



# Overview of 802.15 Projects

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# Disclaimer...

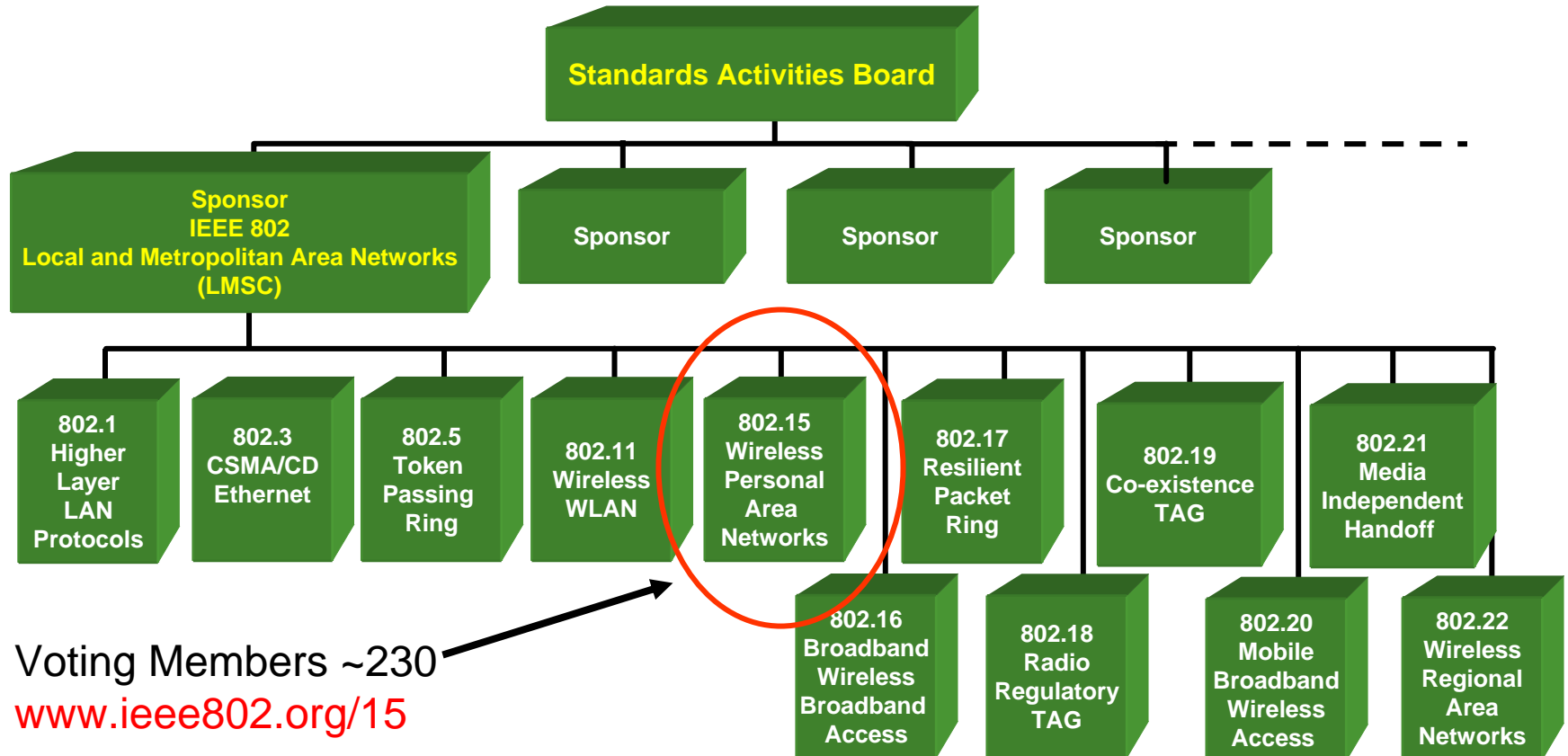
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IEEE-SA Standards Board Operation Manual (subclause 5.9.3)



