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**Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)**

**Submission Title:** [Focused Use Cases and Possible Timeline of Dependable Wireless M2M and BAN]

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**Source:** [Ryuji Kohno<sup>1,2,3</sup>, Jussi Haapola<sup>2</sup>] [1;Yokohama National University, 2;Centre for Wireless Communications(CWC), University of Oulu, 3;University of Oulu Research Institute Japan CWC-Nippon]

**Address** [1; 79-5 Tokiwadai, Hodogaya-ku, Yokohama, Japan 240-8501

2; Linnanmaa, P.O. Box 4500, FIN-90570 Oulu, Finland FI-90014

3; Yokohama Mitsui Bldg. 15F, 1-1-2 Takashima, Nishi-ku, Yokohama, Japan 220-0011]

Voice:[1; +81-45-339-4115, 2:+358-8-553-2849], FAX: [+81-45-338-1157],

Email:[kohno@ynu.ac.jp, ryuji.kohno@oulu.fi, jhaapola@ee.oulu.fi] **Re:** []

**Abstract:** [Body area networks(BAN) should be more dependable for major life critical applications such as medicine, disaster, dependable sensing and controlling cars, buildings, smart grids, and smart city by extending BAN from human body to bodies of cars, buildings, and so on. That is so-called BAN of things like Internet of Things. While keeping advantages of IEEE802.15.6, specifications of MAC and PHY may be revised to make it much more reliable, secure, fault tolerant, robust against undesired factors. This slides may offer opportunity to discuss on use cases and applications of this standard.]

**Purpose:** [The discussion on use cases and applications will lead definition and requirement of current ongoing research and development on dependable wireless networks.]

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# Focused Use Cases and Possible Timeline of Dependable Wireless M2M and BAN

13rd Nov. 2013 Dallas

Ryuji Kohno\*<sup>1,2,3</sup>, Jussi Haapola\*<sup>2</sup>

\*1 Yokohama National University, Japan

\*2 Centre for Wireless Communications (CWC), University of Oulu, Finland

\*3 University of Oulu Research Institute Japan CWC-Nippon

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## Background

- IG-DEP started July 2012 but has not discuss on major use cases and applications yet although definition of Dependability has been discussed.
- Discussion on use cases and applications we should cover in IG-DEP may lead definition and requirement common with and different from IEEE802.15.6 BAN standard.
- Applications Matrix has been useful for developing a categorisation scheme and analysing technical requirements
  - However, insufficient by itself for proposal design and evaluation
- ITU-R has covered M2M in SG11 and others.

# Summary of IG-DEP Sessions in July, Nov. 2012, March, May & July 2013

- Doc. IEEE802.15-12-0370-00-wng0 : **Dependable Wireless M2M Network for Controlling - Applications for Cars, Energy, Medicine, Cities –**
- It was proposed to start **either a new IG on Dependable M2M or a IEEE802.15 TG6 amendment of BAN** in July. It could get about 40 supporting votes for this action.
- **It was asked Pat to postpone its opening** because a few could attend IR meeting in September due to several reasons.
- **Possible use cases and manners of activities** were discussed at sessions in Plenary in November 2012.
- **Two sessions of IG-DEP** in Orlando, March 2013 discussed with 12 attendees to **focus on amendment of TG15.6.**
- **Definition of dependability and its technical feasibility** were discussed in Hawaii, May 2013.
- **Use cases and applications** were discussed in Geneve, July 2013.

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# Contents of IEEE802.15-13-0192-01-wng0 in March 2013

1. Recall of My Presentation in WNG Session in July 2012
2. Review of IEEE802.15.6 for Wireless BAN
3. Background for Amendment of IEEE802.15.6
4. Dependability of Wireless Networks
5. First Focus on Amendment of 15,6 for Dependable Medical BAN and Extend to BAN of Things
6. Possible Amendment of BAN
7. What to be documented
8. IEEE802.15.6 Deficiencies
9. Action Plan for TG6a(amendment of IEEE802.15.6)
10. Questions & comments

# Agenda

1. Definition of Dependability
2. Focused Use Cases and Applications
3. Basic Technical Requirements
4. Procedure of Promotion to Next Steps
5. Possible Time Line
6. Others

# Discussion Items in Previous Meetings(1/2)

1. Whether to go for M2M or BAN amendment is still under consideration.  
Depends on participant interests.
2. How to detect and control effect of device hardware failure?
  - Hardware fault tolerance in devices.
  - How to attain protocol fault tolerance?
3. Dedicated band would solve interference issues.
  - Amount of band available will constrict useable applications.
4. Dependability means the device will certainly work for a specified period.
  - It may work longer, but dependability is not guaranteed anymore.
5. Car control electronics may be too sensitive for wireless acceptance, but auxiliary electronics like entertainment, etc. would greatly benefit from wireless dependable technologies.
  - The systems would be a one whole set however.
6. Mass market may offset additional cost of reconfigurable and reliable technology.

