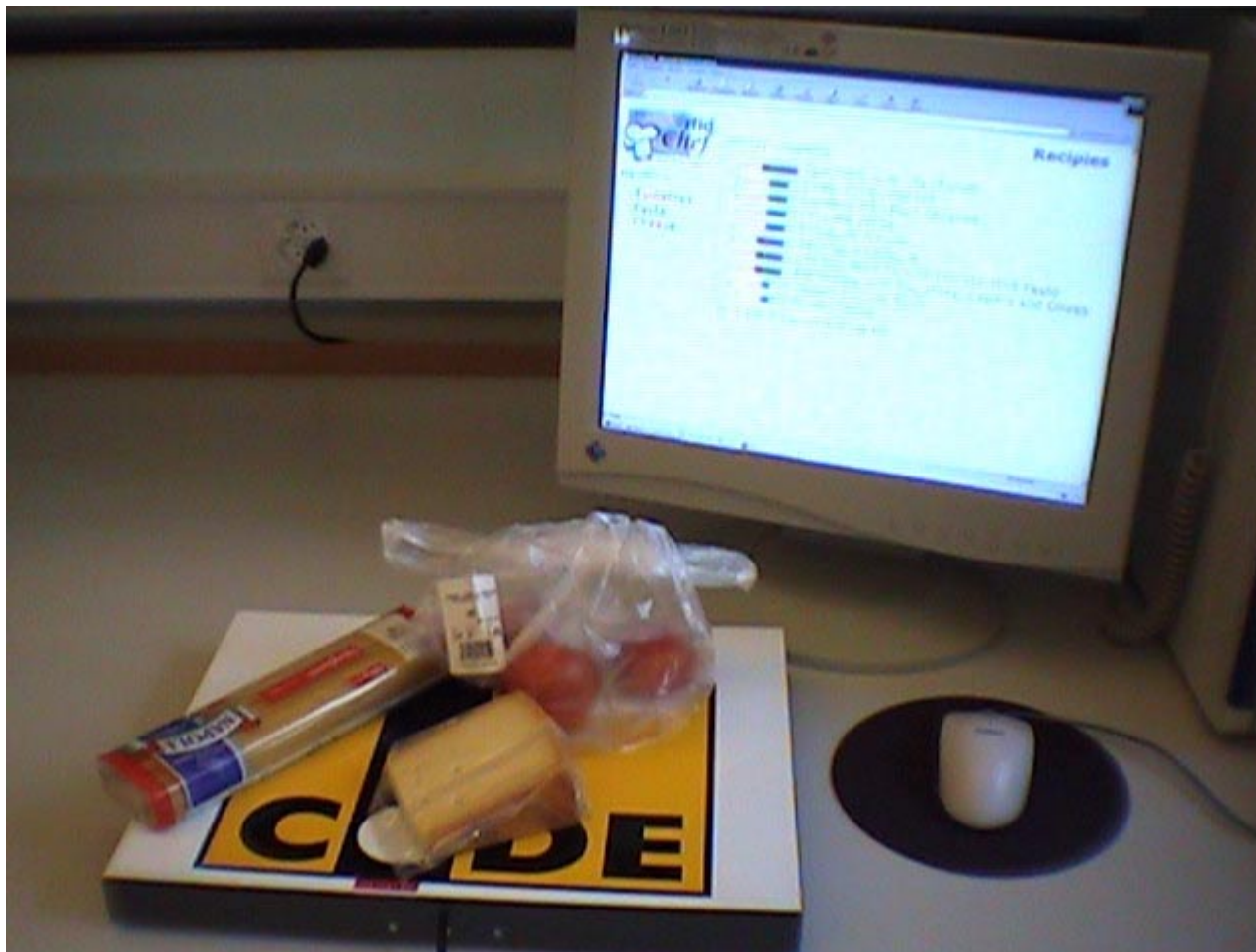- „Radio signature" of documents
- ...