# IEEE 802 Organization

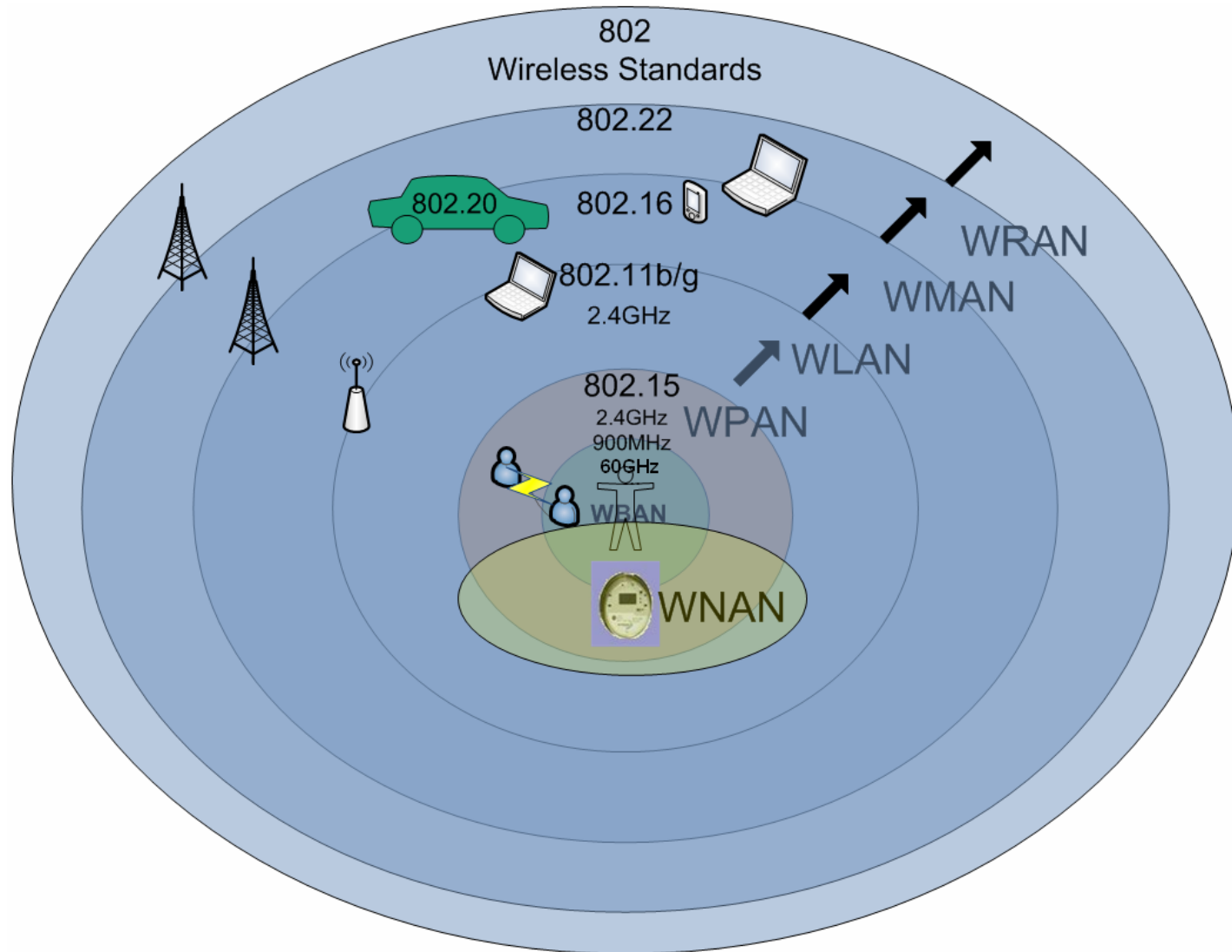
## IEEE Standards Association



Voting Members ~230

[www.ieee802.org/15](http://www.ieee802.org/15)

# 802 Wireless Ecosystem



# 802.15 Historical Retrospective



- In 1997, Fedex and several other companies were looking to have standards for interconnecting devices typically worn
- In March 1998, an 802.11 Study Group was formed to address the issue
- In March 1999, 802.15 was created to develop standards for Wireless Personal Area Networks

# 802.15 Scope and Purpose

- Initial activities focused on wearable devices hence “personal area networks”
- Activities have proven to be much more diverse and varied
  - Data rates from 2kbps to 2gbs
  - Ranges from meters to kilometers
  - Frequencies from 400MHz to 800THz
  - Predominantly non TCP/IP applications
- Focus is on “specialty”, typically short range, communications. If it is wireless and not a LAN, MAN, RAN, or WAN, odds are its 802.15
- Only 802 Working Group with multiple MACs



# 802.15 Completed Projects

- 802.15.1-Bluetooth
- 802.15.2-Coexistence Recommended Practice
- 802.15.3-High Rate (55 Mbps) Multimedia WPAN
- 802.15.3c-High Rate (>1Gbps) mmWave 15.3 PHY
- 802.15.4-Low Rate (250kbps) WPAN
- 802.15.4a-Higher data rate 15.4 PHY
- 802.15.4c-Sub 1 GHz 15.4 PHY for China
- 802.15.4d-Sub 1 GHz 15.4 PHY for Japan
- 802.15.5-Mesh Networking Recommended Practice



