DALHOUSIE UNIVERSITY
Inspiring Minds

Smartphones + Cloud Computing + Near Field Communications (NFC): The next big wave in wireless

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Faculty of Computer Science

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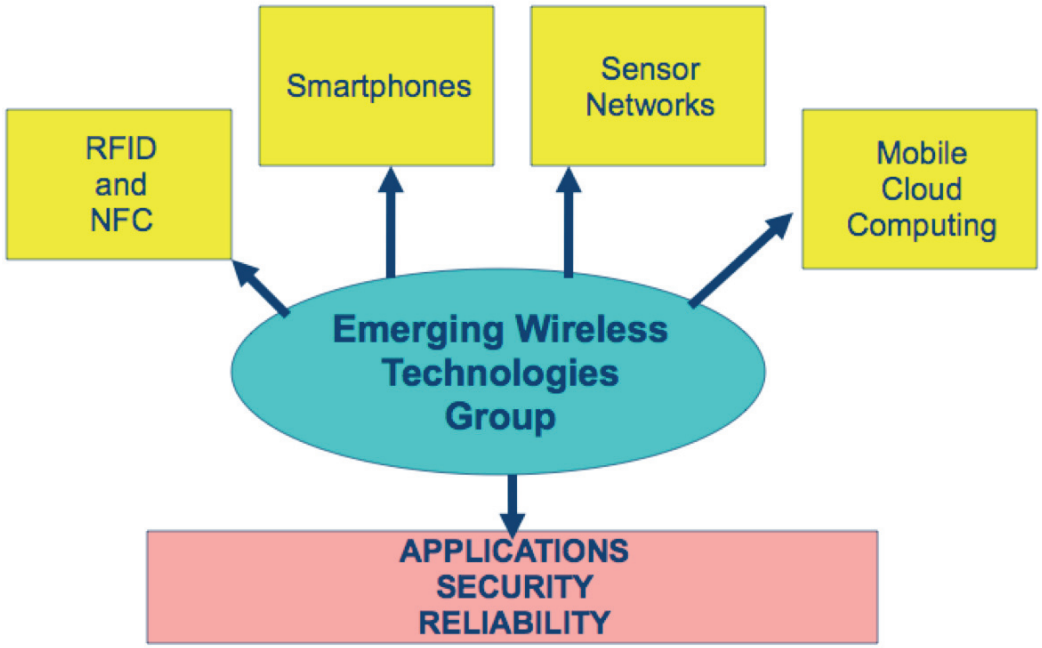

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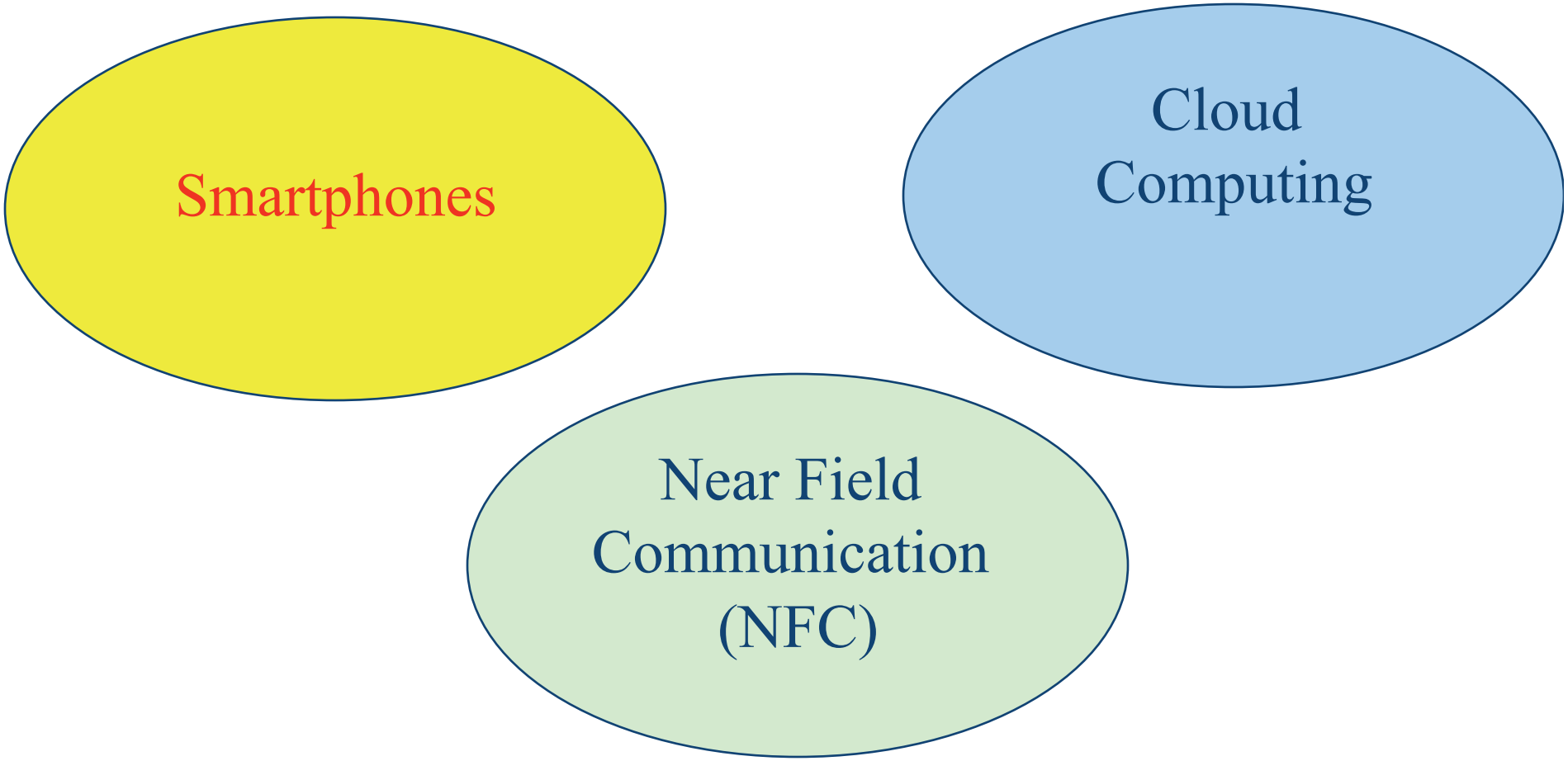
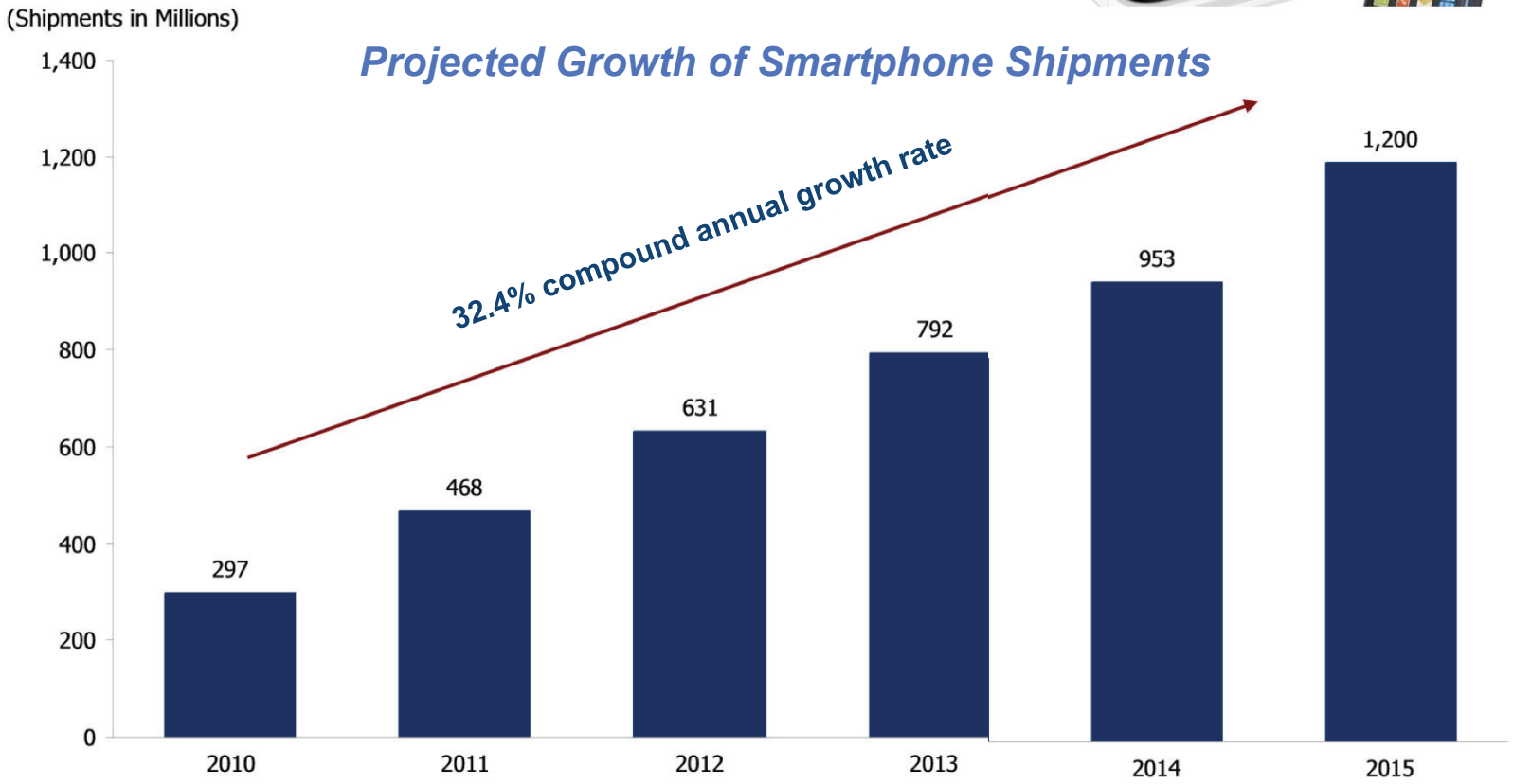


Evolution and Trends
What makes this the new wave in wireless
Opportunities
Challenges