A Context Sensitive Cookbook

- Place grocery items on the kitchen counter

- Nearby display shows dishes that can be prepared with available ingredients

A Context Sensitive Cookbook


Groceries are equipped with RFID tags

Context Awareness

- Properties of the ingredients
  - check whether there is enough of an ingredient
  - prefer ingredients with earlier best-before data

- Properties of the kitchen
  - check whether required tools and spices are available

- Preferences and abilities of the cook
  - prefers Asian dishes
  - expert in vegetarian dishes

Commercial Interest in Linking Atoms to Bits

- Connect the real world to the digital world
  - link between physical objects and Web pages
  - e.g., by using barcode readers or RFID readers
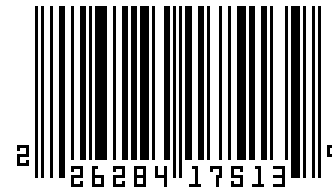
- number is transformed to an URL, associated Web page is returned
- identify object instance, not object type (e.g., UPC)
- but: labels on all objects?

Application Scenarios

- Get information about real objects
  What is contained in this medicine? Listen to music found in an ad.

- Smart assistant
  What parts need maintenance? What is the layout of this machine?

- Services
  Who visited this house before?

- Context awareness
  Is this tool available here?

- Smart home, car, office, …
  Adapt to people's preferences

www.connectthings.com

- Idea: use standard barcodes to get information about products (CDs, medicals, ...)
- Product web site is provided by manufacturer
- Business: sell service to companies, operate servers, promote service
- Customers: Novartis, Siemens, Colgate Palmolive, ...
- Launched 20 Oct 1999, still operating

The Mobile Phone as an „Internet Remote Control"?

- PDAs, mobile phones, and wireless internet appliances become request devices for information
  - displayed on the device or a nearby screen
- „Click" on a physical object
  - access Internet sites without manually entering URLs
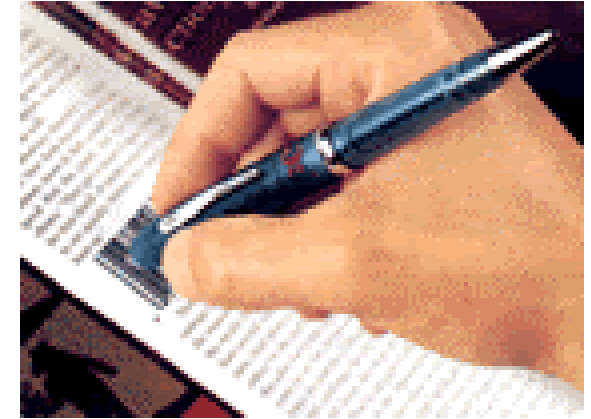 - find information
  - order products
  - …
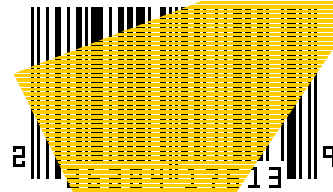
„BarMailer", a snap-in barcode reader for mobile phones

www.bar-mail.org

- Barcode reader with memory
  - capacity to store 100 codes
- Stand-alone or connected to mobile phones
- Send codes via SMS to bar-mail server
  - server sends back e-mail
- Founded 1997 with help from Ericsson
  - 24 June 00: Motorola investment to form new company
  - 14 August 00: running beta-test in Sweden
  - end of August 00: last updates on web site...?
- Filed for protection for
  "from atoms to bits and back again"

„Cross Convergence" Scanner and Pen

writing end

scanning indicator

scanning button

scanning function end

- Mobile scanner and pen, $89.90
- Allows to link from a printed page directly to the Web
- Scans barcodes on printed material and drills down to related web page content
- Up to 100 scans between downloads
- Data well hooks up to computer for information transfer
- First release shipped Oct. 30, 2000

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CueCat

- Barcode scanner (shape of a cat)
  - LED based; attaches to the computer via the keyboard port

- 10 million free scanners distributed in the US by the end of year 2000
  - 50 millions planned in 2001
  - estimated cost of $ 5 - $ 10 per CueCat
  - someone spends at least $ 500 000 000