# 802.15 Active Projects

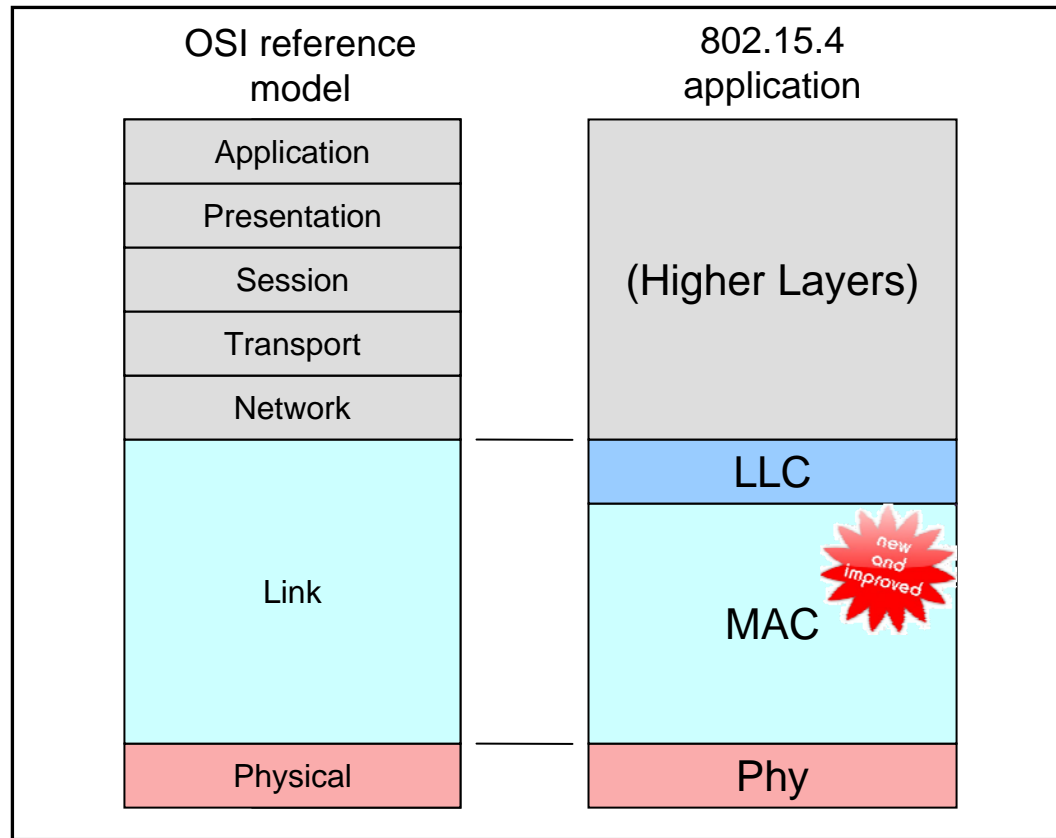
- 802.15.4e- 15.4 MAC Enhancements
- 802.15.4f- 15.4 PHY for Active
- 802.15.4g- 15.4 PHY for Smart Utility Networks
- 802.15.6- Body Area Networking
- 802.15.7- Visible Light Communications





# 802.15.4e

## MAC enhancements



# 802.15.4e- MAC enhancements



- **Scope:** Amendment to the 802.15.4-2006 MAC adding:
  - TDMA: a) determinism, b) enhanced utilization of bandwidth
  - Channel Hopping: additional robustness in high interfering environments and enhanced coexistence with other wireless networks
  - GTS: a) Support for peer to peer, b) control over the length and number of slots
  - CSMA: improved throughput and reduced energy consumption
  - Security: support for options such as asymmetrical keys
  - Low latency: reduced end to end delivery



# 802.15.4e- MAC enhancements



- This proposed functionality facilitates:
  - Industrial applications (such as those addressed by HART 7 and the ISA100 standards)
  - Enhancements defined by the proposed Chinese WPAN standard.
  - MAC functionality needed for the applications served by
    - 802.15.4f PHY Amendment for Active RFID
    - 802.15.4g PHY Amendment for Smart Utility Networks



# 802.15.4e- MAC enhancements



## Timeline:

Technical resolutions complete	Nov 2009
Finalize Draft	Mar 2010
Work Group Letter Ballot	Apr 2010
Resolve comments & 1 <sup>st</sup> recirc	Jun 2010
Resolve comments & final recirc	Sep 2010
Start Sponsor Ballot	Nov 2010
Comment resolution & reballot	Jan 2010
Submit to IEEE RevCom	Mar 2011



# Active RFID 802.15.4f



## 802.15.4f Active RFID

- Scope: 15.4 PHY for Active RFID readers and tags having:
  - Very low energy consumption
  - Support for a variety of active RFID tag operations including simplex and duplex transmission (reader-to-tag and tag-to-readers), multicast (reader to a select group of tags), uni-cast as in reader to a single tag, tag-to-tag communication, and multi-hop.
  - Support for a large tag population (hundreds of thousands)
  - High reliability for applications such as active tag inventory counting or auditing.
  - World-wide usability, with or without licensing
  - High tolerance to interference from other devices operating within the same band
  - Proven coexistence with other 802 wireless standards operating in the same bands.