The Smartphone Revolution

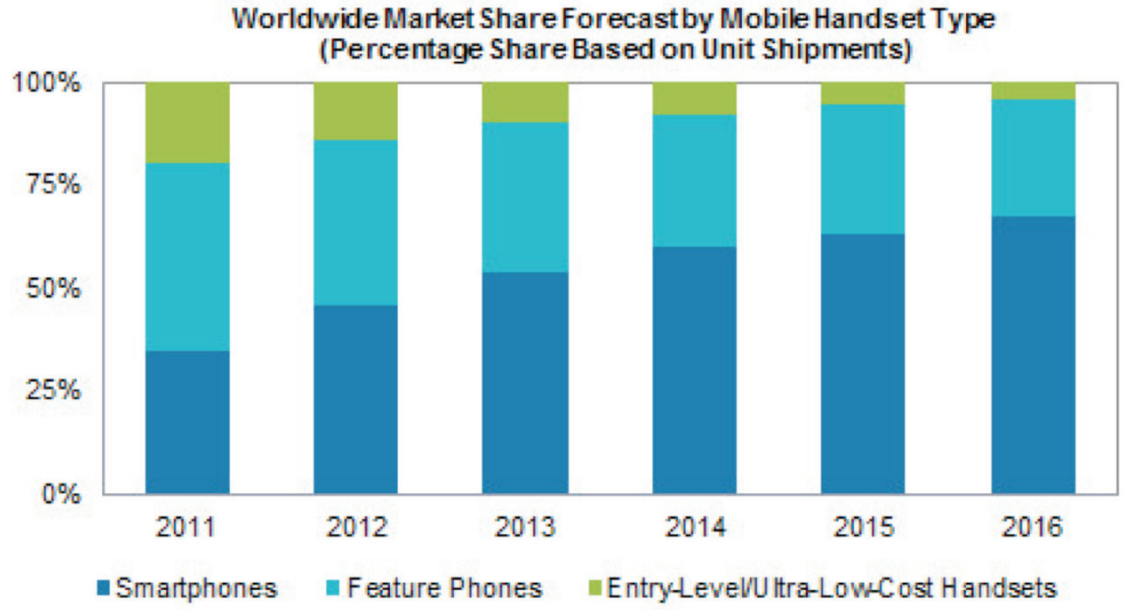
Growth in mobile communication technologies has been unprecedented....

More than half a billion smartphones were shipped last year….



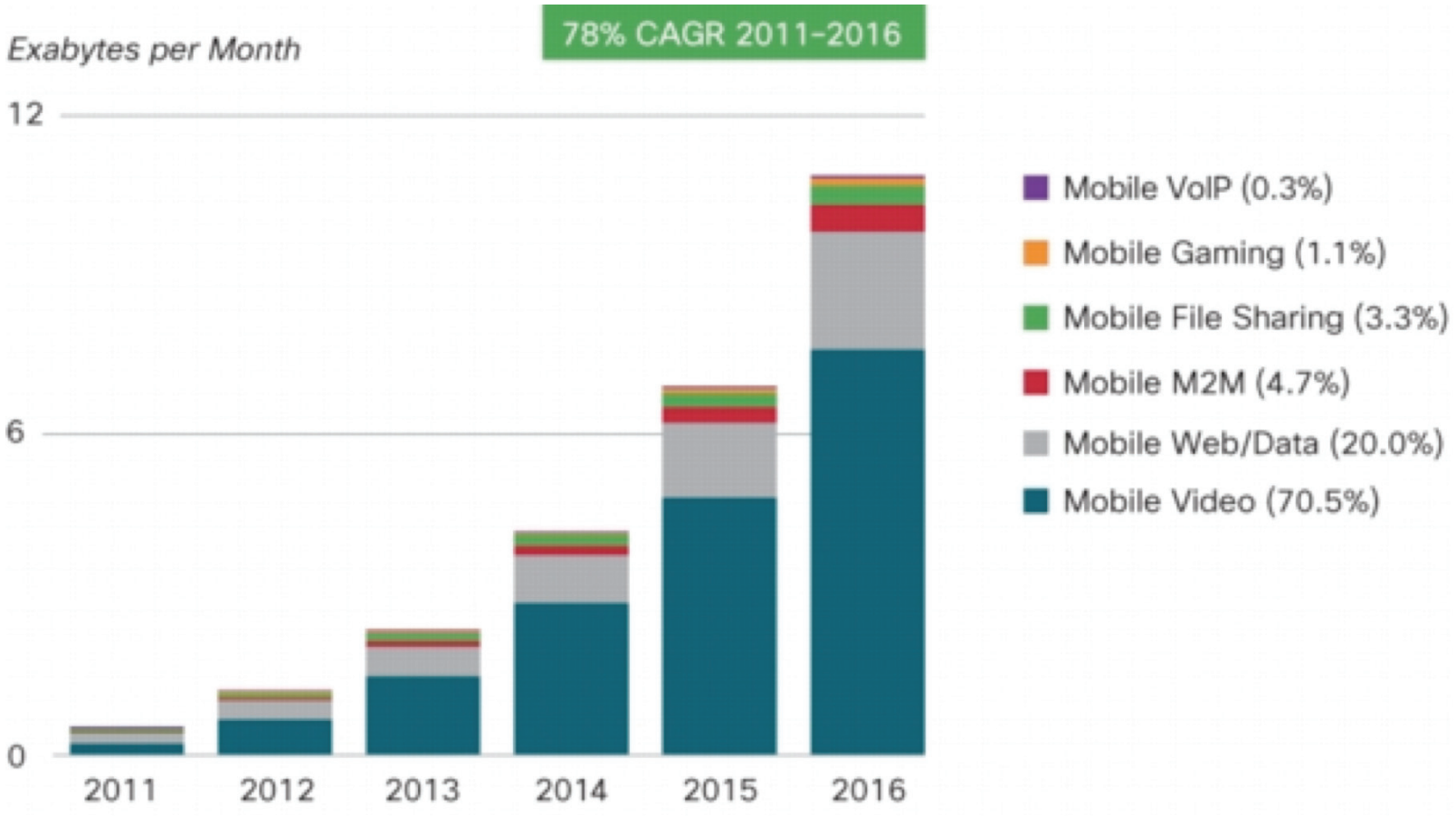
Source: Gartner and Berg Insight (2012)

By 2016, smartphones will represent 67.4% of all mobile handset sales ….



Source: IHS iSuppli Research, August 2012

Global Mobile Traffic Trends



Figures in legend refer to traffic share in 2016.
Source: Cisco VNI Mobile, 2012

Which platform will win?

Now

Source: http://www.email-marketing-reports.com/wireless-mobile/smartphone-statistics.htm

Martin Cooper with the world's first cell phone

We have come a long way from the "Brick" phone .... Or have we really?

I can't hear you .. You are breaking up. And what on earth is an Eye Phone?

Image source:

http://arstechnica.com/gadgets/2010/10/gallery-a-decade-of-smartphone-evolution/3/