# 1. Dependability in Wireless Networks

- **Meanings of Dependability:**

- For us, “**Dependability in network**” means to guarantee lowest performance enough high in a sense of highly reliable, safe, secure, fault tolerant, robust services in any predictable and even unpredictable worse environments.

- **Demand for Dependable Networks:**

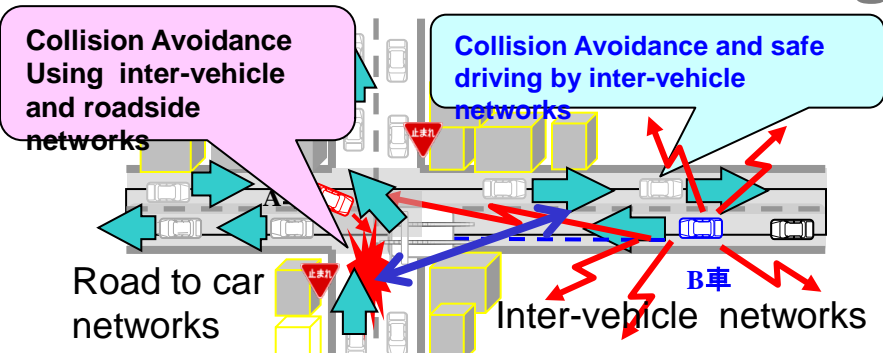
- Need for **Highly Reliable, Robust Communications for Controlling**
- Transition from Human centric communications to **Machine-to-Machine (M2M) communications**.
- Highly reliable, safe, secure and robust communications for **M2M Controlling** is necessary.
- **Integrated wired & wireless networks** provide dependable, green and ecological networks adaptable for environment.



## 2. Focused Use Cases and Applications

- Application Matrix Discussion: Participants are requested to send their envisioned use cases to start formulating the application matrix.
- So far Identified use cases are: Refer to Table ‘Use Cases’ in doc #412r2
- Use Cases
  - Medical
  - Car
  - Factory automation
  - Disaster prevention
  - Indoor positioning
  - Energy flow control
  - Building and smart city management
  - Public safety
  - Personal information space
  - Government information