# IEEE 802.15.4f Proposed Draft Outline

- Includes four frequency bands for global use
  - Ultra-Wideband (UWB)
    - 7 GHz (US), 6 or 8 GHz (EU), 10 GHz (Korea/Japan)
  - 2.4 GHz (up to 27 narrowband 750 KHz channels)
  - 433 MHz (single channel centered at 433.92 MHz)
  - 125 KHz (Magnetic) – pending verification that the 802.15.4 MAC will support this PHY.
- Requires the addition of a one-way 'BLINK' frame to the MAC

## 802.15.4f- Active RFID



### Timeline:

Technical resolutions complete	May 2010
Finalize Draft	July 2010
Work Group Letter Ballot	Aug 2010
Resolve comments & 1 <sup>st</sup> recirc	Nov 2010
Resolve comments & final recirc	Jan 2010
Start Sponsor Ballot	Feb 2010
Comment resolution & reballot complete	July 2010
Submit to IEEE RevCom	Sep 2011



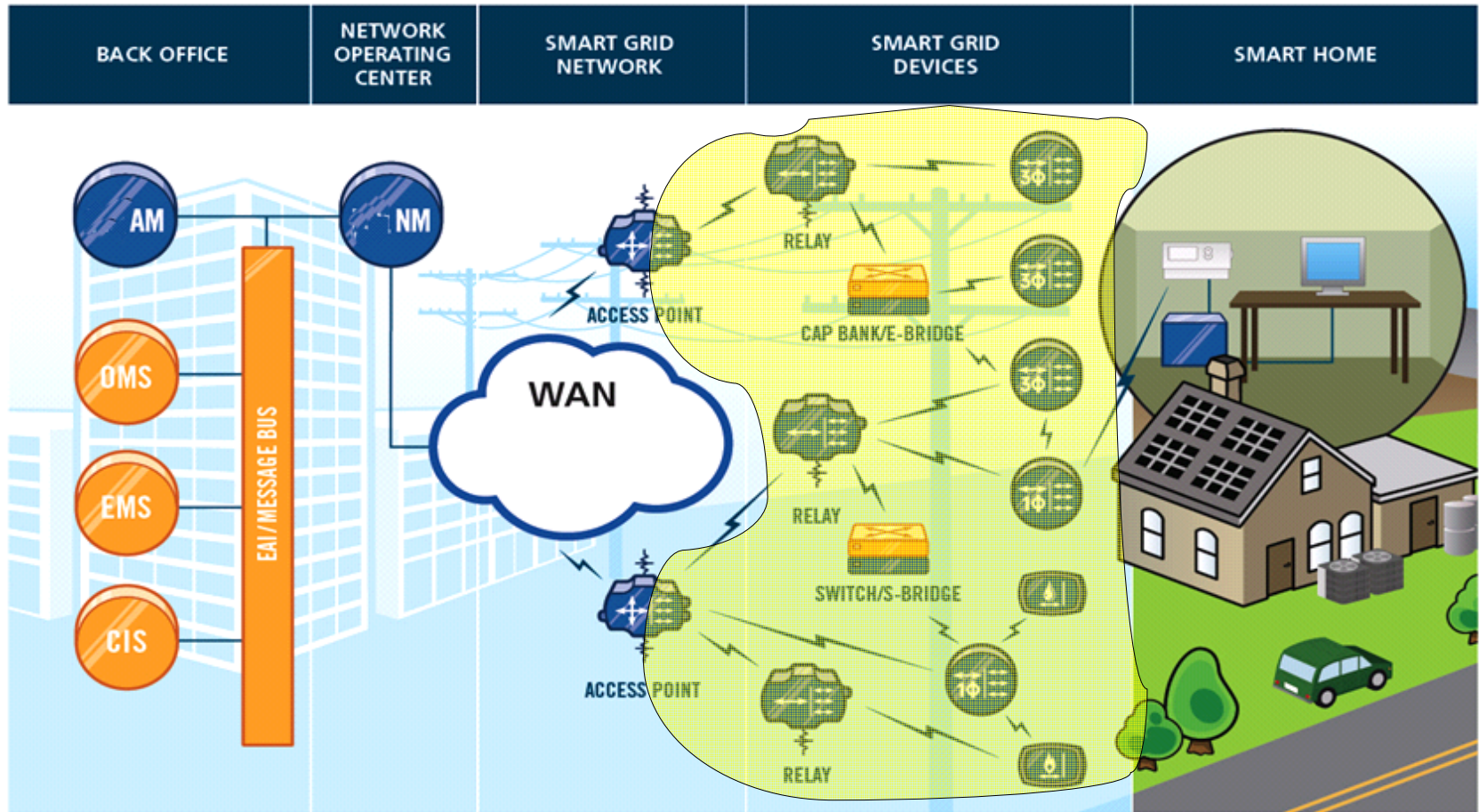
# Smart Utility Networks

## 802.15.4g



# 802.15.4g-Smart Utility Networks

## Where does it fit?



# 802.15.4g-Project Scope

- IEEE 802.15.4 PHY amendment for Wireless Smart Metering Networks supporting:
  - Operation in any of the regionally available license exempt frequency bands, such as 700MHz to 1GHz, and the 2.4 GHz band.
  - Data rates of at least 40 kbps but not more than 1000 kbps
  - Principally outdoor communications
  - Optimal energy efficient link margins given typical environmental conditions encountered in Smart Metering deployments.
  - PHY frame sizes up to a minimum of 1500 octets
  - Simultaneous operation for at least 3 co-located orthogonal networks
  - Connectivity to at least one thousand direct neighbors characteristic of dense urban deployment
  - Coexistence with other 802 systems in the same band(s)
  - Mesh Networking



