Open Interconnect Consortium

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Intel Open Source Technology Center
Content

- IoT Opportunities and Challenges
- Open Interconnect Consortium Vision
- Goals & Strategy
- Open Interconnect Consortium
  - Members & Structure
  - Standards - Compliance - Marketing
  - Open Source Project
  - Roadmap
- Technology
The Internet of Things is...
Intelligence Everywhere

50B DEVICES*

COST OF SENSORS 2X PAST 10 YEARS

COST OF BANDWIDTH 40X PAST 10 YEARS

COST OF PROCESSING 60X PAST 10 YEARS

44 ZETTABYTES**

COST OF PROCESSING 60X PAST 10 YEARS

* IDC
** IMC/EDC: The Digital Universe of Opportunities
*** Goldman Sachs
Fragmentation Solutions today

OIC makes it all work together...

Vertical

Software

Platforms

2013 Maker Boards Market Share, by Unit

Others

2013

Beagle

Galileo

Arduino

DIY Boards

Raspberry Pi

OPEN INTERCONNECT

CONSORTIUM
Open Interconnect Vision

• Enable IoT
  - Secure and reliable device discovery and connectivity across multiple OSs, platforms, and technologies

• Enable scale
  - Industry consolidation around a common interoperable approach, across all vertical markets
Organization Goals and Strategy
Why Open Interconnect Consortium?

• Current IoT connectivity difficulties...
  - Technical issues
  - Intellectual property rights issues
  - Organizational/structural issues

• Open Interconnect Consortium (OIC) is being formed by...
  - IoT industry leaders
  - A connectivity framework
  - Across vertical markets
  - Standards development
  - Open source
  - Royalty free IPR
  - An inclusive approach to technologies
New Modes of Communication
New Modes of Communication

- **Local Network / Same Subnet (Wi-Fi, Ethernet, etc..)**
- **Peer-to-Peer**

= Local Network / Same Subnet (Wi-Fi, Ethernet, etc...)

**Smart Devices**

**Client to Cloud**
### New Modes of Communication

<table>
<thead>
<tr>
<th>Cloud</th>
<th>Smart Devices</th>
<th>Things &amp; Wearables</th>
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<tr>
<td>Client to Cloud</td>
<td>Peer-to-Peer</td>
<td>Bridging &amp; Forwarding</td>
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- **Cloud**
  - Internet
  - Wi-Fi
  - Bluetooth
  - STUN/TURN

- **Smart Devices**
  - Peer-to-Peer

- **Things & Wearables**
  - Bridging & Forwarding

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= Local Network / Same Subnet (Wi-Fi, Ethernet, etc…)

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**OPEN INTERCONNECT CONSORTIUM**

**10**
New Modes of Communication

Client to Cloud

Smart Devices
Peer-to-Peer

Things & Wearables
Bridging & Forwarding

IoT Cloud Services
Reporting & Control

= Local Network / Same Subnet (Wi-Fi, Ethernet, etc…)

Internet

Wi-Fi

Direct

STUN/TURN

BLE

Internet

OPEN INTERCONNECT

CONSORTIUM
New Modes of Communication

We need a way to make IoT device connectivity as easy for developers and manufacturers as connecting a client to a server in the cloud.

Local Network / Same Subnet (Wi-Fi, Ethernet, etc…)

Internet
New Modes of Communication

We need a way to make IoT device connectivity as easy for developers and manufacturers as connecting a client to a server in the cloud.

OIC is addressing the challenge of IoT connectivity

=Solved

Client to Cloud

Smart Devices
Peer-to-Peer

Things & Wearables
Bridging & Forwarding

IoT Cloud Services
Reporting & Control

Scope of OIC - IoTComms

Internet

Local Network / Same Subnet (Wi-Fi, Ethernet, etc…)

OIC is addressing the challenge of IoT connectivity
OIC Goals

• Single solution covering interoperability across multiple vertical markets (Consumer, Enterprise, Industrial, Automotive, Health, etc...), OSs, platforms, modes of communication, transports and use cases
  - Common communications protocols for discovery and connectivity across multiple peer-to-peer transports
  - Common approaches for security and identity
  - Common service-level protocols, object models & developer APIs
• Promotes interoperability vs. closed solutions
• Promotes innovation and allows differentiation
• Connecting from smart devices to the smallest connected things
“OIC is a standard & open source project that delivers “just-works” interconnectivity for developers, manufacturers and end users.”
About the Open Interconnect Consortium
Members