Evolution…

1979
First cell phone network launched in Japan

1983
Motorola releases DynaTAC, nicknamed “Zack Morris”

$3995

1985
First cellular services: Cellnet and Vodafone

1989
Motorola MicroTAC, first flipphone

$3500

1991
First GSM network in Finland

2010
US declares iPhone Jailbreaking and Android rooting legal

2009
LTE Service 326.4 Mbps

2007-2009
Onset of "SMART" PHONES and TOUCH SCREEN TECHNOLOGY

2001
High speed data
First camera phone

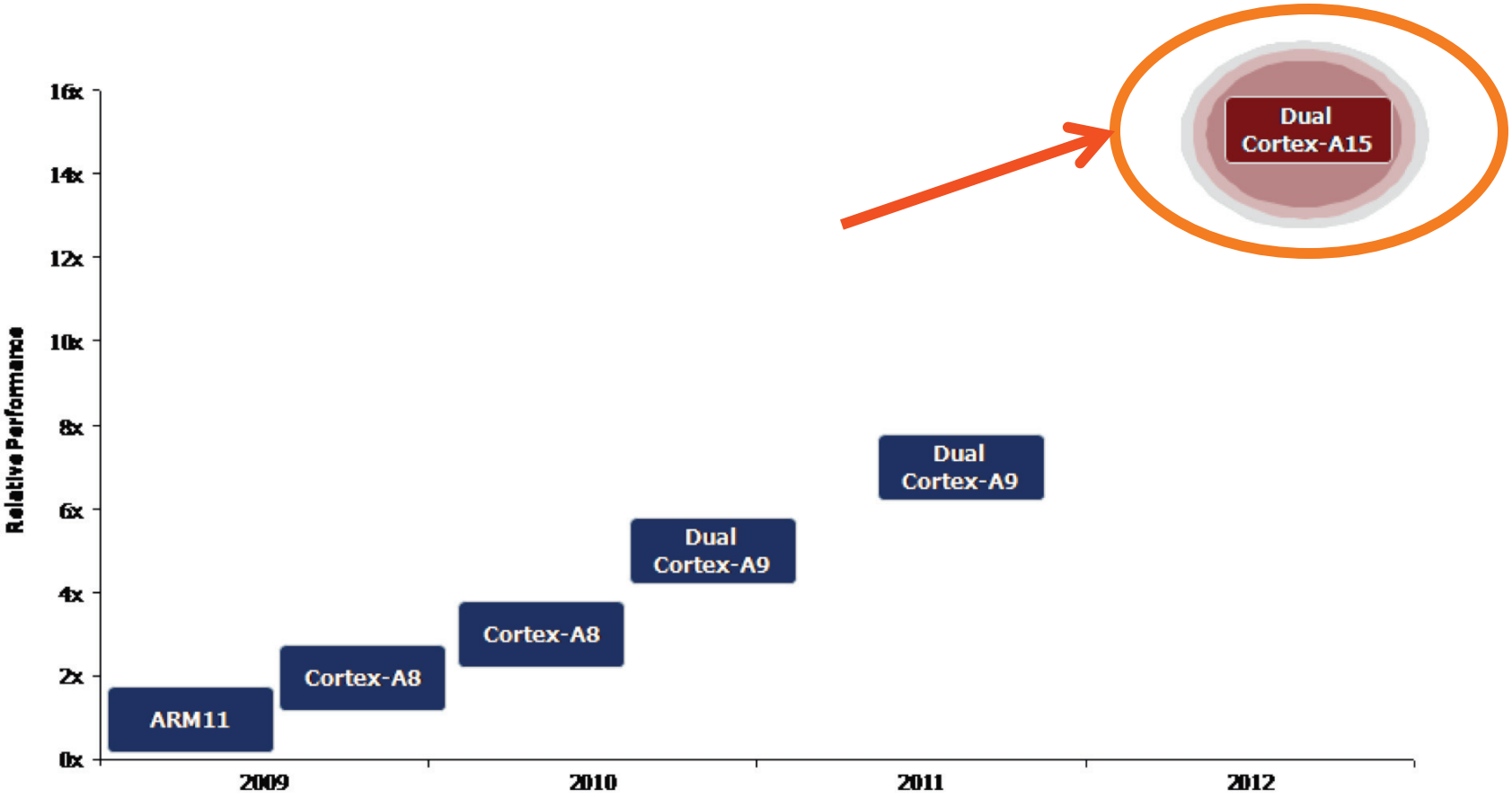
Evolution continues …

1999
Blackberry 850,
Onset of
Mobile Web

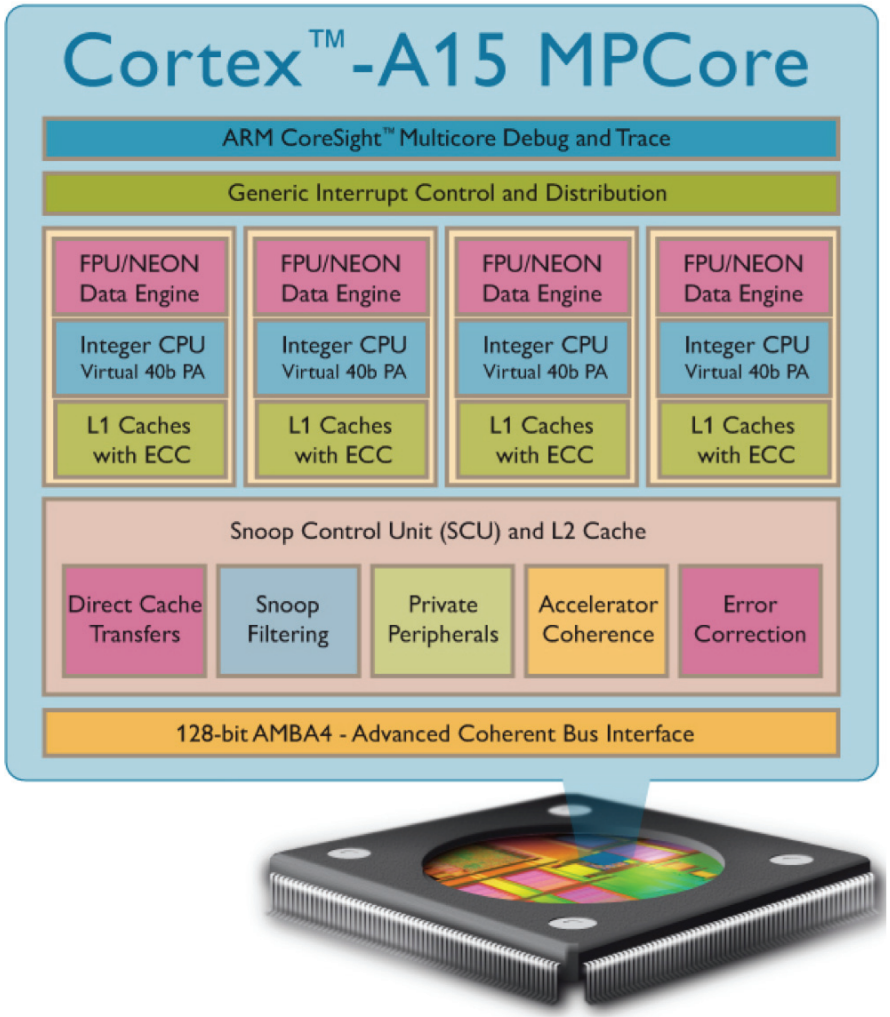
1996
Motorola releases StarTAC, first phone with vibration feature

1992
First SMS message texted
Merry Christmas

Architecture and performance



Source: Wall Street Research, March 2011



ARM's A15:

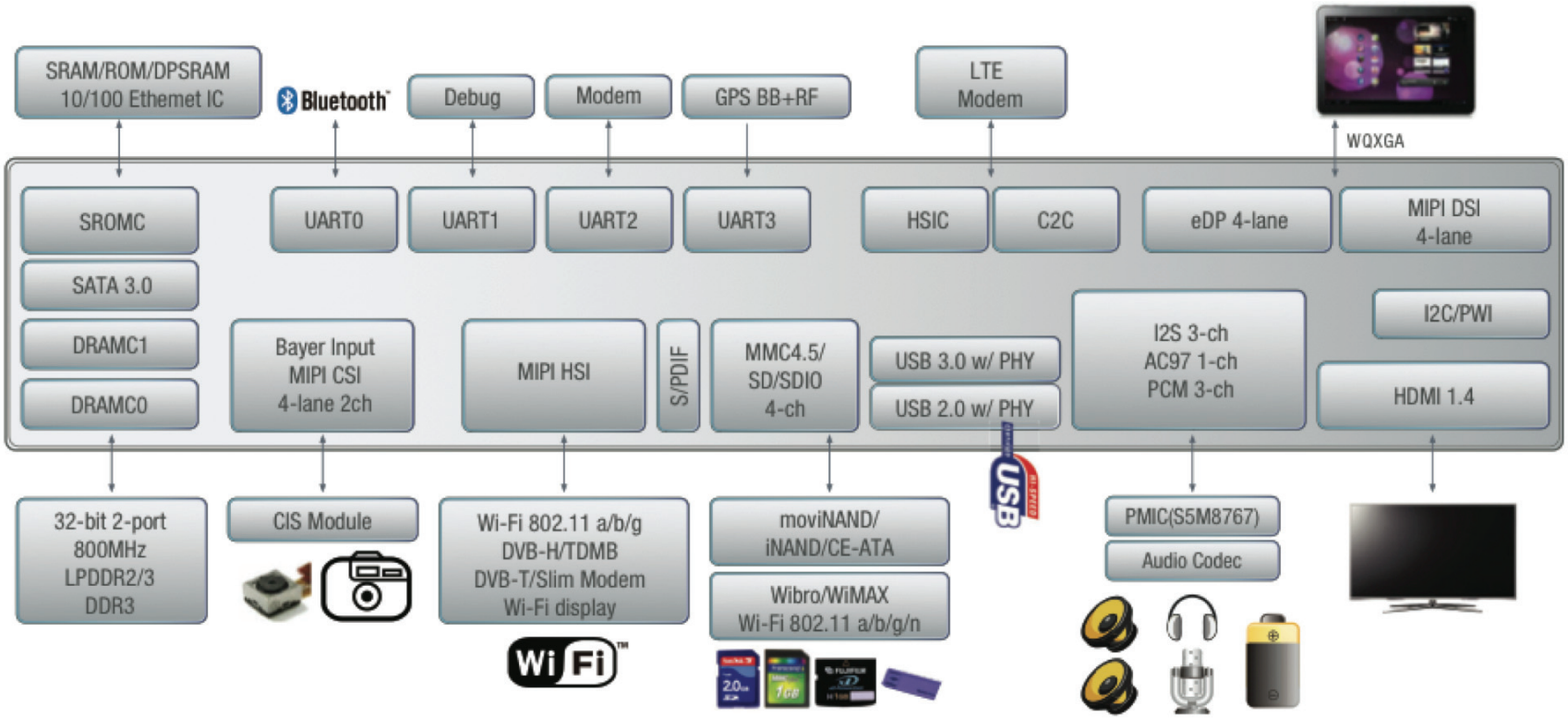
Up to 2.5 GHz
1,2,4 or 8 cores
1 TB main memory
32KB/32KB L1 and L2 caches with error correction
Advanced SIMD

Source: www.arm.com

This is a workstation + server on a chip …
Who needs desktops or laptops anymore?

The new smartphone architecture

Multi-network connectivity: (WiFi, WiMAX, LTE, Bluetooth, GPS, ….)
Super graphics: GPU with 2560X1600 resolution and 12.8 Gbps
HD video encoding and decoding capability



The Exynos 5 Dual System on Chip Architecture

The smartphone will soon be our principal computing device ….

Cloud Computing

BIG DATA is the new "sexy" term in CS

- *2.5 ZettaBytes (2.5 X 10^{21} bytes) of digital information exist on the planet today.*
- *Each day we are adding 2.5 ExaBytes (2.5X10^{18} bytes) of data.*
- *90% of the world's data was created in the last two years alone!*
- *Data comes from posts to social media sites, digital pictures and videos, purchase transaction records, cell phone GPS signals, sensor data, etc.*
- *Market for Big Data expected to grow to 16.9 Billion $ by 2016.*

Traditional computing models are not viable any more…

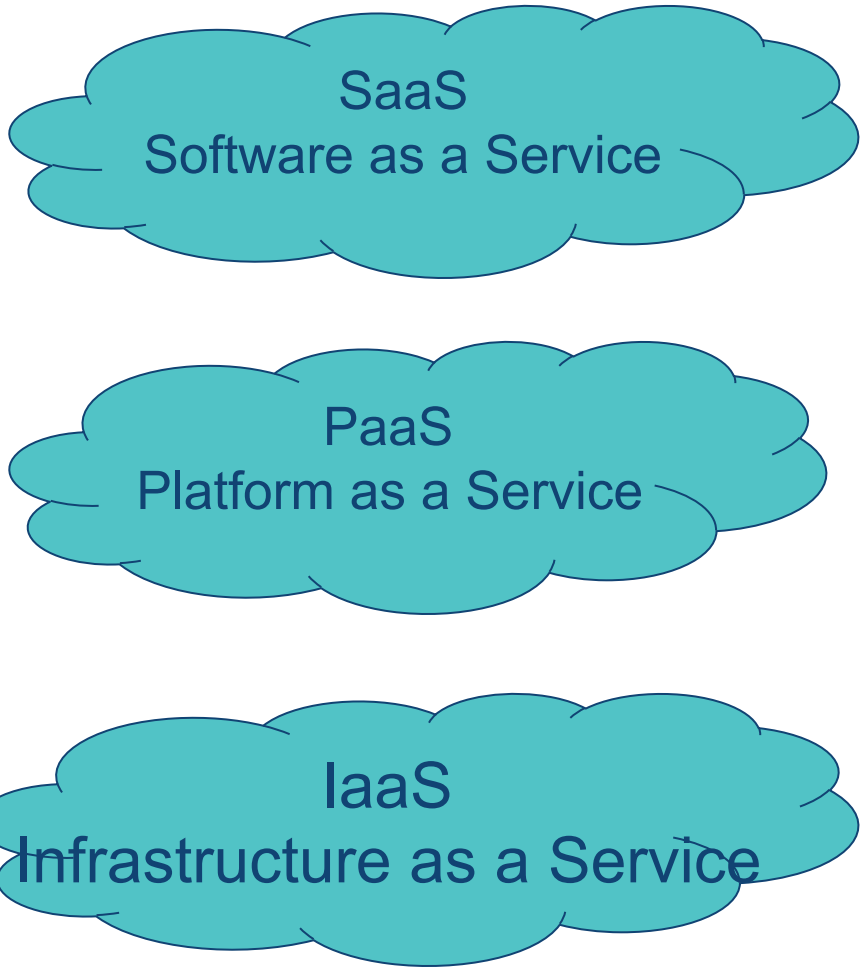
- ***Big data analytics (web mining, genomics, satellite data processing, sensor data, etc.) requires enormous computing and storage.***
- ***Many of these are highly interactive web applications.***
- ***Small and medium sized enterprises need scalable computing power and services at affordable cost.***
- ***There is a need for device independence and universal access to applications.***

Cloud Computing

"Why buy when you can rent (cheap)?"