## 802.15.4g-Current Status and Activities May 2010

- Addresses North America, Europe, Japan, Korea and Chinese Regulatory domains
- Draft in Working Group Letter Ballot
- Providing input to NIST Priority Action Plan #2

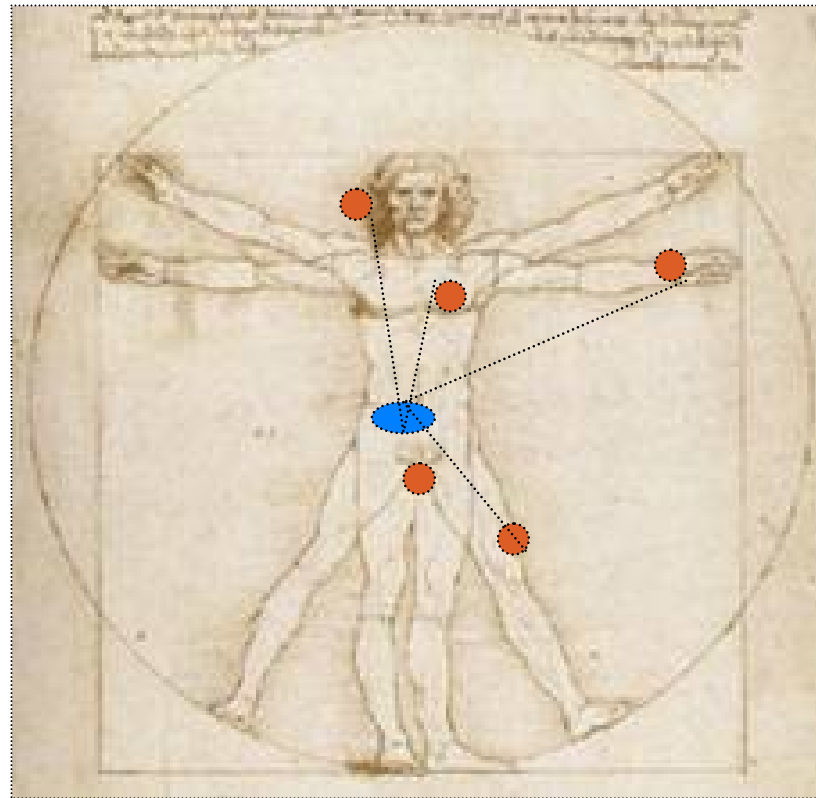


# 802.15.4g-SUN Schedule

Meeting Date	Milestones / Objectives
Nov-09	Agree on content for Baseline Draft
Jan-10	Finish draft for Working Group Letter Ballot
Mar-10	Comment resolution, 1 <sup>st</sup> recirc
May-10	Comment resolution, 2 <sup>nd</sup> recirc
Jul-10	Comment resolution, prepare for sponsor ballot
Sep-10	Comment resolution, 1 <sup>st</sup> recirc
Oct-10	Complete comment resolution, 2 <sup>nd</sup> recirc
Dec-10	Submit to RevCom

# Body Area Networks (BAN)

## 802.15.6 Overview



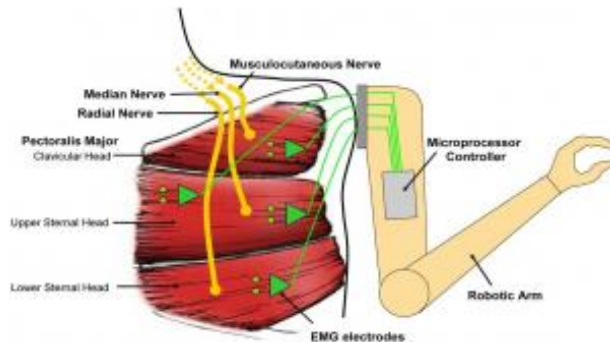
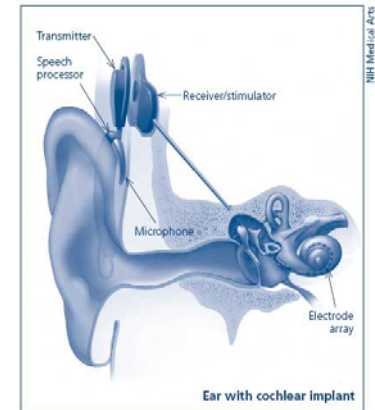
# 802.15.6 Body Area Networks