- Sends the Web browser directly to the „right" location when scanning the barcode of an ad in a magazine
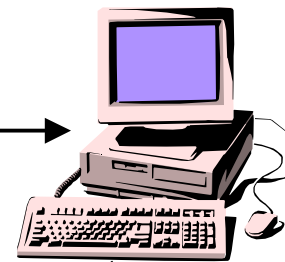
Mapping of Barcode to Web Page

barcode +
CueCat serial number

User

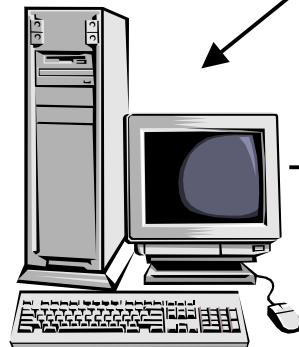User has to
register to use
the software
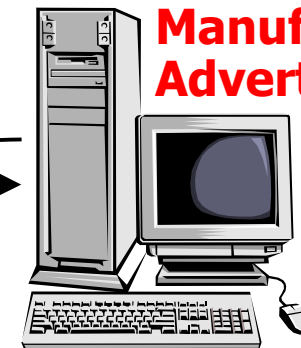
①

barcode +
serial number +
user data

②

Web page related
to product or
document

④

**Manufacturer,
Advertiser, ...**

- Map barcode to URL
- Log user data
- Send targeted
  advertisements

③

Provider

CueCat Revenue Model

- „Our revenue model is being the gate keeper between codes and their destination online"
  - software in the computers links to Digital Convergence
  - code is encrypted by the scanner
  - scanner adds its serial number
  - DigitalConvergence keeps mapping from barcode to URL as its property

CueCat Reverse Engineering

- **Hackers** know
    - how to **decrypt** the resulting code (base64 + XOR)
    - how to manipulate the hardware so that it doesn't include the **serial number**
    - … it **doesn't encrypt** the bar code number
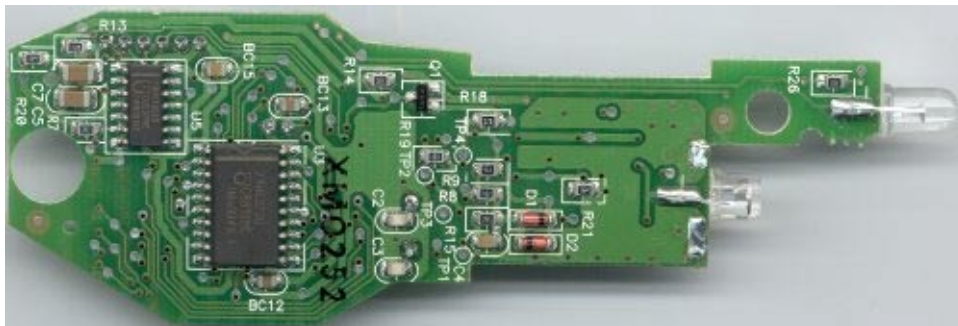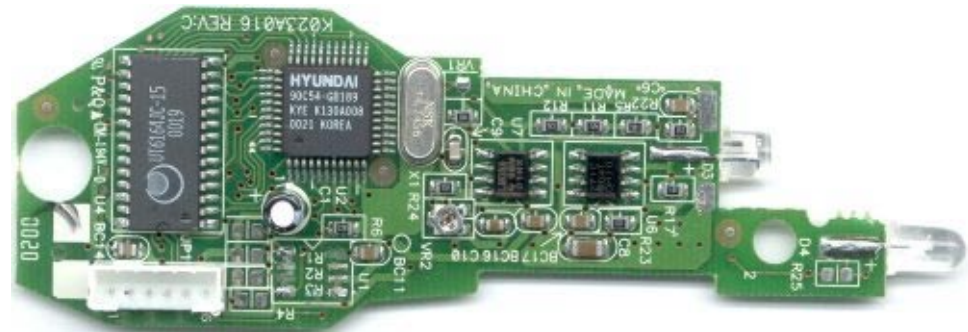
- **Digital Convergence** doesn't like
    - reverse engineering
    - open barcode **directories**
    - **free applications** (e.g., download amazon.com information from ISBN numbers on books)
    - LINUX **drivers**

Business Risk Factors

- "WE ARE DEPENDENT ON INTELLECTUAL PROPERTY RIGHTS AND OTHERS MAY INFRINGE UPON THOSE RIGHTS."