- *Collection of integrated hardware, software and services.*
- *Platform provides very simple GUI and APIs to clients.*
- *On demand services that are always on, anywhere, any time and any place.*
- *Elastic (scale up and down in capacity and function)*
- *"Pay-per-use-and-only-for-what-you-use" principle.*

Cloud



The "Home Shopping" Model

I will pay … you do the rest

Rent hosted set of software

Gmail, SalesForce, LotusLive

with the implementation

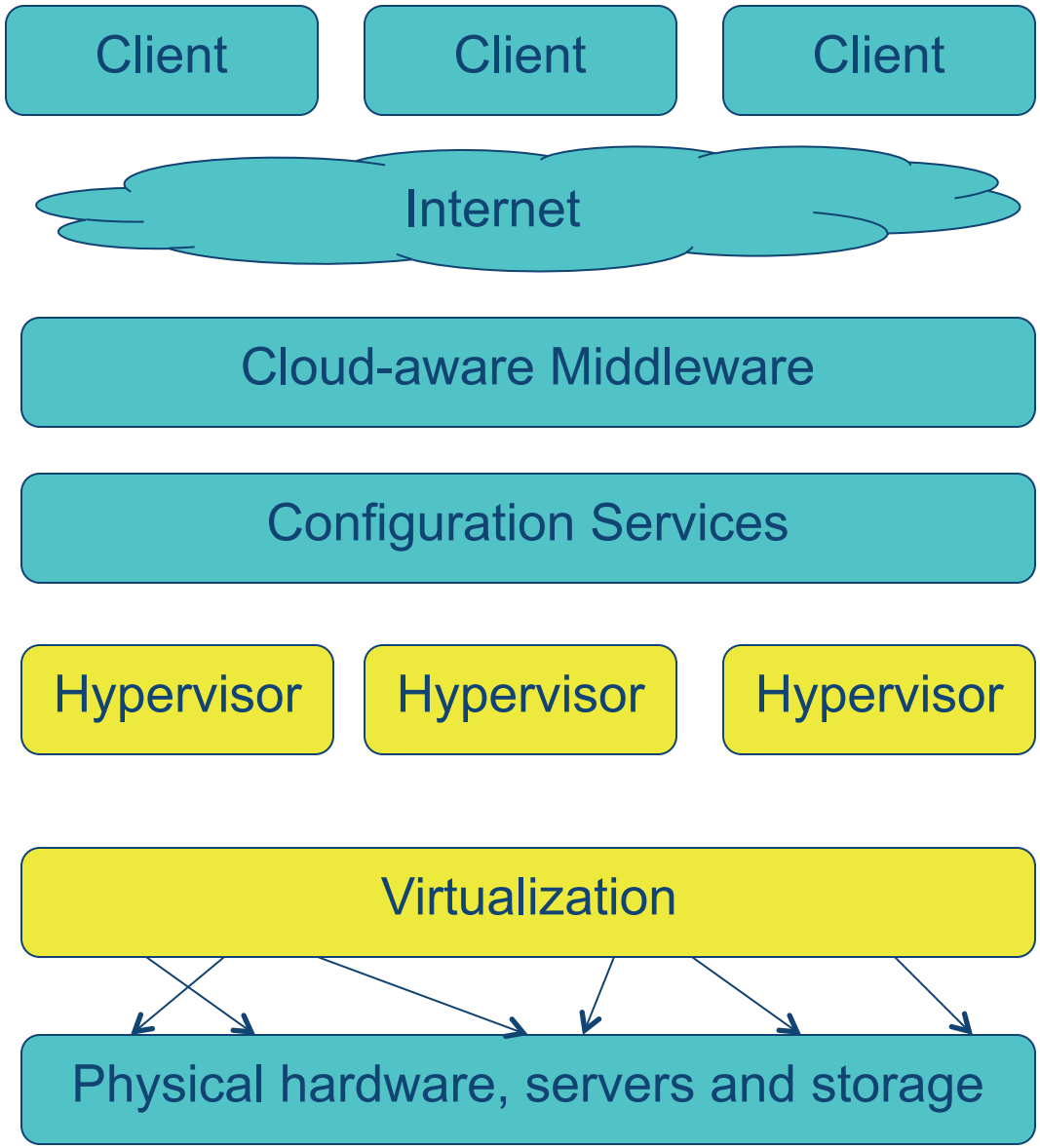
Rent hardware + application software

Windows Azure, Google App Engine

Rent CPU cycles, bandwidth, memory

Amazon's Elastic Compute Cloud(EC2), GoGrid, AppNexus

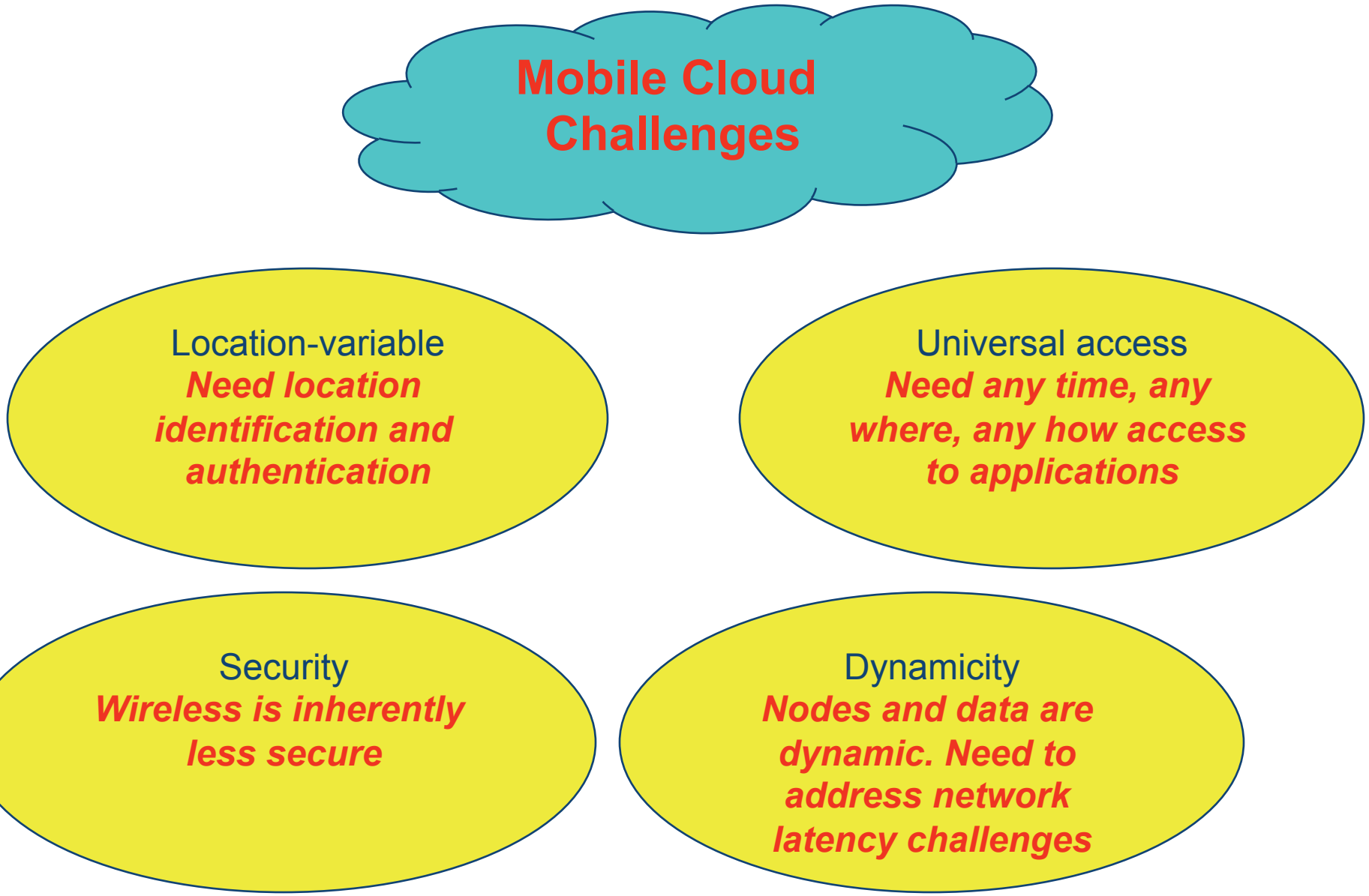
CLOUD ARCHITECTURE



The Mobile Cloud: Smart devices + Cloud Platforms

The Mobile Cloud

Powerful smart devices that can simultaneously and seamlessly take advantage of cloud resources


Mobile Cloud Challenges
Location-variable
Need location identification and authentication
Universal access
Need any time, any where, any how access to applications
Security
Wireless is inherently less secure
Dynamicity
Nodes and data are dynamic. Need to address network latency challenges

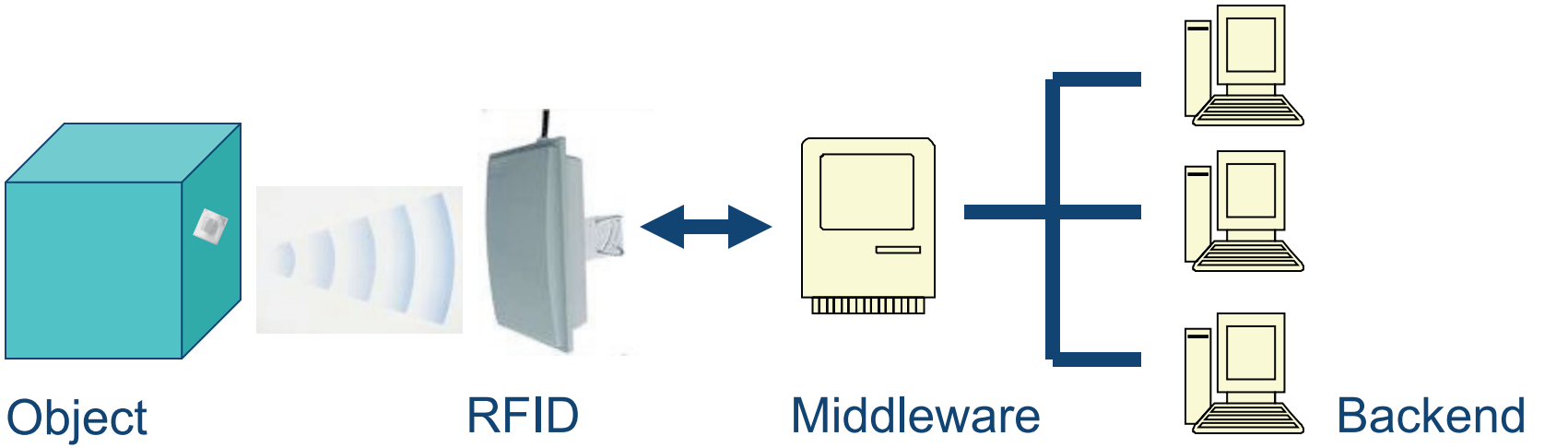
Can we tap into the mobile cloud using a device that is location-verifiable, sends short messages and provides universal access (and is reasonably secure)?