- Scope: Standard for short range, wireless communication in the vicinity of, or inside, a human body (but not limited to humans)
  - Uses existing ISM bands and/or bands approved by national medical and/or regulatory authorities
  - Supports QoS, extremely low power, & data rates up to 10 Mbps
  - Complies with strict non-interference guidelines where needed
  - Considers effects on portable antennas due to the presence of a person (varying with male, female, skinny, heavy, etc.)
  - Meets Specific Absorbed Radiation Limits
  - Accommodates user motions



# 802.15.6 BAN Applications

- Physiological and vital signals monitoring
- Neuro-stimulator
- Remote control of medical devices
- Disability assistance
- Elderly People Assistance
- Fitness Monitoring
- Wearable Audio - Video





# 802.15.6 Channel Model Challenges

- The channel model will include body effects.
  - Specific Absorption Rate (SAR), health effects
  - Body shadowing causes severe attenuation at some frequencies
  - User motion causes large variations in channel
  
- New channel models are needed
  - Access point to surface of body
  - Surface of body to surface of body
  - Surface of body to inside body
  - Inside body to inside body

Swallowable camera



Implanted  
glucose sensor



Implanted  
Insulin pump

# 802.15.6 Potential Frequency Bands

- **Medical Implant Communications System (MICS)** band 402-405 MHz, USA, EU, Korea, Japan (FCC 47 CFR 95.601-95.673 Subpart E)
  - 10 channels of 300kHz
  - Adaptive frequency agility
  - 25uW EIRP
- **Med Radio** FCC proposed band 401 - 402 MHz and 405 - 406 MHz
- **Wireless Medical Telemetry Service (WMTS)** Band  
608 – 614 MHz (TV ch 37), 1395 – 1400 MHz, 1427 – 1432 MHz
- **Industrial, Scientific & Medical (ISM)** Band  
868/915MHz, 2.4GHz, 5.8GHz
- **UWB** Band
- **RFID** links: 135kHz, 6.78MHz, 13.56MHz (ERC Rec 70-03)
- **Inductive** Link band 9kHz - 315kHz (ECC Report 12)
- **Capacitive** carrier less baseband transmission



# 802.15.6 BAN Timeline 2010

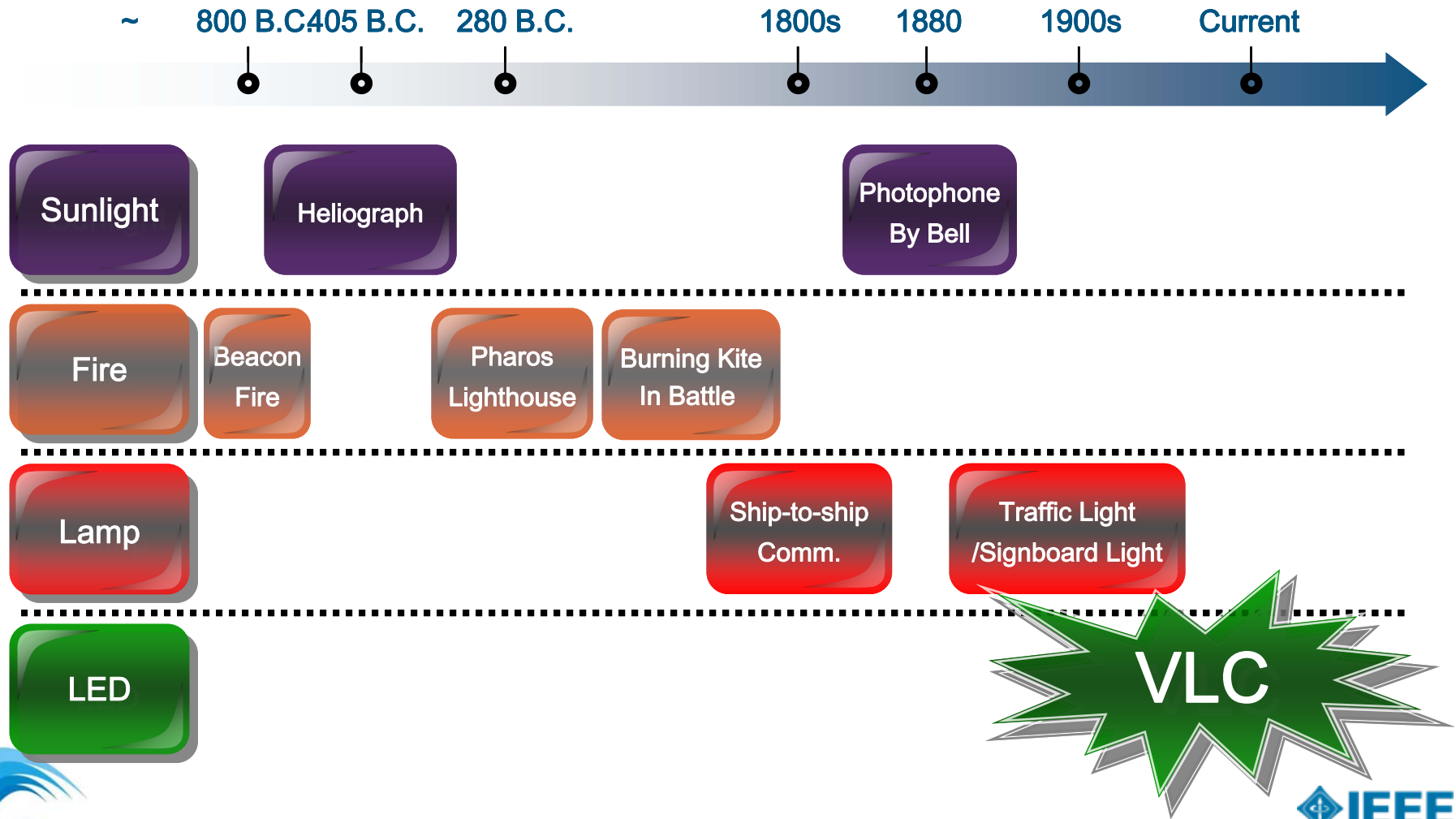
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Merge Proposals	>	>	>	>	>											
Agree on content for Baseline					>											
Draft Work				>	>	>										
Draft Completion							>	>	>							
Draft Ready for 1st letter ballot									>							
1st letter ballot complete										>	>					
Resolution of comments											>	>	>			
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# Visible Light Communications (VLC)