# Possible Use Cases of Dependable M2M and BAN for Sensing and Controlling

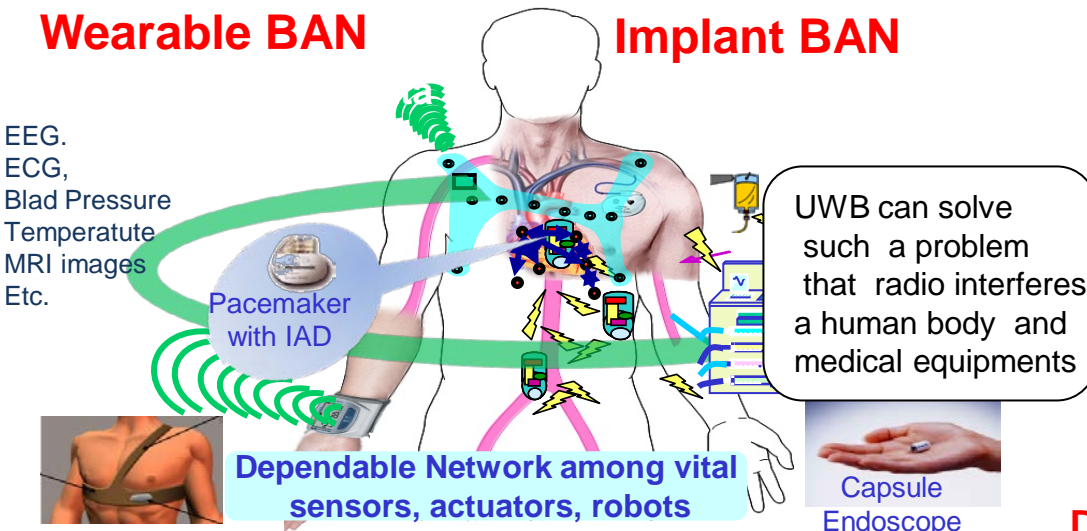


**Car Navigation & Collision Avoidance Radar**

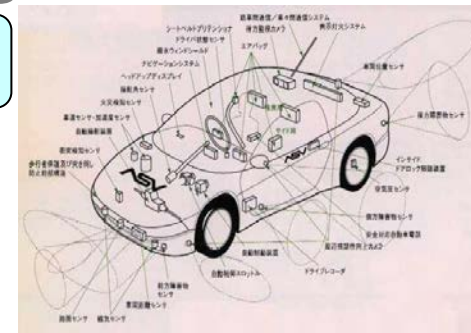
**Dependable Wireless Networks for Transportation**

**Wearable BAN**

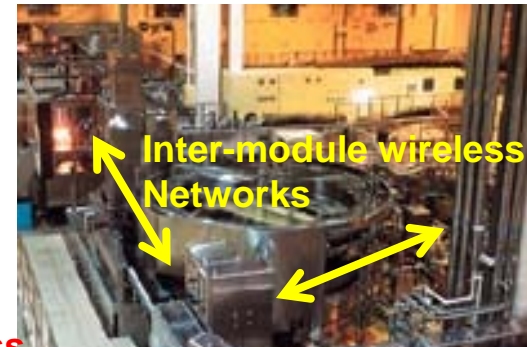
**Implant BAN**



**Dependable BAN for Medical Healthcare**

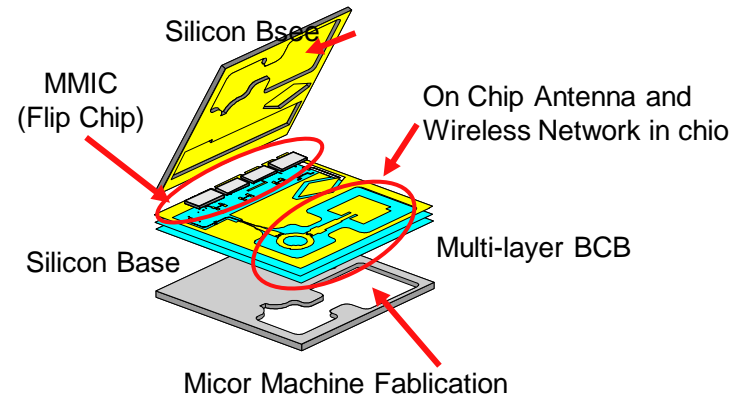


**Car LAN & Wireless Harness**



**Factory Automation (FA)**

**Dependable Wireless Sensing Controlling for Manufacturing (CIM)**



**Dependable Wireless System Clock in Micro Circuit & Network in Devices**

## 3. Basic Technical Requirements

- After defining dependability in network, we need to find reasonable technologies to satisfy requirements.
- Application Layers:
  - Information Security: Encryption and Authentication
- Network Layers:
  - Redundant Routing: Parallel, Relay or Multi-hop, Network Coding etc.
- Data Link & MAC Layers:
  - Non-opportunistic and reliable, secure MAC
- Physical Layers:
  - Diversity technologies in time, frequency and space domains
  - Channel coding for error-controlling, Hybrid ARQ, Space-Time Coding etc.

# Discussion Items in Previous Meetings(2/2)

To pursue dependability in network may be possible to go beyond IEEE802.15scope.

Document (doc #440r0) on techniques for dependability at communications layers.

Approach by layers: Management layer at the side with hooks to other layers.

(1) Application Layer: Quote from Hawaii session: “Collect trending retransmissions and other info to prevent failures.”

(2) Link Layer:

- Quote from Hawaii session: “MAC layer error may be able to correct by adaptation to guarantee delay specification (e.g. to switch to fragmentation, change to lower coding rate, change back-off window, change number of retransmission attempts, cooperate with other MACs to create virtual MIMO, use L2R), rather than incur delay by going to Apps layer.”

(3) Physical Layer:

- Quote from Hawaii session: “MIMO and multipath are friends of dependability with PHY layer redundant links.”

- Quote from Hawaii session: “PHY layer can be adaptable to environment, by switching frequency particularly, if you are in a null.”