Diamond
- CISCO
- GE Software
- Intel
- MediaTek
- Samsung

Platinum
- ADT
- Atmel
- CAICT
- Dell
- EyeBall Networks
- HP
- Honeywell
- Siemens

Gold
- Acer
- ActnerLAB
- Alliance
- Aepona
- CableLabs
- Cadence
- Zula
- Rti
- Gluu
- InFocus
- IIOT
- Flextronics
- Laplink
- Lenovo
- Mashery
- McAfee
- Metago
- NewAer
- Nitero
- OSS
- Nokalva
- MIT
- Kit
- Internet Trust
- Realtek
- Remo
- ROost
- Electro-Mechanics
- Silego
- Silego Technology
- Swiftlet
- T
- U9
- U9
- research
design
tool
- UL
- Vmc
- WIng
- WInd River
- Works Systems
- Nia
- Hong
- Interconnect
- Consortium
High Level OIC Governance Structure

OIC

Board of Directors

Standards

Open Source

Membership

Technology Planning

Ecosystem

Marketing Communications

IoTivity
Open Source Project

Steering Group

Projects

Functions

Sponsored (funded) by OIC
Develops reference implementation of OIC standard
OIC Organisational Structure

Open Source Work Group

- Task Groups TBD

Marketing Communications Work Group

- PR TG
- Events TG
- Branding TG

Ecosystem Work Group

- Use Case TG

Technology Planning Work Group

Standards Work Group

- Core Framework TG
- Security TG
- Smart Home TG
- Industrial TG
- Certification TG

Board of Directors

Membership Work Group

Events TG
OIC Intellectual Property Rights Policy

• OIC is a royalty free organisation
• Open source project (IoTivity) – Apache 2.0
  – Copyright & patent coverage for submitted code
• Standard – RANDZ
  – Cross licensing of “necessary” patent claims covering “Compliant Portions” of a member company’s certified products
Compliance Testing & Certification

• Mandatory feature:
  - Defined in the specification,
  - Released in open source, and
  - Mandatory in the Interoperability certification program.

• All other features are optional
  - Note: some features that are in both the specification and open source may be still be optional
Technical Overview
Interacting with Attributes – Messaging

Get

What’s your Status?

I’m Off.
Interacting with Attributes – Messaging

Set your Status to On

Set

OK.
Interacting with Attributes – Messaging

Subscribe

Tell me when your **Status** changes

My **Status** is now **On**

OK
Unidirectional Streaming

Stream connection request

Stream connection

Stream endpoint info
Bidirectional Streaming

- Stream connection request
- Stream connection
- Stream endpoint info
Conceptual Framework

Profiles
- Consumer
- Enterprise
- Industrial
- Automotive
- Education
- Health

Framework
- Discovery
- Data Transmission
- Data Management
- Device Management
- Security, Identity & Permissions

Transports
- Bluetooth
- Wi-Fi Direct
- Wi-Fi
- LTE
- Remote Access
- Cloud
- ZigBee
### Resources and Structures

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- **On-off state**
- **Brightness**
- **Temperature**
- **Location**
- **Friendly name**
- **Sensor version**
- **Etc…**

- **Property**
  - Resource Type
  - Resource Interface
  - Discoverability
  - Resource version
  - Access Control List
  - Observable
  - Etc…

- **Attribute**
  - On-off state
  - Brightness
  - Temperature
  - Location
  - Friendly name
  - Sensor version
  - Etc…
Grouping Devices

Collection: Things in the Garage
- **Garage Door Opener**
  - Resource: Door Mechanism
    - Action: Open/Close/Stop
    - Status: Closed/Not-Closed
    - Detailed Status: Open/Opening/Closing/Closed/Etc...
- Resource: Light
  - Status: On/Off
How You Can Use OIC Technology...

• Use the code from IoTivity.org
  - Open to any individual or company
  - Code is available at IoTivity.org under the Apache v2.0 license

• Join as a member
  - Certify spec compliant apps and devices
  - Use OIC branding
  - Benefit from patent cross-licensing protection
  - Go to www.openinterconnect.org for membership agreement, etc…
How You Can Participate in the OIC...