## 802.15.7

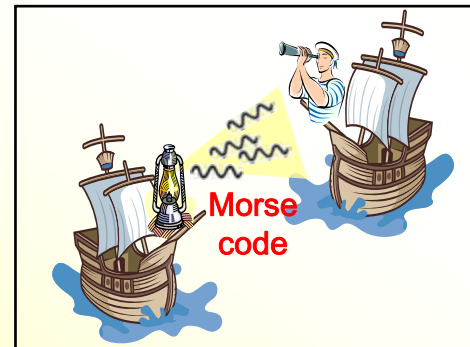


# VLC history



# VLC history – Low speed

- ❖ Information delivery through reflection by mirror (Heliograph)
- ❖ The use of fire or lamp
  - Beacon fire, lighthouse, ship-to-ship comm. by Morse code
- ❖ Traffic light : signal discrimination by color (Walk/Stop)



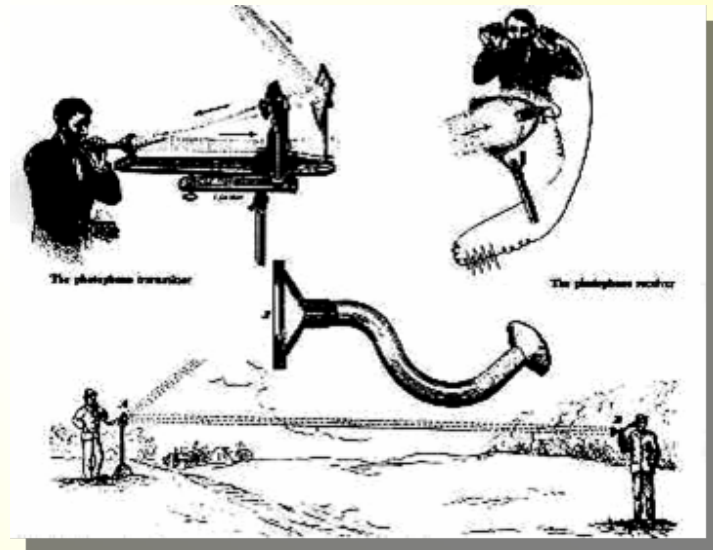
# VLC history - Photophone

## ❖ Bell's Photophone (1880)

- Optical source : sunlight
- Externally modulation by vibrating mirror
- Receiver : parabolic mirror with crystalline selenium cells
- 700 ft (213m) sound transmission



<http://www.freespaceoptic.com/>



Excerpted from: The New Idea Self-Instructor edited by Ferdinand Ellsworth Cary, A. M. (Monarch Book Company, Chicago & Philadelphia, 1904)



# 802.15.7 Visible Light Communications

- **Scope: defines a PHY and MAC for short-range optical wireless communications using visible light in optically transparent media**
  - Spectrum extends from 780 to 380 nm in wavelength (~400-800 THz)
  - Data rates supporting audio and video multimedia services
  - Adherence to any applicable eye safety regulations.
  - Fixed and mobile visible links
  - Resistance to noise and interference from sources like ambient light





# 802.15.7 Visible Light Communications

## ■ Purpose: Provides means to

- Access to several hundred THz of unlicensed spectrum
- Avoid electromagnetic and RF interference
- Provide additional security by allowing the user to see the communication channel
- Augment and complement existing services (such as illumination, display, indication, decoration, etc.) from visible-light infrastructures.