- Quote from Hawaii session: “PHY layer error may be able to correct by adaptation (switch to a better antenna) to guarantee delay specification rather than incur delay by going to Apps layer.”

# 3.1 Physical Layer Technologies Satisfying Multiple Demands for Dependable M2M and BAN

(1) Countermeasure techniques against fading  
Interference from other systems in a body area

: Equalization, Diversity, Coding, Antenna etc.

(2) Positioning • Ranging = Position recognition in  
Implanted Devices : Radar, Navigation, Roaming

(3) Awareness and Control = Inside body sensing  
: Observation of environment, Sensor, Adaptive control

(4) Security = Authentication • Privacy for vital  
: Charge information, Privacy protection, terror measure

(5) Reconfigure = Changing operation • Fault search  
ing: Changing to new technology, Fault maintenance

(6) Antenna and Diversity  
: Securing of good wireless communication environment

(7) Low power consumption = Long operable time  
Implementation of low power consumption and high quality

Spread Spectrum & UWB Technology

Array Antenna, STC & MIMO Technology

Software Defined Radio (SDR) and Cognitive Radio Technology



## 3.2 Communication Technologies in each Layer for Dependable M2M and BAN

Application layer	Control algorithm
Network (NWK) layer	Scheduling (packet order control) Routing (route control)
Medium access control (MAC) layer	Time slot control (TDMA) Frequency control (FDMA) Contention window control (CSMA)
Physical (PHY) layer	Transmit power control Modulation level control Coding rate control

# 3.3 Cross Layer & Multi-Layer Optimization for Dependable M2M and BAN

**Dependable Wireless with Less Power Consumption & Robustness**

**Application Layer** : Information Security(Encryption and Authentication, User Friendly Interface . . .

**Network Layer** : Integrated Wired & Wireless Network Architecture, Network Security(IP SEC) . . .

**Data Link & MAC Layer** : Priority Access Control, Fault Tolerant Routing, ARQ, Hybrid ARQ, Distributed Resource Management, . . .

**Physical Layer** : Cognitive, Reconfigurable, Adaptive, Robust Radio, Error-Controlling Coding, Space-Time Diversity, Equalization, Coded Modulation, . . .

**Device/ Electronics Layer**: Tamper Free Hardware, Robust Packaging, SoC, SOP, On-chip CODEC for channel Coding and Encryption . . .

Joint Optimization of Multi Layers

## 3.4 Higher Layers Technologies for Dependable M2M and BAN

1. **Contention Free Protocol in MAC** (TDMA, Polling, Hybrid CFP & CAP etc)
2. **ARQ and Hybrid ARQ in Data Link** (Type I, II)  
combination of transmission and storage(buffering)
3. **Parallel Routing** (Risk Diversity) and **Network Coding**  
in network architecture
4. **Fault Tolerant Network** (Redundant Link and Parallel Hopping) and **Cognitive Networking**
5. **Encryption and Authentication in Application Layer**  
(AES, Camellia, Secret Sharing)



