

Internet of Things - Opportunities

Prof Ramalingam Sridhar

Department of Computer Science and Engineering

University at Buffalo, Buffalo, NY, USA

Internet of Things

Smart people

Smart machines

Smart everything

Connected world

- connected machines; devices and people through internet

Big Data



Applications

Healthcare

Food

Disaster prediction

Weather

Transportation

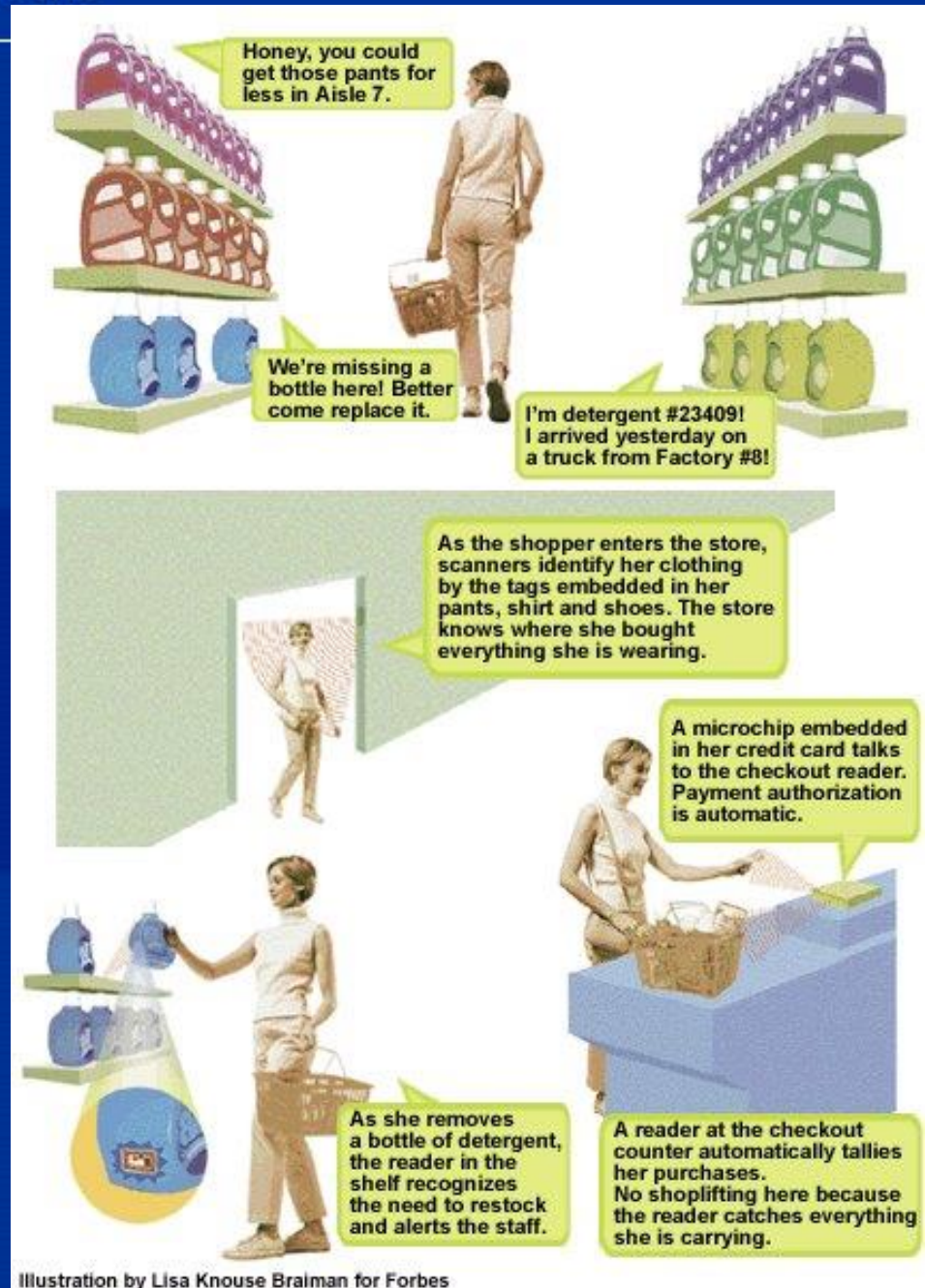
Smart homes

Day-to-day support

Scientific discovery

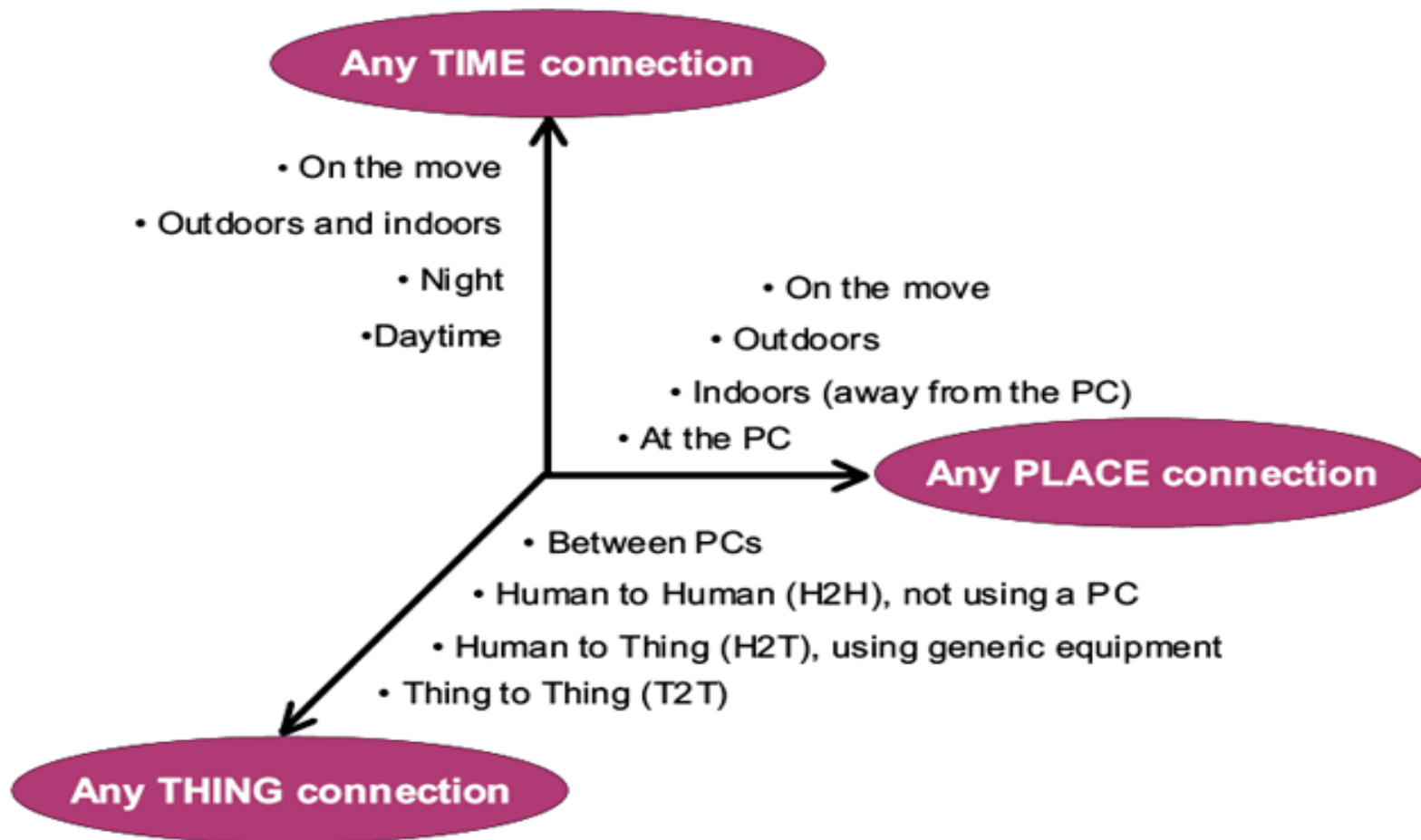
Personal health

Smart shopping



Challenges and requirements

- Things that connect
 - Homes; devices and more
- Network expanding
 - More connections; more nodes; ipv6
- Sensors and data
- Heterogeneous devices; languages; protocols, processors and systems
- Power constraints
- Anytime Anyplace Anything
- Context aware systems – data centric – Service oriented



Source: ITU adapted from Nomura Research Institute

More on Challenges and requirements

Scalable

Cloud support

Security at all levels

Reliability

Trust

Privacy

Opportunities at every level

Features

Sensor Network

Security at all levels

Reliability

Trust

Privacy

Opportunities at every level

Intelligent Systems for a More Connected World

WHAT ARE INTELLIGENT SYSTEMS?

