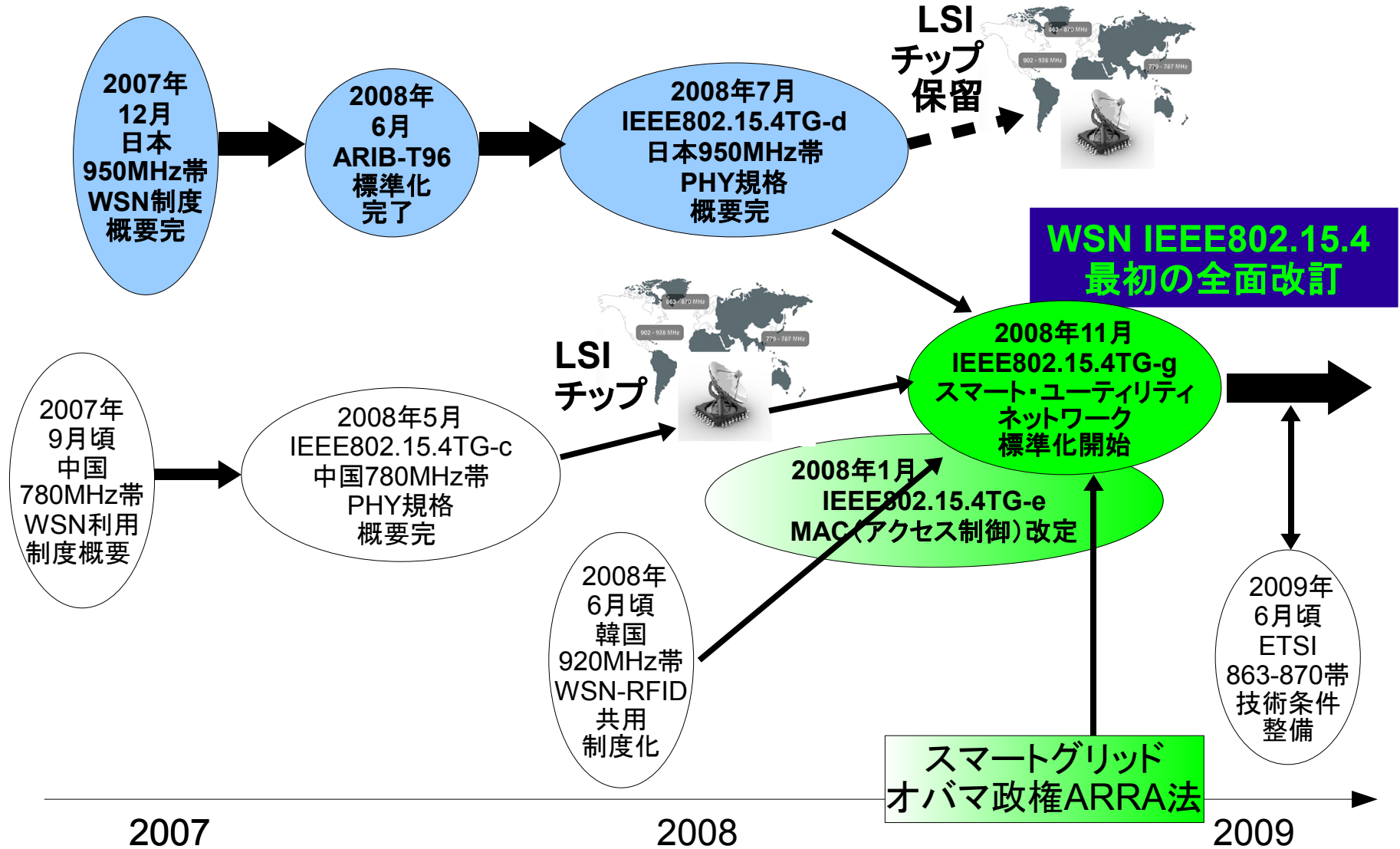


# 950MHz帯 WSN : 現況と課題

(WSN: ワイヤレスセンサーネットワーク)

横河電機 島田 修作

# UHF (950MHz) 帯-国際標準化の状況



# UHF帯 WSN 応用マーケットの活況予想

- UHF帯を含む WSN 世界市場状況

: **CAGR 10%** 超

⇒ 産業分野(工場管理・制御、エネルギー効率)

: **CAGR 30%** 超(世界)?