# 802.15.7 Visible Light Communications

- **Need: Visible light is drawing great interest as a new (rediscovered?) communication medium**

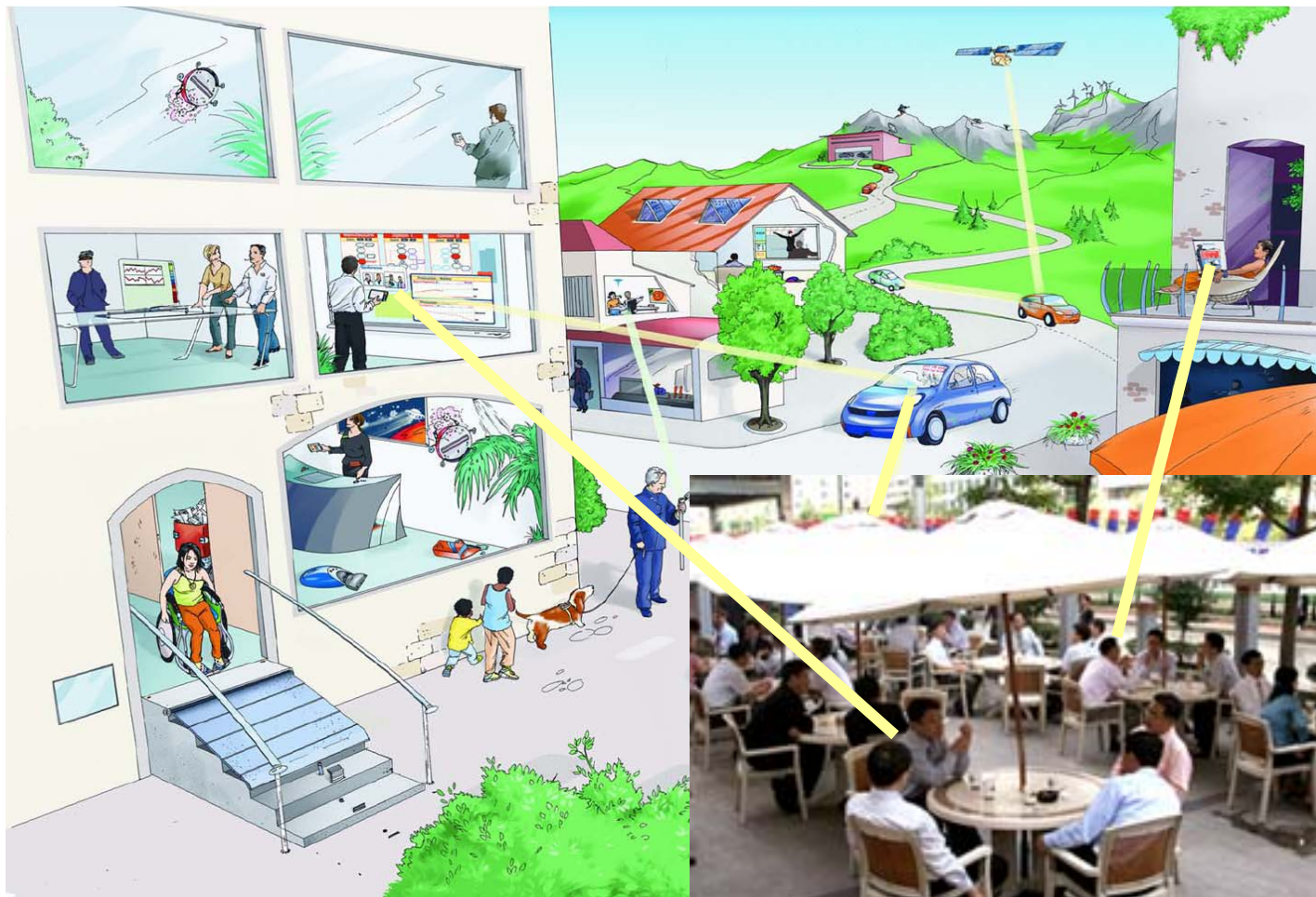


- LED sources are rapidly replacing conventional ones
- Visible band is free from Radio Frequency (RF) regulations and interference
- Well suited for use in RF crowded or RF restricted environments.
- Enhanced physical-layer security and intuitive usage

# 802.15.7-VLC Application Scenarios



# ❖ 802.15.7 -VLC, Ubiquitous Connectivity



# 802.15.7 Visible Light Communications



- Timeline:
  - Draft in Letter Ballot
  - Targeting end of 2010 for completion

# 802.15 Potential Future Projects

- ❑ Personal Space Communications
- ❑ Low Energy Critical Infrastructure Monitoring
- ❑ Terra-Hertz networks
- ❑ Support for Specialty Bands
- ❑ 802.15.7- Visible Light Communications amendments





## Questions?

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