Near Field Communication (NFC)

NFC is a derivative of RFID (radio frequency identification)

- Automatic identification of objects by radio waves.
- Wireless system:
  - *Objects are tagged*
  - *Tags store data and respond to queries from readers*
  - *Data retrieved from tags can be used to identify, track and manage objects automatically*

Basic elements of an RFID system



Object with RFID tag

RFID Reader

Middleware

Backend System

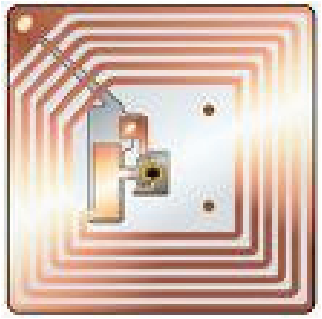
Microchip + Antenna + Data (EPC)

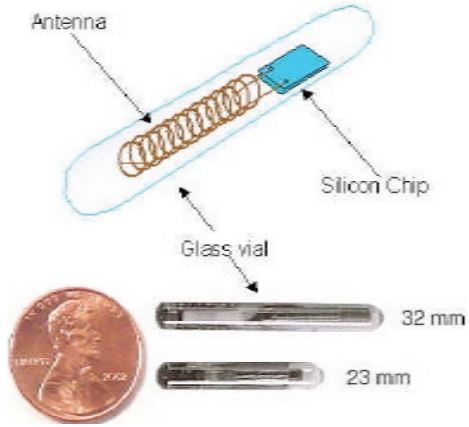
Reads tag data

Converts raw tag data into meaningful information; Ensures it is free from multiple or bad reads; Resolves reader collision.

Application software for matching, tracking, storage, alerts, etc.

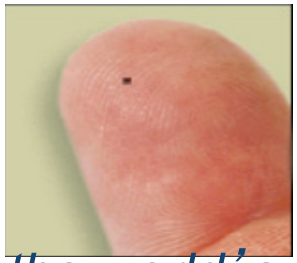
Tags





Silicon chip with
antenna and small memory

Stores a unique identifier →
EPC (Electronic Product Code) →
Key to a record in a database



One of the world's smallest RFID tags:
Mu-chip introduced by Hitachi → 0.05 mm X 0.05 mm

Near Field Communication (NFC)

- *A much shorter range RFID technology*
  - *Reading device needs to be < 4 cm from the tag*
  - *Requires less power*
  - *More secure (due to close range operation)*
  - *13.56 MHz frequency*
  - *106, 212 or 424 Kbps data rate*
  - *Small data bursts (64 bytes)*

NFC is not new …

Japan has been the pioneer in using the technology for several years.

… but there is something new happening to the technology

Onset of smartphones with embedded NFC chips

NFC Forum to ensure standards and compliance

Catalysts for NFC adoption

Commercial solutions and apps

Consumer demand

Seven years ago (2006)

Nokia 6131
First mobile
flip phone with
NFC capability

2.5 years ago (Jan 2011)

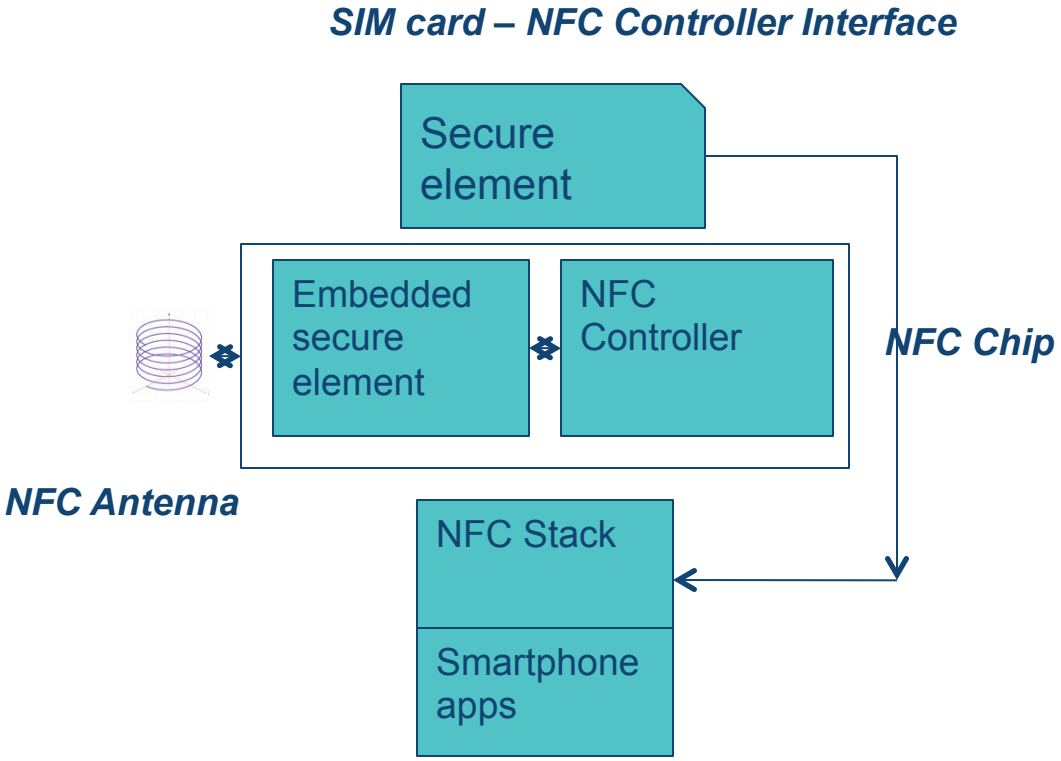
Google's Nexus S
with Android 2.3.3
Gingerbread
First NFC smartphone

And now

Plus tablets and other wearable NFC devices
And more to come ….

Source: NFC Forum

NFC Architecture



NFC Modes of Operation:
Tag Reading/Writing

NFC-enabled smartphone

Smartphone powers tag within a range of 4 cm.

Tag broadcasts data which is read by the smartphone

NFC tag

NFC Modes of Operation:
Card Emulation

NFC-enabled smartphone

NFC reader generates a magnetic field

When the smartphone is tapped on the reader, data from the phone is transferred to the reader

NFC Reader

NFC Modes of Operation:
Peer to peer

Initiator sends or requests data from target device

Target device responds

Target

Initiator

Now let's look at the three technologies ….

Independently …

Smartphone

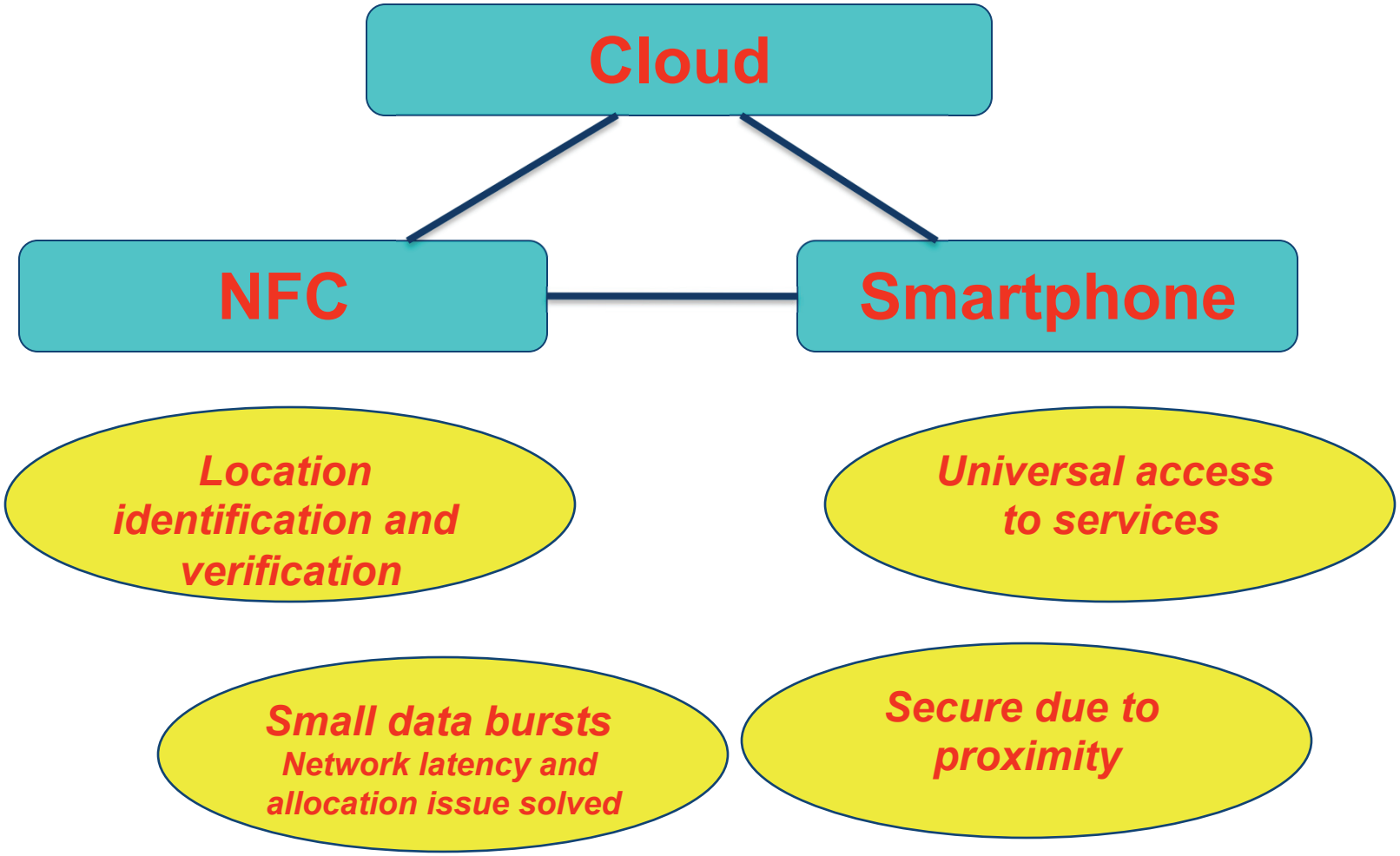
Powerful local device, but needs to tap into the mobile cloud