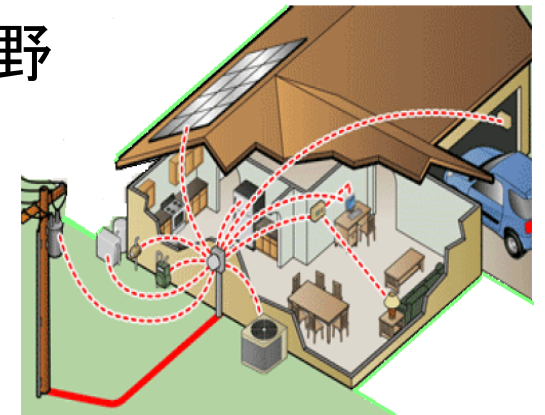
→ 石油・化学他の素材プラントの効率化分野

: **CAGR 80%**(世界)?

⇒ インフラ分野

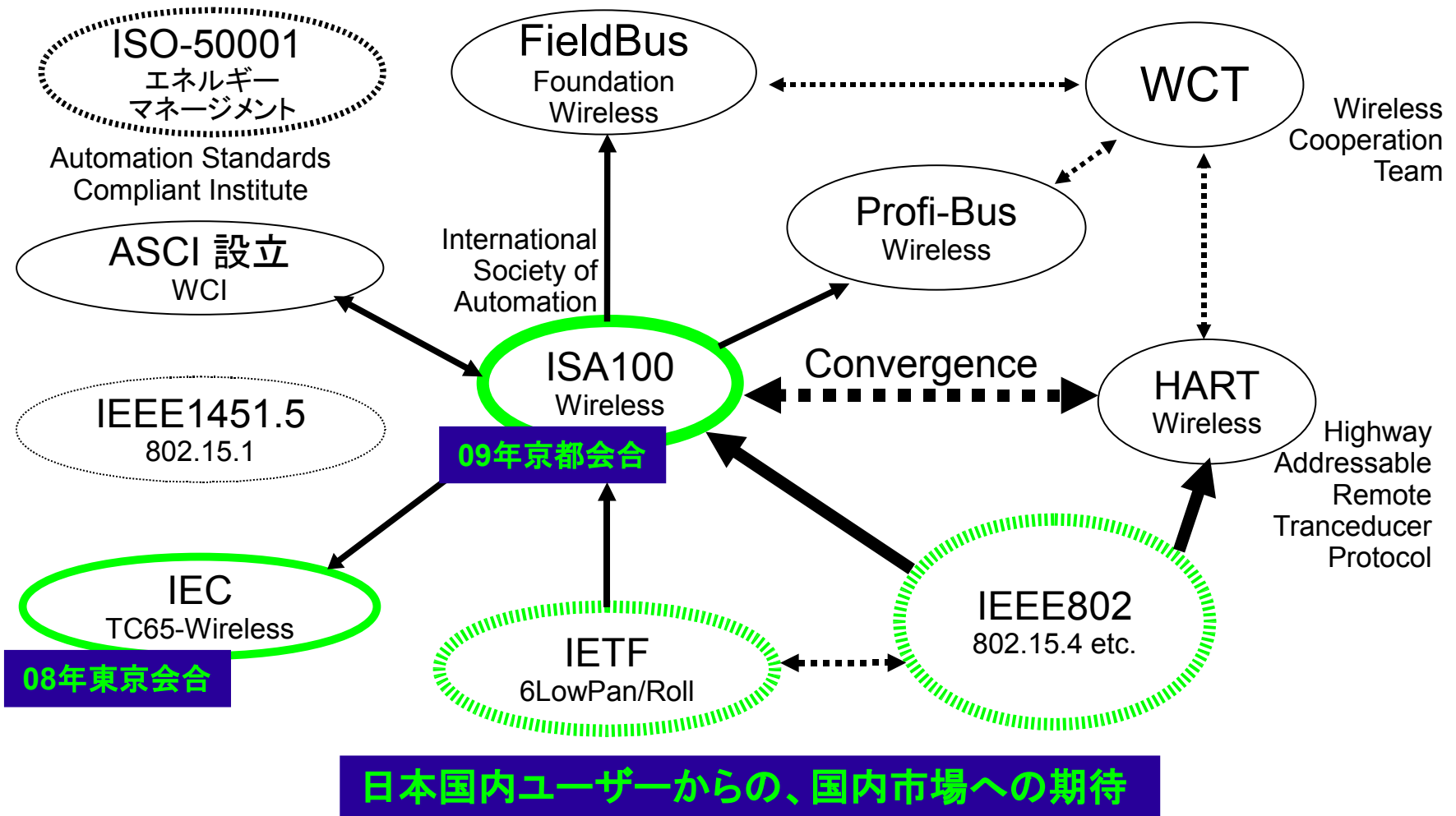
(ユーティリティ(電気)、ファシリティ(ビル))