  - "We rely on patent, trademark, trade secret and copyright laws, as well as confidentiality procedures and licensing arrangements, to protect the proprietary technology that we have developed, but we can give no assurance that such laws or procedures will provide sufficient protection to us or that others will not develop technologies that are similar or superior to ours."

- "OUR RIGHT TO KEEP INFORMATION COLLECTED IN OUR DATABASES MAY BE CHALLENGED IN THE FUTURE."
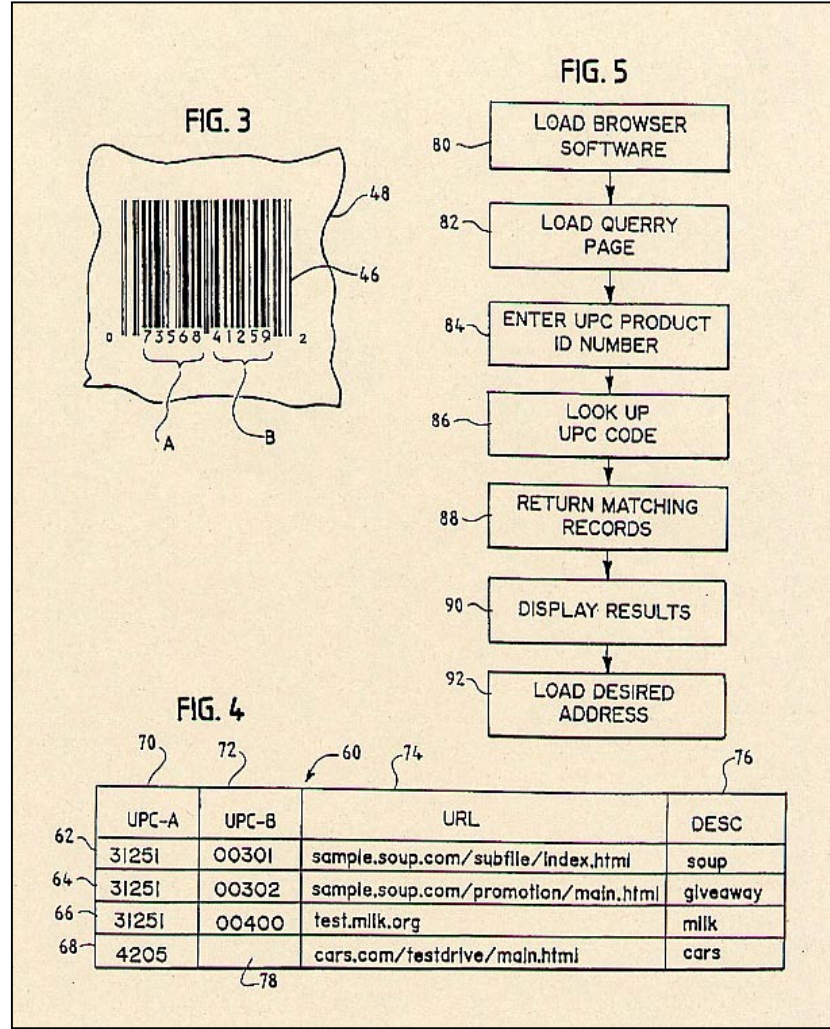
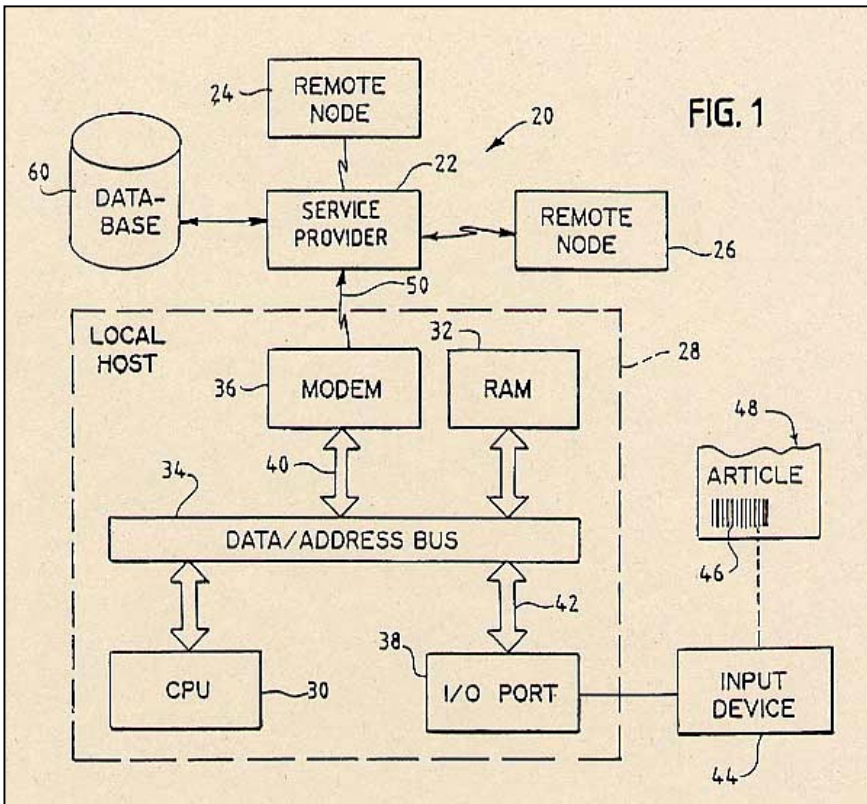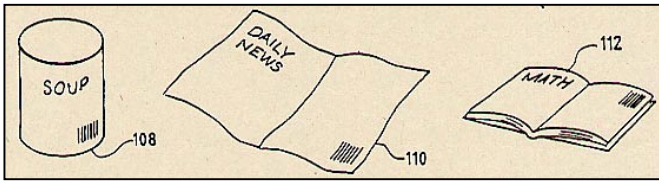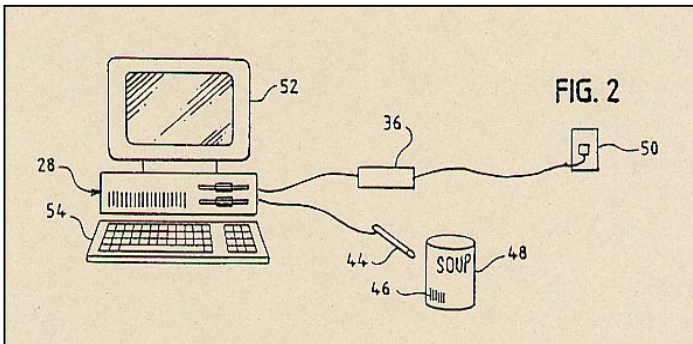F.Ma. 35