Intelligent Systems are devices that transform how we travel, shop, make things and more.

7 Connected Devices per Person
By 2020 each person will own an average of 7 connected devices¹.

COMMUNICATIONS

Managed
Can be remotely monitored, updated and power controlled

Connected
Shares data through Internet and the cloud

Secured
Protects data against malware, theft and tampering

#2 Data Breach
Medical data disclosure is the second most breached source of data².

MEDICAL

71% of Shoppers are Multi-Channel...
based on respondents planning their 2011 holiday shopping³.

RETAIL

23.6M Connected Cars

23.6 million cars will have Internet access by 2016, rising from 8.7 million in 2010⁴.

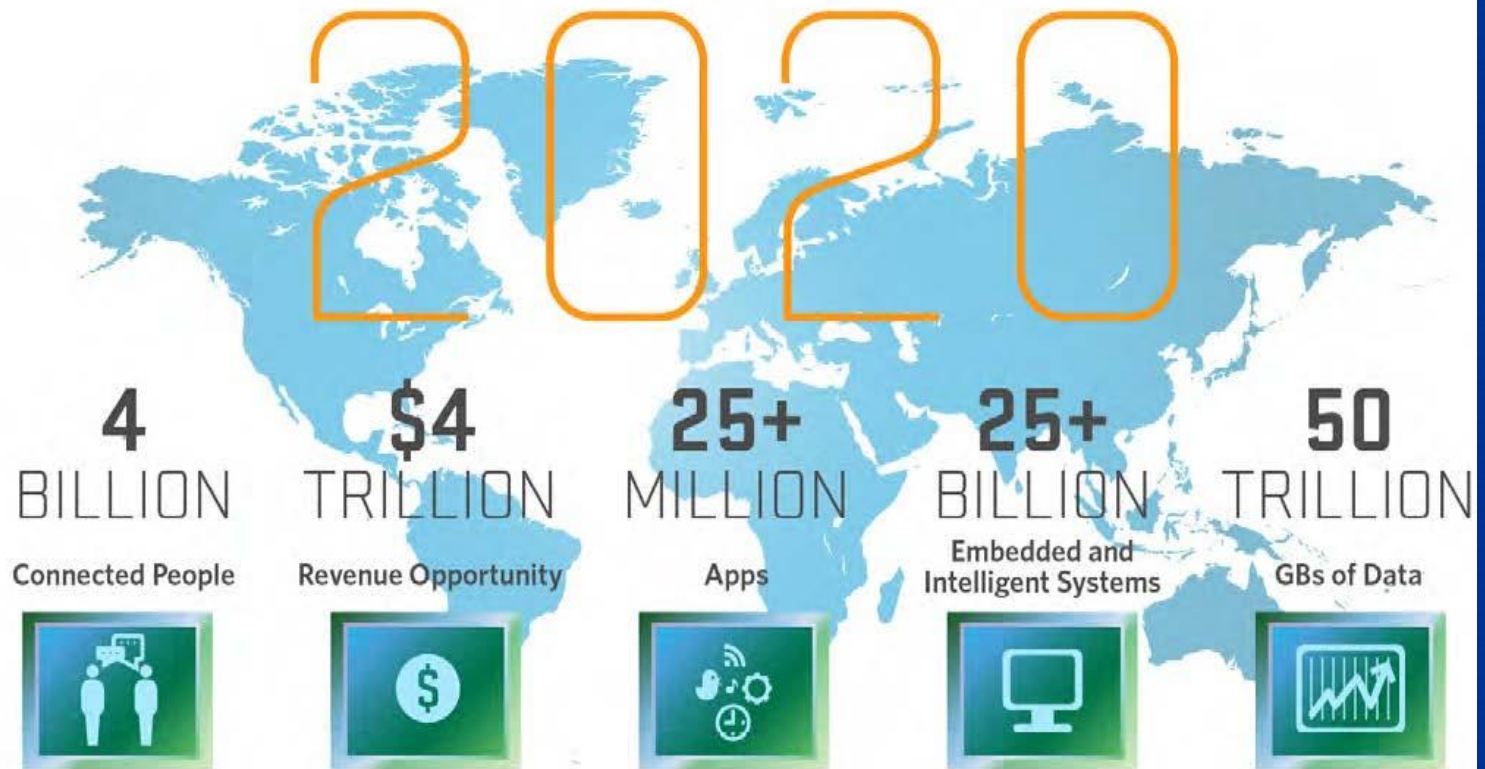
VEHICLES

30% Annual Growth Rate
Projected increase in connected machine-to-machine devices over the next 5 years⁵.