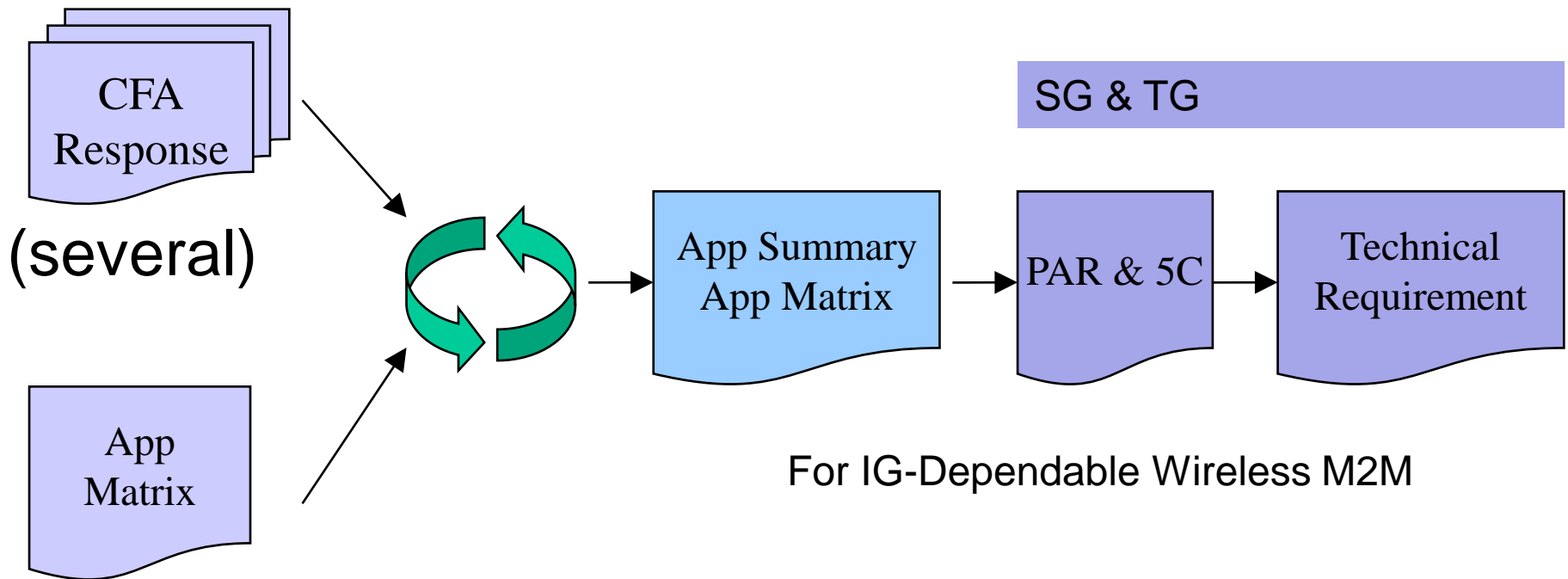
## 4. Procedure of Promotion to Next Steps

- We tried to proceed establishing IG, SG, and TG on Wireless Dependable M2M Network since the plenary session of July 2012. However, due to some restriction procedure was not speeded up.
- There are two major approaches to procedure IG to SG and TG.
  - (1) focus on amendment of BAN 802.15.6
  - (2) focus on different PHY and MAC for dependable M2M
- An amendment of IEEE802.15.6 must be more realistic while keeping advantages of the BAN standard as IEEE802.15.6a (?)

## 5. Possible Time Line

- IG → WG → SG → TG → Standard
- Technical Requirement
- 5C and PAR
- Proposals
- Down selection
- Letter Ballots
- Sponsor Ballots
- Rev Com Approval

# Development process



For IG-Dependable Wireless M2M

Amendment of 802.15.6

New use cases of dependable M2M

# Document purpose

- To collate identified 802.15 IG-DEP applications into a single design document which will be distributed with the call for proposals.
- To provide a single point of reference (and application reference numbers) which can be used as a common point of reference when evaluating and comparing call for proposal responses.
- To identify omitted or erroneous application information requiring for further discussion.
- Refine the applications matrix categorization scheme through use.

# Document structure

- Table of contents
- Use Cases & Applications, categorised
  - Parameters
  - Free text description
  - CFA slide extracts
- Acknowledgements

# Going forward

- The Applications summary document is now the primary applications document
  - Apps matrix now obsolete, all info from the matrix is contained in the new doc
- Seeking to endorse the document at Jan. 2013 meeting, for distribution with CFP
- Comments and feedback on the Summary and Autumn document are requested, close next March

# Contributions

- Not all applications may be comprehensively described but major applications must be covered.
- If you can offer further details, either updated parameters or free text, please contribute
- Send content contributions to
- Jussi Haapola <jussi.haapola@ee.oulu.fi> and  
Ryuji Kohno <kohno@ynu.ac.jp>

# Reference documents

- Applications Summary Document of IEEE802.15.6 BAN
  - 15-08-0407-00-0006-tg6-applications-summary.doc
- TG6 Applications Matrix
  - 15-08-0406-00-0006-tg6-applications-matrix.xls
- IG-DEP kick-off documents
  - IEEE802.15-12-0370-00-wng0 in July 2012
  - IEEE802.15-13-0192-01-wng0 in March 2013
- IG-DEP agenda documents
  - Closing Minutes IEEE802.15-13-0454-00-0dep in July 2013
  - Dependable Tech. IEEE802.15-13-0440-00-0dep in July 2013
  - Use case IEEE802.15-13-0416-00-0dep in July 2013



# Discussion

Scope of project:

- Address PHY and MAC layer functionality
- Possibility to create management plane on the side of PHY and MAC layers
- Enabling adaptive behavior in 802.15 PHY and MAC layers
- Enable hub to hub communications
- PHY layer additions?
- ETSI SmartBan status