Patent US5978773

„System and method for using an ordinary article of commerce to access a remote computer.“

NeoMedia Technologies, Inc., Fort Myers, FL
Issued / Filed Dates: Nov. 2, 1999 / Oct. 3, 1995

A system and method for using identification codes found on ordinary articles of commerce to access remote computers on a network. In accordance with one embodiment of the invention, a computer is provided having a database that relates Uniform Product Code ("UPC") numbers to Internet network addresses (or "URLs"). To access an Internet resource relating to a particular product, a user enters the product's UPC symbol manually, by swiping a bar code reader over the UPC symbol, or via other suitable input means. The database retrieves the URL corresponding to the UPC code. This location information is then used to access the desired resource.

FIG. 2

FIG. 1

FIG. 3

FIG. 5

80	LOAD BROWSER SOFTWARE
82	LOAD QUERRY PAGE
84	ENTER UPC PRODUCT ID NUMBER
86	LOOK UP UPC CODE
88	RETURN MATCHING RECORDS
90	DISPLAY RESULTS
92	LOAD DESIRED ADDRESS

FIG. 4

	UPC-A	UPC-B	URL	DESC
62	31251	00301	sample.soup.com/subfile/index.html	soup
64	31251	00302	sample.soup.com/promotion/main.html	giveaway
66	31251	00400	test.milk.org	milk
68	4205		cars.com/testdrive/main.html	cars

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Patent US6108656

„Automatic access of electronic information through machine-readable codes on printed documents."