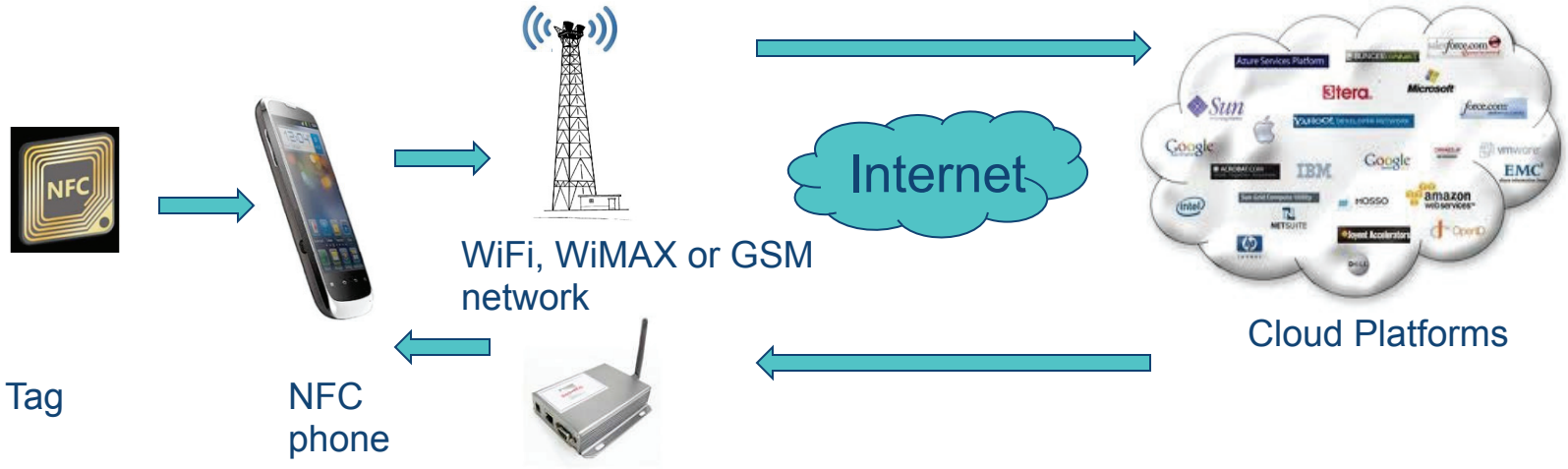
Cloud

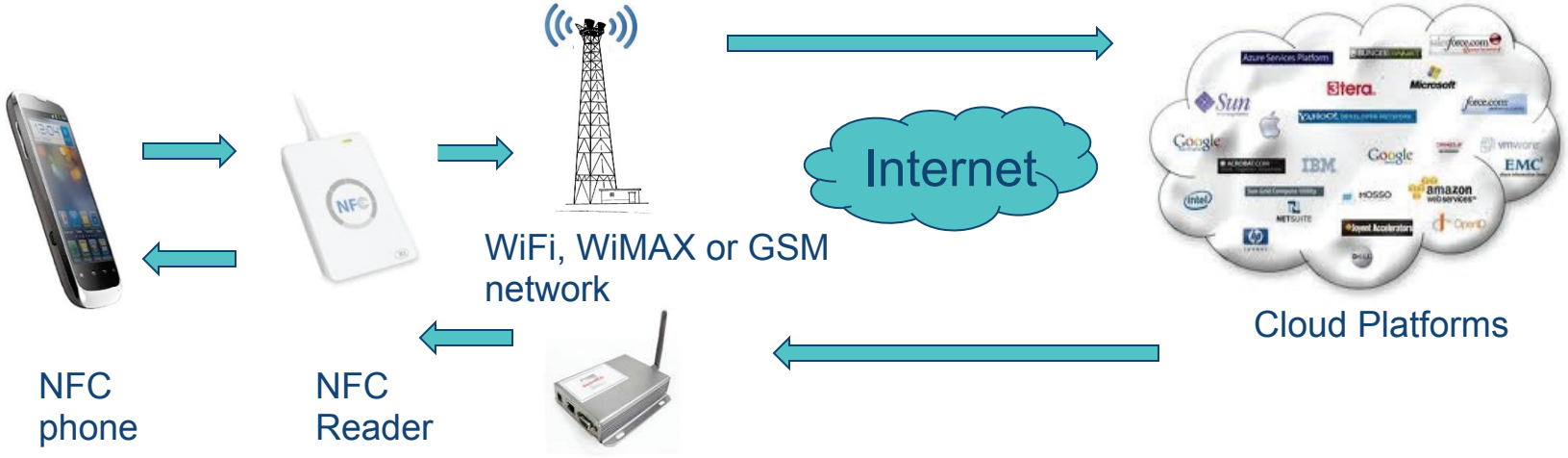
Provides vehicle, but needs location identification

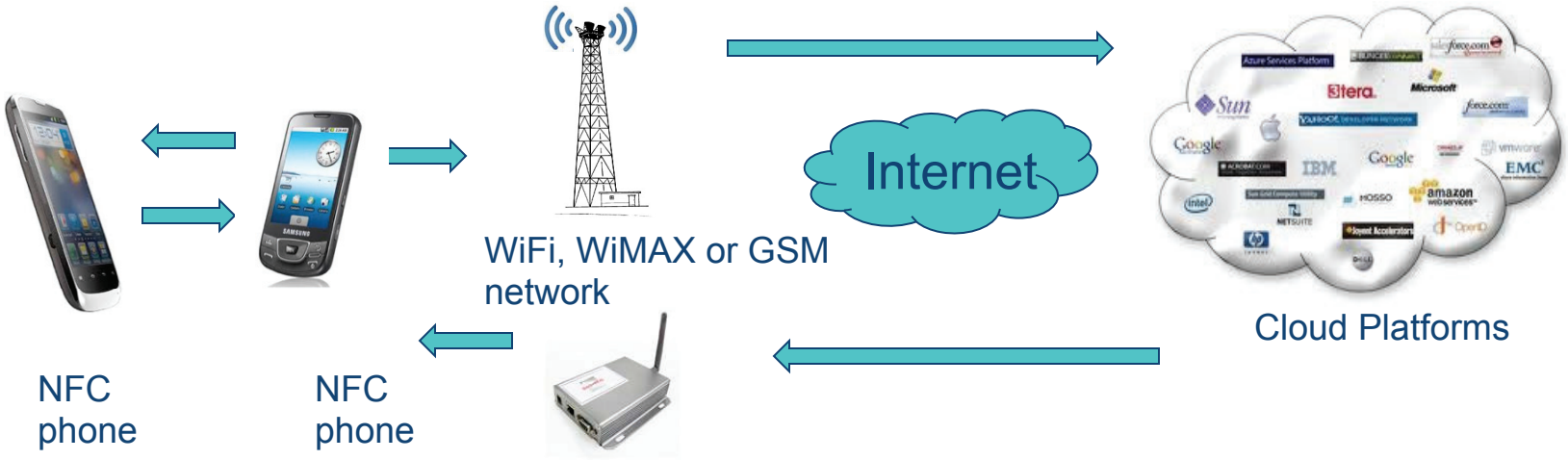
NFC

Provides location identification but needs a vehicle for data transfer

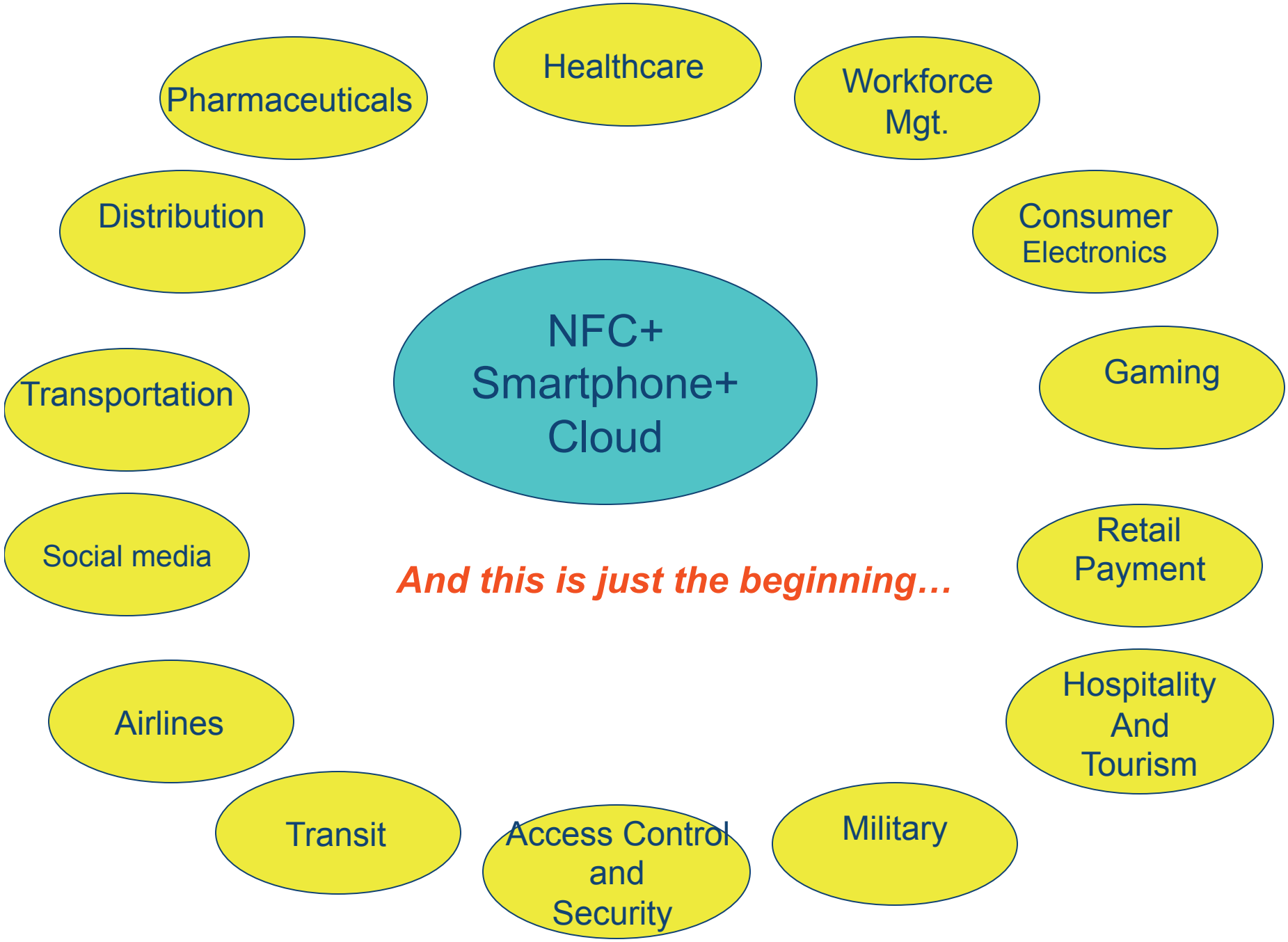

Cloud
NFC
Smartphone
Location identification and verification
Universal access to services
Small data bursts
Network latency and allocation issue solved
Secure due to proximity


