IPv6, IoT and beyond

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IoT6 Consortium

Mandat International (Coordinator) (Switzerland)
Ericsson (Serbia)
Run My Process (France)
University College of London (UK)
University of Murcia (Spain)
Vienna University of Technology (Austria)
University for Applied Sciences Western Switzerland (Switzerland)
Luxembourg University (Luxembourg)
Korea Advanced Institute of Science and Technology (S.Korea)
+ Industry Advisory Board
Objectives

Research the potential of IPv6

Develop a highly scalable IPv6-based Service-Oriented Architecture

Explore innovative forms of interactions
  a) Multi-protocol integration
  b) Mobile & cellular networks
  c) Cloud computing services (SaaS)
  d) RFID & Smart Things Information Service
  e) Information and intelligence distribution

Cross-domains integration

Sensors
RFID / STIS
Building automation
Mobile phones
Business Processes
End-users

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SaaS integration

Cloud Computing
(SaaS)

Users

IoT6

Internet of Things

Why IPv6?

IPv4 addresses

World population

IoT population

2020

Scalability challenge

4 Bio

7 Bio

50 Bio
IPv4 → IPv6

**IPv4** $= 2^{32}$  
$= 4.3 \times 10^9$ addresses  
$= 4,294,967,296$

**IPv6** $= 2^{128}$  
$= 3.4 \times 10^{38}$ addresses  
$= 340,282,366,920,938,463,463,374,607,431,768,211,456$

Ex: 192.168.0.1  

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**IPv6 high scalability**

$4.3 \times 10^9$ IPv4 addresses  
$7 \times 10^9$ Human beings  
$5 \times 10^{10}$ IoT devices  
$8.6 \times 10^{11}$ Neurons in a brain  
$5.1 \times 10^{14}$ Square meters on the Earth surface  
$10^{15}$ Synaps in a brain  
$5.1 \times 10^{20}$ Square milimeters on the Earth  
$7 \times 10^{20}$ Grains of sand on earth  
$\sim 10^{23}$ Stars in the universe  
$7 \times 10^{27}$ Atoms in a human body  
$1.4 \times 10^{37}$ Atoms in all human bodies

$3.4 \times 10^{38}$ IPv6 addresses
IPv6 addressing

IPv6 address - 128 bits

<table>
<thead>
<tr>
<th></th>
<th>Network ID</th>
<th>Host ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHERE</td>
<td>64 bits</td>
<td>64 bits</td>
</tr>
<tr>
<td>OWNER</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Network location

Device unique identifier

IPv6 Google stats

Graph showing IPv6 statistics over time.
IPv6 profile

- High scalability
- Global deployment
- End-to-end connections (Solving the NAT barrier)
- Stateless Address Autoconfiguration (SLAAC)
- Strong Security enablers
- IPv6 adaptation to constrained devices
- Mobility
- Fully Internet compliant

Triple convergence

Internet of Things

Internet Protocol version 6

Cloud Computing
IoT6 Vision

IPv6/v4
IPv6 Local Network
IPv6 Sensor Network
Non-IP Sensor Network
6LoWPAN
Heterogeneous protocols

IoT6 STIS

IoT6 in Europe
Information about Obj A.
Obj A.

IoT6 in Korea
IoT6 – International fora and standardization

IERC European Research Cluster on IoT
IPv6 Forum
IPSO
ETSI → oneM2M
IETF → 6LoWPAN, CoAP, CoRE, 6TiSCH
ITU → JCA IoT
IEEE → IoT SubCom

Examples
IPv6 application to IoT
Universal Device Gateway

Multi-protocol integration

Universal Device Gateway
www.devicegateway.com
Turn it IPv6

Using IPv6 to communicate with non-IP devices

Why IPv6?
The emerging Internet of Things will have to interconnect over 50 Billion smart communicating devices. IPv4 is limited to 4 billion public IP addresses
IPv6 provides 340.282.300.000.000.64.0.125.0.0.128 to 340.282.300.000.000.64.0.125.0.0.191.0.0.192 addresses, or 40 Trillions of Billions of Billions of addresses per human being on the earth. Since 2008, we work on the inclusion of legacy protocols in IPv6.