Issued / Filed Dates:
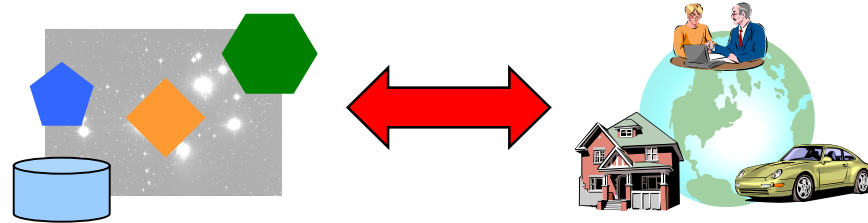Aug. 22, 2000 / May 11, 1999

NeoMedia Technologies, Inc.

...

FIG.3

F.Ma. 38
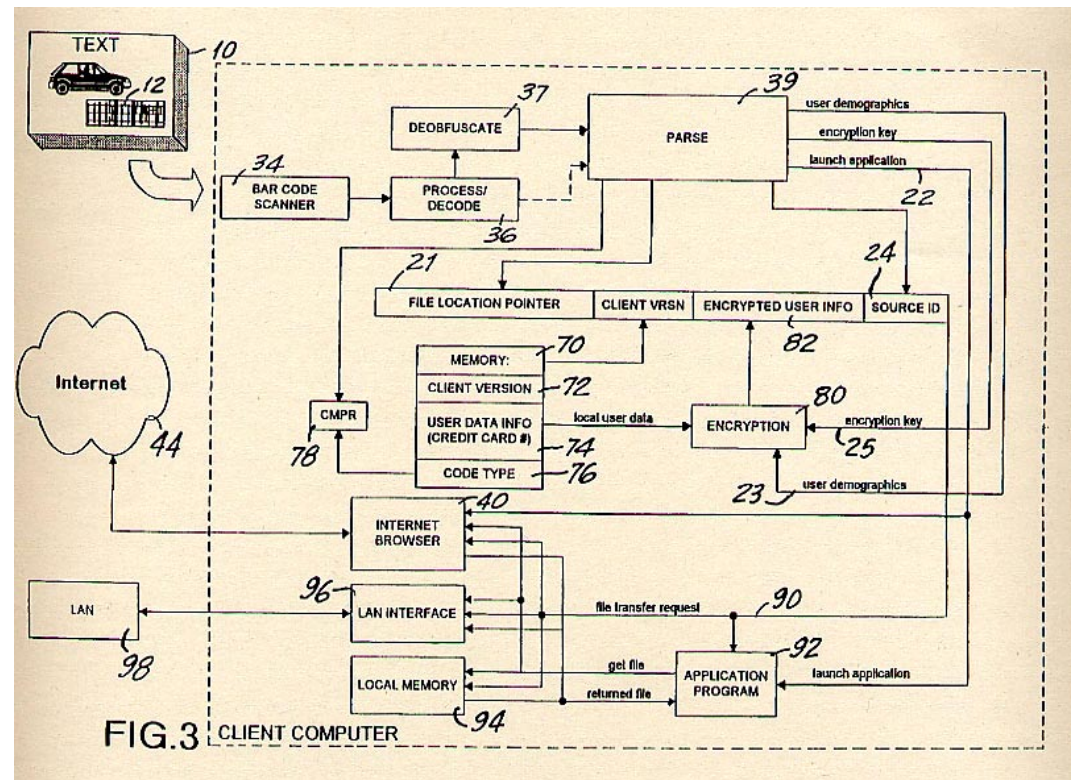
Two Worlds that Collide ?

- If there is tight interaction between the physical and the virtual world – what happens?
  - what is gained?
  - what is lost?

- Can it make a better world, or just better business?
- Which techniques are needed? Which are suitable?
- What are the limits?