NFC
Internet
WiFi, WiMAX or GSM network
Cloud Platforms
Tag
NFC phone


Internet
WiFi, WiMAX or GSM network
Cloud Platforms
NFC phone
NFC Reader


Internet
WiFi, WiMAX or GSM network
Cloud Platforms
NFC phone
NFC phone

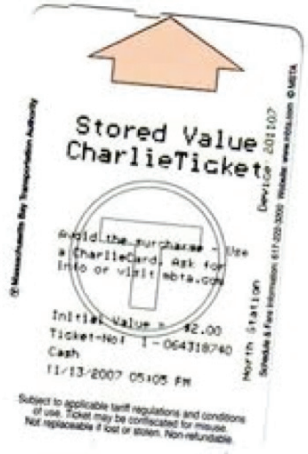
Opportunities


Pharmaceuticals
Healthcare
Workforce Mgt.
Distribution
Consumer Electronics
NFC+ Smartphone+ Cloud
Transportation
Gaming
Social media
And this is just the beginning…
Retail Payment
Airlines
Hospitality And Tourism
Transit
Access Control and Security
Military

NFC Payment + Loyalty Card Systems

- Get rid of your "Costanza" wallet
- Just TAP and
  - *Pay for your purchases*
  - *Download coupons*
  - *Update your reward points*

Our personal world now …



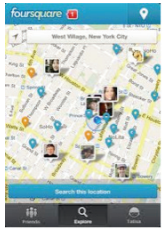
The near future:
Location-based advertising + Presence-based services =
Enhanced consumer experience

Loyalty

Mobile apps

Payment

Presence-based Services



XPERIA

Couponing

Google offers

yelp

Hospitality and tourism

Hotels

- Self-checkin
- Unlock guest room doors
- Pool and gym access

Restaurant

- Reservation

Shows

- Access information
- Download apps and vouchers

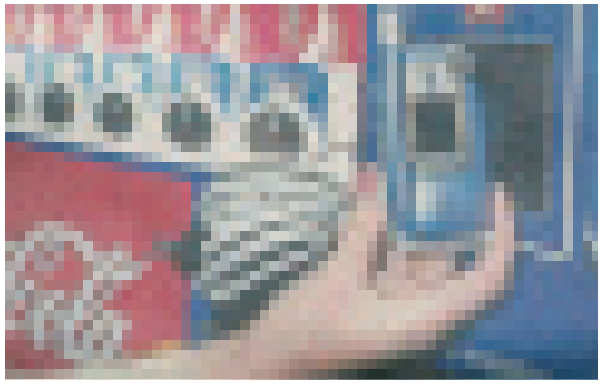
NFC and Transit

- “Wave and Enter”: Fast and easy ticketing and boarding access
- Download transport timetables
- Get location-relevant maps and discount offers
- Find local taxi services
- Get car rental with ease

Source: NFC Forum
Nokia presentation

Smart Posters

- A wave of your mobile phone on the smart poster will let you get extra information.
- Play movie trailers.
- Translate information into a language of your choice.



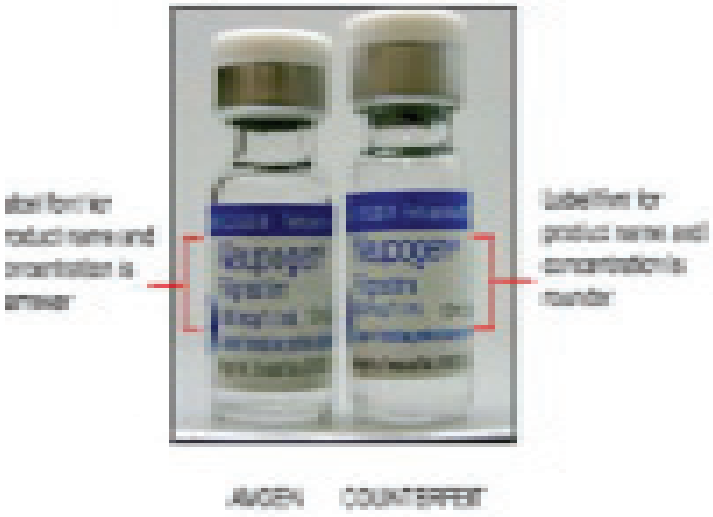
NFC in the enterprise

- Remote time and attendance recording and monitoring –tag-based checkin/checkout
- Delivery of just-in-time instructions
- Confirmation of service delivery

Source: NFC Forum

Distribution and Logistics

- Track critical shipments via NFC tags
- Monitor temperature-sensitive packages in transit
- Anti-counterfeiting: “Is the product genuine?” “Is the chain of custody intact?”



Source: S.Miles, TMEDA Workshop, 2006

Source: NFC Forum

Sharing by pairing

- Exchange business cards
- Download meeting notes
- Share contacts, videos, pictures, location information, maps

NFC and Consumer Electronics

- Pair in-car devices, home entertainment systems, cameras
- Quick and secure Bluetooth or Wi-Fi setup
- Read product history from smart tag to NFC phone

Gaming

- Phone to phone touch games (e.g., unlock levels)
- Get location-linked features via tags
- Rumble U Pokemon figures with tags

Augmented Reality on your smartphone

- Play a historical video when you scan a picture at a museum.

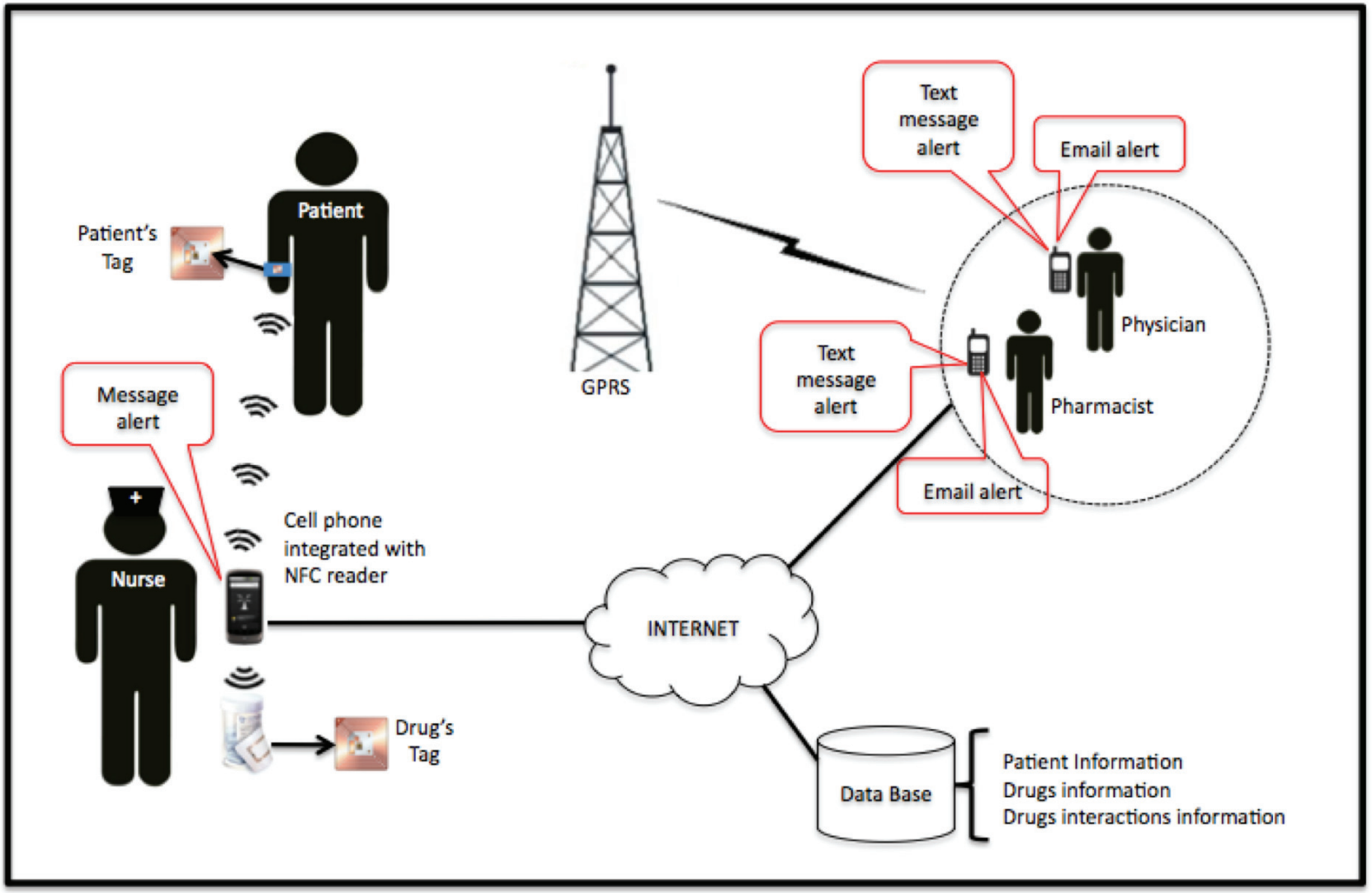
- Scan a tag on a furniture/appliance and the phone will display how it will fit into your living room.