: メータ読取、普及1%から**本格普及**へ(スマートグリッド)



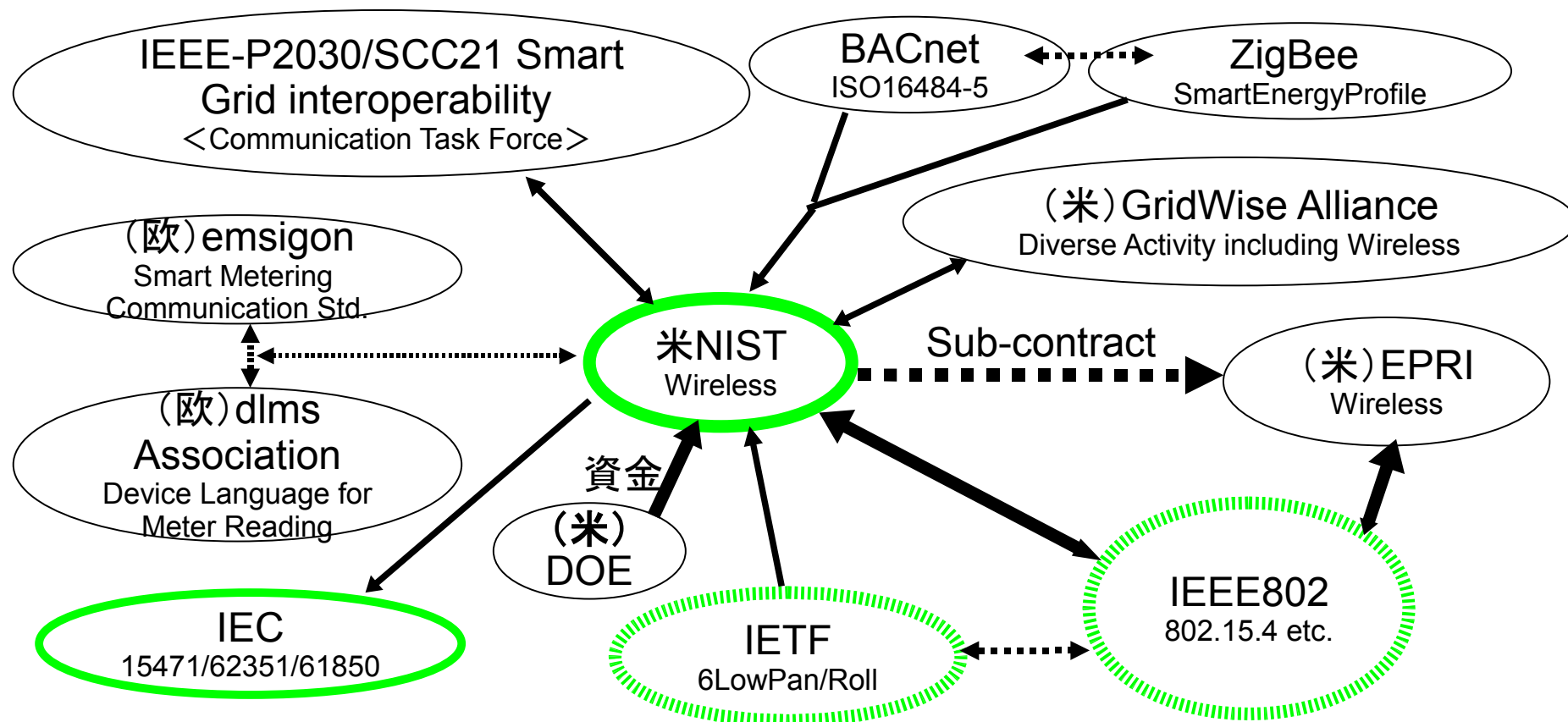
# WSN ユーザー応用システム標準

## < 産業用ワイアレス分野の活発な活動状況 >



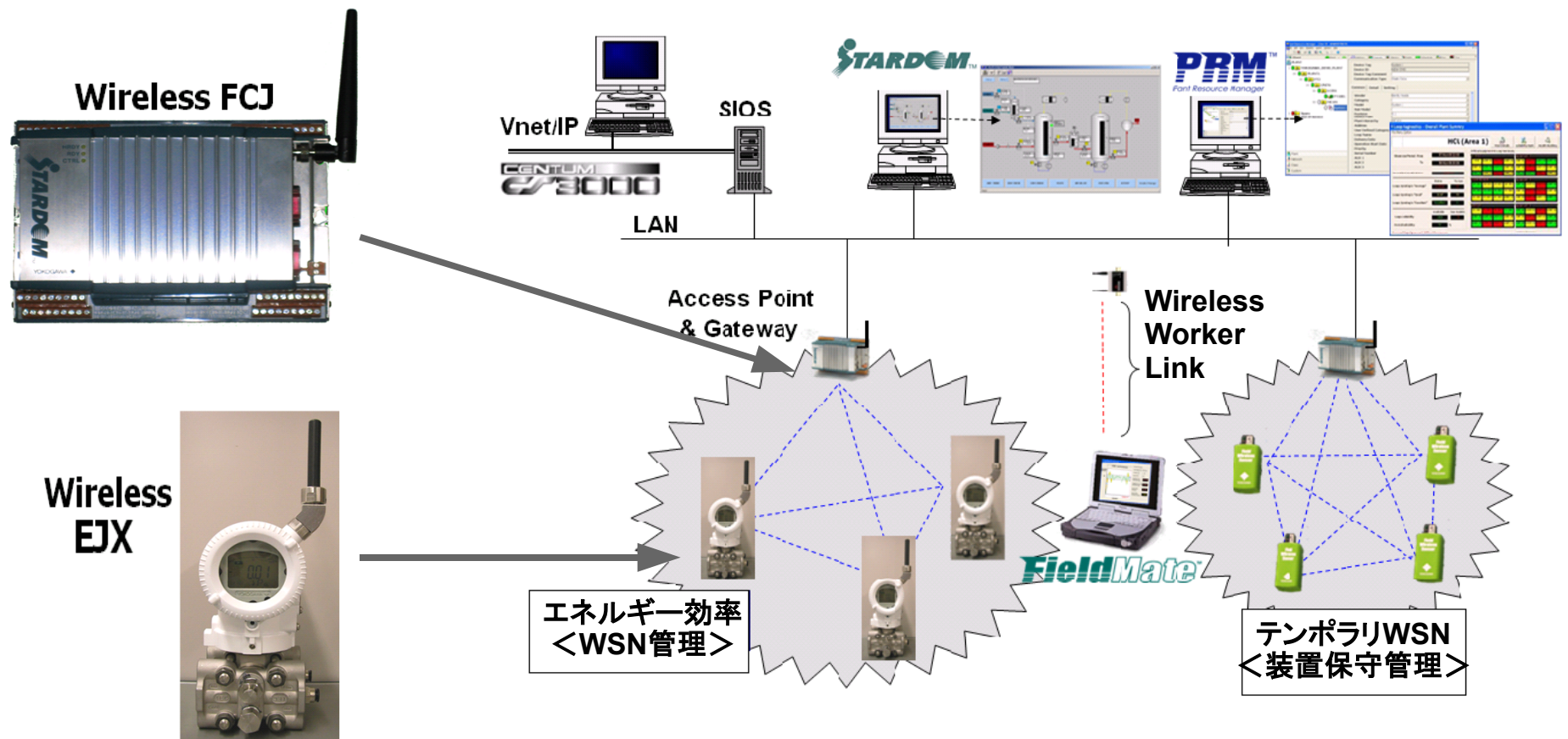
# WSN ユーザー応用システム標準

## < スマート・グリッドの ICT 関連組織の活発化状況 >



# 製品とアプリケーションの例

<ドラフト国際標準 (ISA100.11a) 対応の限定ユーザー向け製品>



# WSN の市場要求

## 屋外・簡単・便利

- ・ 950MHz帯：伝搬特性(周波数再利用)と浸透性
- ・ 適切なカバレッジ範囲(到達距離)
  - 許容送信電力：状況に合わせた eirp 選択範囲
- ・ 免許不要、ライト・ライセンス、専門家実装