• Contribute code to IoTivity.org
  – Open to any individual or member company

• Participate in standards development
  – Open to Gold and above member companies and Individual members

• Vote on standards development; lead Work and Task Groups
  – Open to Platinum and above member companies
SmartHome IoTivity Demo

Smart Home Components:

- **SmartHome GW**: Intel MinnowBoard MAX as both OIC client and server
- **Control Panel**: OIC client
- **Smart Devices**: OIC servers

Uses open-source IoTivity code to:

- **Get STATUS** from IoT “Things” including sensors
- **Take ACTIONS** on IoT “Things”

OIC-enabled smart devices:

- **LED**: Intel Edison
- **Fan**: Arduino
- **Smoke Detector**: Arduino
- **Motion Sensor**: Arduino
Thank you !!!
OIC Membership and Participation

• OIC is a non-profit entity governed by bylaws
  – Board of Directors has fiduciary responsibility (financial, legal, etc…)
  – Sets up working groups to accomplish OIC goals
  – Work/task group structure below BoD defined in “Operational Guidelines”, not bylaws

• IoTivity.org hosted by the Linux Foundation
  – Independent governance and infrastructure, sponsored (funded) by OIC
  – Charter to provide reference implementation of OIC standard (but not limited to ‘only’ a reference implementation)
Board of Directors

• Each Diamond member appoints one director to the board
  – Diamond members also appoint 1 Alternate, on joining

• 2/3rd board majority of current Diamond member appointed directors required to accept new Diamond members

• Every 2 years, starting 2 years after founding…
  – Diamond and Platinum Members vote to elect 2 additional (Platinum) Directors for 2-year term from list of candidates nominated by Platinum Members

• Board of Directors may set up working groups
  – Work group rules or flexibility concerning membership, participation, voting, leadership and the ability to set up Task Groups is determined by the BoD at time of formation
OIC Approach

• Unique combination of standards & open source implementation
• Specification, certification & branding to deliver reliable interoperability
  - Connectivity framework that abstracts complexity
    • Easy to use for developers
  - Open specification that anyone can implement
  - IP protection & branding for certified devices (via compliance testing)
  - Service-level interoperability
• Open Source implementation to enable application developers and device manufacturers
  - Android, iOS, Windows, Linux, Tizen, VX Works, Contiki, single threaded RTOSs and more...
  - Many active contributors across the entire code base
Accessing OIC Resources

Application

Resource Model
- Security, Identity & Permissions
- Discovery
- Comms
- Device Management

Transport Abstraction
- Local IP
- Bluetooth
- LE

API - Language Mapping

Entity Handler

Resource Model
- Security, Identity & Permissions
- Discovery
- Comms
- Device Management

Transport Abstraction
- Local IP
- WiFi Direct

Shared Transport
Accessing Non-OIC Resources

Application

Resource Model
- Discovery
- Comms
- Device Management
- Security, Identity & Permissions

Transport Abstraction
- Local IP
- BLE

Protocol Plug-In Manager
- Protocol Plug-In

Resource
- Comms

API - Language Mapping

Local IP

Shared Transport

Wi-Fi Direct
Protocol Plug-ins: Adding Immediate Capabilities

Diagram:

- Application
  - API - Language Mapping
    - Resource Model
      - Discovery
      - Comms
      - Device Management
      - Security, Identity & Permissions
    - Transport Abstraction
      - Local IP
      - WiFi Direct
  - Protocol Plug-In Manager
  - Protocol Plug-In
- Resource
  - Comms
Light Resource Examples

- **Resource 1:**
  - **Light**
  - Status: On/Off

- **Resource 2:**
  - **Light**
  - Status: On/Off
  - Dimming: 0-100

- **Resource 3:**
  - **Light**
  - Status: On/Off
  - Dimming: 0-100
  - Hue: RGB
  - Hue: HSL
  - Colour Temp: K
Garage Door Opener Resource Example

Collection
- Garage Door Opener

Resource
- Door Mechanism
  - Action: Open/Close/Stop
  - Status: Closed/Not-Closed
  - Detailed Status: Open/Opening/Closing/Closed/Etc...

Resource
- Light
  - Status: On/Off