Devices

- 10/100 switch
  IP_fire: 192.168.0.0/24
- 10/100/1000 switch
  IP_fire: 192.168.0.0/24
- KNX radiator
  IP_fire: 192.168.0.0/24
- ZigBee temperature sensor
  IP_fire: 192.168.0.0/24
Turn it IPv6

Using IPv6 to communicate with non-IP devices

Switch

Protocol: IPv6

Description: Plug-in module for switching 230V appliances, halogen and fluorescent lighting on or off.

IPv6 address:

2001:0DB8:0000:0000:0000:0000:0:0/128

Video camera view

Casio VQ-229/PV-5 video camera

This video stream requires VLC.

Direct link to the video stream: IP camera #1

There is latency in the video stream.

www.turnitipv6.com

Hobnet

12
**Key Objectives**

**FIRE platforms** for Future Internet applications on automation and energy efficiency for buildings.

- IPv6/6LoWPAN infrastructure of buildings
- 6lowApp standardization
- Novel **algorithmic models**
  - energy efficiency, radiation-awareness, data dissemination, localization, etc.
- Integration with **building management applications**
Use cases

Local Adaptation to Presence
The room environment adapts to human presence.

- The air-conditioning switches on.
- The blinds are adjusted.
- The lights level adapts to the human position. The light level is high enough in the area of human presence for comfort reasons while it’s kept low in other areas to achieve better energy efficiency.

Here, one of the things is raising a hypothesis:
Automatic opening of a curtain.

Use cases

Electric Device Monitoring
Electric devices that are in use in bedrooms can be automatically switched off to save energy. The TV and washing machine are switched on when person A is in the room. Once the person leaves the room, the TV is switched off and washing machine is still running until the program termination and then switches off.

In this building, you don’t have to yell at me ‘cause I forgot to switch off something.

Only if building: could collect dirty socks too!

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Smart IPv6 Building

Turning buildings into smart environments with IPv6 as a universal integrator
EAR-IT

Researching IoT-based Audio Monitoring for Smart Buildings and Smart Cities

Acoustic Sensing

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Multi sites deployment
802.15.4 WASP motes:
- 1'600 lamp post
  noise, T, H
- 375 car park
  detection
- Meshed network

Multi sites deployment
Environment
Heterogeneous
protocols
Heterogeneous
sensors, actuators and
devices

End-users interactions
IoT Lab integration

IoT Lab integration

IoT Lab
European Research Project
Crowd sourcing driven research

IoT Lab testbeds integration
IPv6 main benefits

- **Scalability** \((2^{128} \text{ addresses})\)
- **On-going global adoption**
- **End-to-end (NAT free) = authentication…**
- **Security** (IPSec, etc.)
- **IoT compliance** (6LoWPAN, CoAP, RPL, 6TiSCH)
- **Cross domains / cross systems integration**
- **Mobility**
- **Stateless Address Autoconfiguration** (SLAAC)
- **Fully Internet and Cloud compliant** = direct interaction with the World
UNIS Smart Campus

200 fixed IoT units: SmartPlogg (1000+ sensors), 100 embedded GWs, 100 mobile IoT units, 10 smart displays, 30 smartphones

Smart Office Testbed

Heterogeneous sensors and actuators + energy metering

Functional areas:
- Meeting space
- Office desks / work stations
- Lounge area
- Kitchen / Toilets

IPv6 and 6LoWPAN/CoAP environment + heterogeneous communication protocols
Smart HEPIA testbed

Focus: 4th and 5th floor
Facades exposition: South and North
Sensors, actuators and energy meters

Functional areas:
- Class rooms
- Office spaces
- Lobby
- Toilets
- Technical areas
- Data centre

UniGE Batelle

WSN TelosB, Waspmotes, actuators, RFID, etc.
CoAP environment

Sébastien Ziegler  www.iotlab.eu
CTI Patras

Diverse sensor motes (TelosB, Iris), Android smartphones
Electricomechanical devices (lights, HVAC, curtains, etc.)
Control Cube actuators, Smart power meters, etc.

IoT Lab testbeds – related projects

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Triple integration

Testbed as a Service

Specific focus

Privacy by design
Personal data protection

Economic sustainability

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IoT Lab perspective

TaaS - Testbed as a Service

Extended local exp.

Distributed and pervasive exp.

Use cases exploration

Designing an innovative idea / use case using IoT and/or crowd sourcing applications addressing one of the following topics:
- Health: Ebola crisis?
- Environment
- Refugee camps
- Smart city
- Smart home

We need for each use case:
• Title
• Short description
• Equipment required
• Benefits
THANK YOU!

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