NFC and Healthcare

- One-touch check-in at doctor appointments with NFC device
- Patient monitoring
- ***NFC for medication error reduction and prevention***

NFC for Drug Interaction and Drug Allergy Detection

Maali Alabdalhafith (Masters work)



NFC-Enabled Smartphone Application for Drug Allergy and Drug Interaction Detection

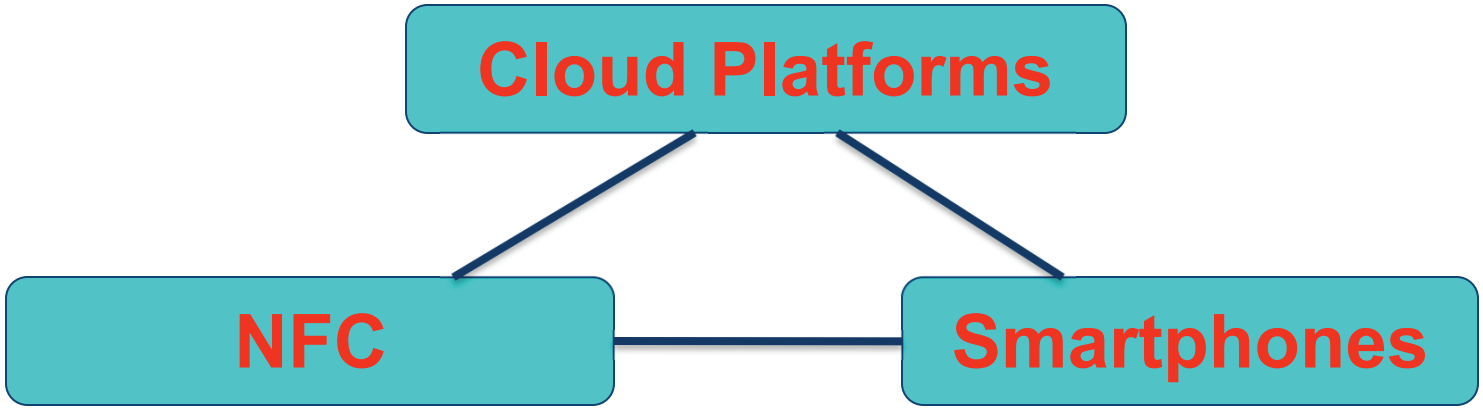
NFC Tap-and-Track

Challenges

NFC-Smartphone-Cloud Challenges

- *Security*
- *Standardization and Adoption*
- *Environmental*

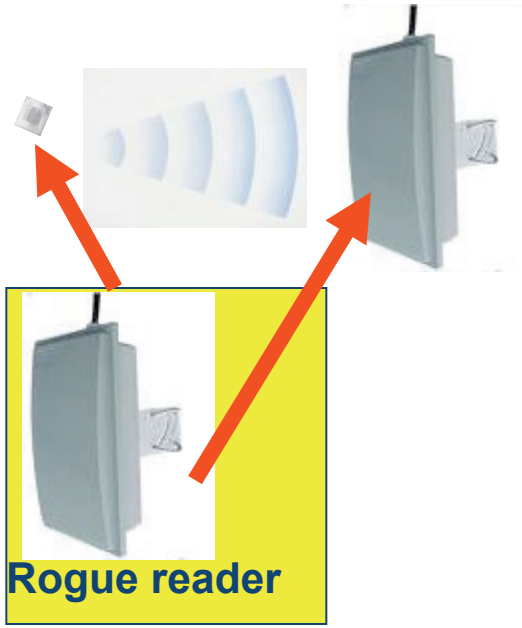
Challenges will span security issues in three technologies …



Security issues

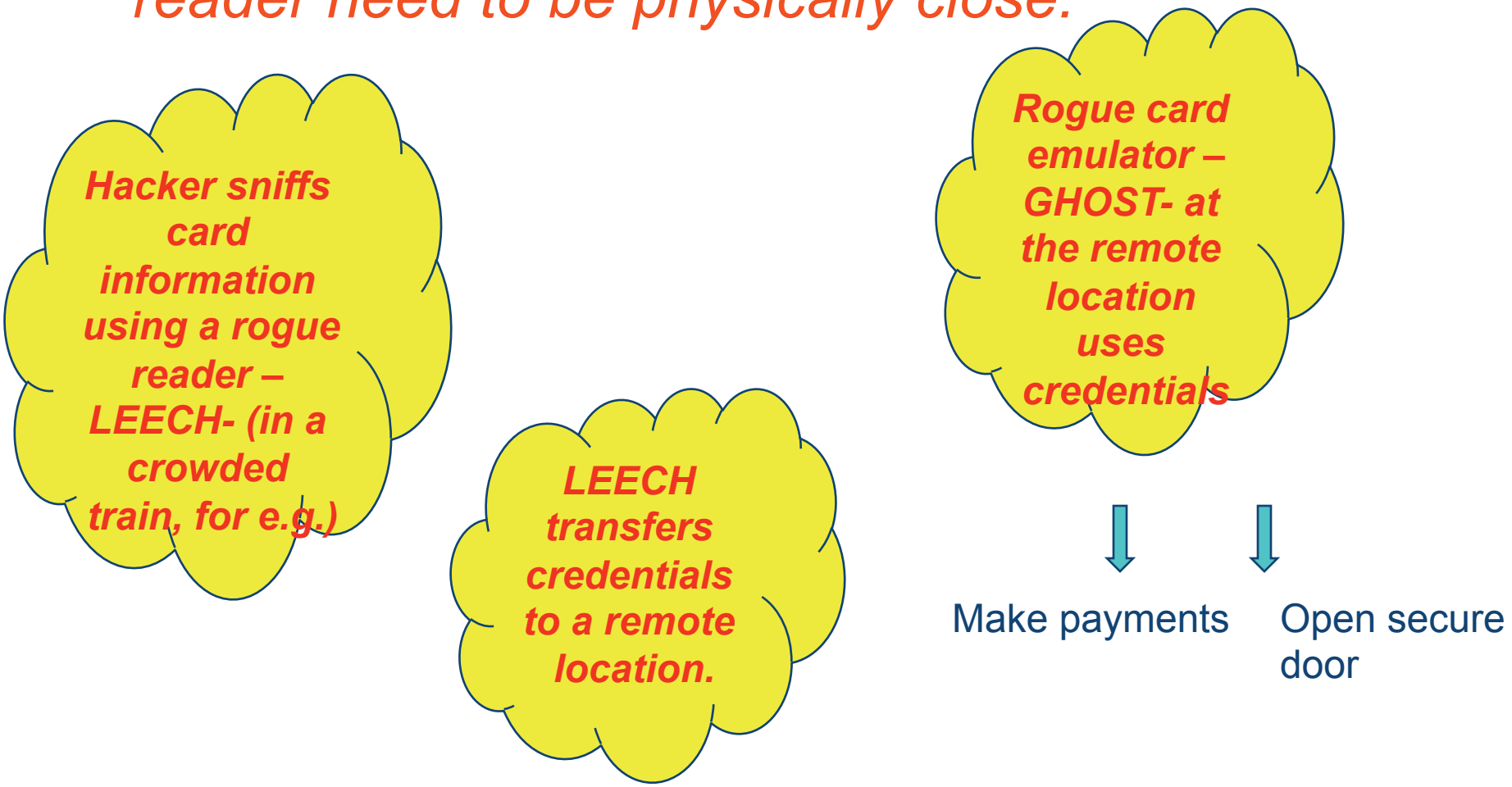
Intrusions

- *Tag eavesdropping*
  - Not a big threat due to proximity.
- *Reader eavesdropping*
  - Is a possibility



Ghost and leech attack

Breaks the assumption that the card emulator and reader need to be physically close.



Security issues

- *Tag cloning*
  - **NFC tags are vulnerable to cloning attacks – simple physical replication.**
  - **URL spoofing and modification**
- *Malware*
  - **Peer to peer mode can be a target for buffer overflow and malware attacks**
- *Denial of service*
  - **NFC readers and tags can be jammed by rogue readers and other NFC equipment.**

Standardization and Adoption Challenges

- *Interoperability with different carriers*
- *Cloud provider neutrality*
- *Integration with existing POS systems*

Environmental issues

- *Millions of NFC tags will be manufactured.*
- *Tags contain silicon, adhesives, nickel, copper, aluminum and silver materials.*
- *When the products with the tags are discarded, these will be contaminants for paper, pallet, steel, glass, and plastic recycling.*
- *Miniscule but voluminous.*

What can happen if tags are shredded during the recycling process?

Are there economic ways for removal of tags?

In closing ….

The momentum for NFC-based smartphones tapping into the mobile cloud is mind-boggling…

- 300 million NFC devices estimated to be sold this year(Deloitte Research)
- 50% of all smartphones will have NFC capability by 2015 (Gartner)
- Global mobile transactions predicted to grow to more than $1 Trillion by 2015 (Yankee group)

Growing up smartphone

"It'll start as a nanny and end as a nurse"

IEEE Spectrum, September 2012

The Really Smart Phone – tapping into "collective intelligence" (Alex Pentland, MIT Media Lab)

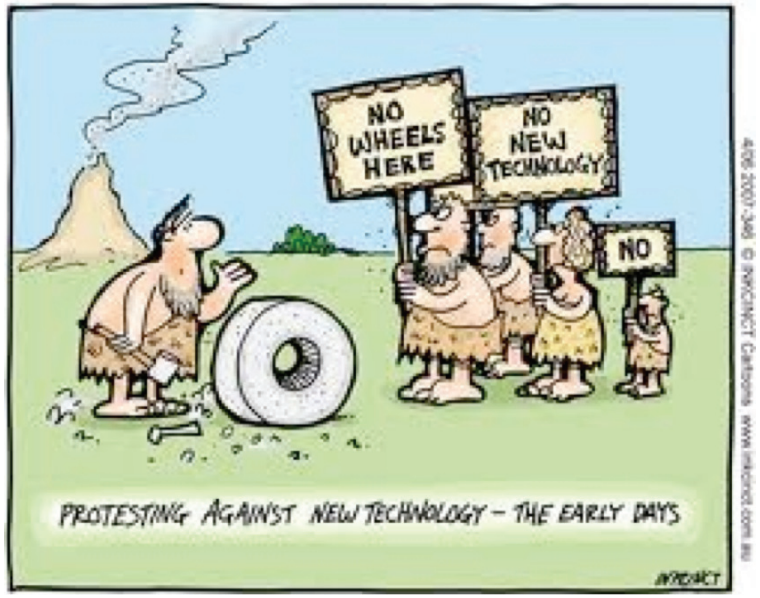
The advent of "superorganisms" →
The Internet of People +
The Internet of Things

Colony of humans and smart objects sensing, computing and actuating in co-operation

A new horizon: NFC and the information jungle

When a new technology rolls,
if you are not part of the steamroller,
you are part of the road.

- Stewart Brand



THANK YOU!