INDUSTRIAL

¹ Cisco, "The Internet of Things: How the Next Evolution of the Internet Is Changing Everything", April 2011
² Bloor Research, "Security challenges in the US healthcare sector" white Paper, December 2010, <http://www.mcfee.com/us/resources/white-papers/wp-bloor-healthcare-security.pdf>
³ Deloitte U.S., 2011 Annual Holiday Survey, http://www.deloitte.com/assets/Docum-UnitedStates/Local%20Assets/Documents/Consumer%20Business/us_retail_AnnualHolidaySurvey_2011_pr_102611.pdf
⁴ McKinsey Global Institute analysis, "Big data: The next frontier for innovation, competition, and productivity", June 2011
⁵ Wall Street Journal, <http://online.wsj.com/article/SB10001424052702304066504576349763614933844.html>, estimate from research firm, Frost & Sullivan

©2013 Intel Corporation. All rights reserved. Intel and the Intel logo are trademarks of Intel Corporation in the U.S. and/or other countries. *Other names and brands may be claimed as the property of others.



Source: Mario Morales, IDC.

IoTs – topics involved - features

Networking

IP protocols

Many to many connectivity

- device to device
- device to human
- device to system
- local, regional
- global

IoTs – topics involved - features

Sensor Networks

Embedded System

Processor Capabilities

Scalability

Systems of Systems connections

Inter operability

Support to wide ranging operating systems,
environments

Iot - Features

Sensor network

- Always on connectivity
- Ultra low power
- Energy Harvesting
- Wireless
- Tolerance to device failure or mortality

IoT - Processor

Scalability

Common architectural features

Hardware – Software CoDesign

- SoC features

Adaptability to varying needs

- specialized features add on through hardware or software depending on the application

Power aware design

IoT – Embedded system

System level adaptation to needs

Domain specific features

Embedded memory

- Novel Memory technologies (leading to ultra low power)

IoT platform for varying applications that can be tweaked to the needs

Energy aware design

Processor level / System level / Application level
/domain specific adaptation for power

- energy aware mobile solutions
- experimental measure of energy consumption
- determining the features to tweak for better energy consumption
- user adaptability
- modeling various components contribution to power consumption and using that to determine overall energy adaptation

Applications - Healthcare

Understanding diseases, healthcare and public health

Developing novel cures based on IoT based data

Wearable devices/computing/monitoring

Getting support to locations where there is need

Telemedicine – supporting many who don't get
healthcare

Applications – People support

City wide IoT adaptation

Smart city – Energy control through lighting adapted to external light through dimming control

Structural control – bridge sensors

Smart homes

simple control to total support

Automated maintenance related support

Automotive

Support in automobiles

- Lane travel

- Accident reporting

- Assistive driving

- Numerous safety features

- Entertainment

- Easy navigation

 - Gesture control

 - Computing/Communication/IoTs interaction

Automotive

Cloud support

Varying services

Upgrades

Customized features based on biometric or other
recognition

Autonomous vehicles

IoT plays a key role in autonomous vehicles

They enable these vehicles performance

Industrial automation

Robotics + IoT

Process control

Safety

Monitoring environmental conditions

even across places across cities around the world

Data

Data acquisition

In usable format to the applications

Big Data

Size of the data in application scenarios

Security/Privacy

Privacy

Users need to trust; uniform rules across countries

Security

Adding security features

Hardware and software

Hardware security through MEMS

Special Memory structures

Miscellaneous criteria

Fast time to market

Low cost

Mobility

Compatible with network needs

Miscellaneous

Intel

IBM

Cisco

TSMC

Bosch

Samsung

Research at the Universities

- Network based

- Big Data

- Limited work in hardware systems side

Internet of People to Internet of Things

What is IoT?

<http://www.intel.com/content/www/us/en/internet-of-things/videos/iot-platform-chalk-talk-video.html>

Summary

- Internet of Things provides great opportunities in all fields of Engineering and Computer Science
- World population will reach 9 billion by 2020: IoT – 50-200 billion (with internet connections)
- Application in all fields
- Makes life better for all; more lives saved; food reaches everyone; resources are better utilized; crimes are prevented with more data; disasters are averted