## 高信頼性

- ・ 2.4GHz帯の情報家電と分離
- ・ ダイバーシティ
  - 空間・経路、周波数、時間
- ・ タイムリーでセキュアな情報伝送
  - 制御、アラーム
- ・ 単一故障の波及回避
  - 冗長性(メッシュ)

## 電池動作

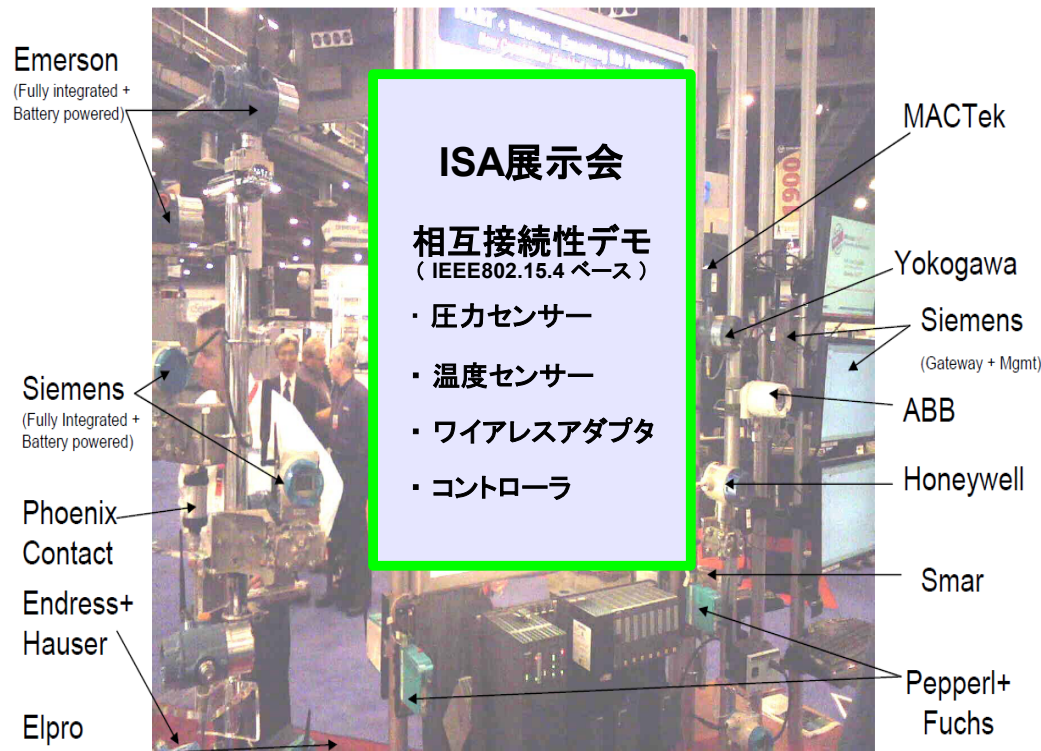
- ・ 低設置コスト・設置困難場所
- ・ 電池長寿命
  - 低電力-高集積 LSI 化
  - 高効率アクセス制御
  - 省電力プロトコル
- ・ 長メンテナンス周期
  - 5年～フリー：電力ハーベスト

エネルギー効率 / 低カーボンインフラ



# WSN 相互接続性 と 地域対応

< 相互接続性デモが継続的に実施される状況 >



- 過去 : 2.4GHz ISM帯 (写真)
- 予定 : UHF帯 (米国 915MHz帯)
- 計画 : 欧州863-870MHz帯
- 今後 : 中国780MHz帯 (積極的)
- 将来 : ユニバーサル化が目前
  - 異なる周波数
  - 共通的な信号
  - 同一プロトコル
  - 類型的な技術条件

• 日本 : 世界をリードする必要

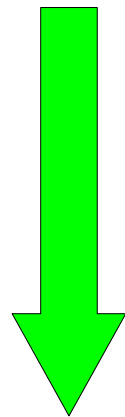


# UHF帯制度 WSN の国際比較

Regulatory Domain	US	Europe	Japan	China	Korea
Frequency Band	902 – 928MHz	863 – 870MHz (*)	<u>951 – 956MHz(*)</u>	779 -787MHz (*)	917 - 923.5MHz(*) Priority 920.6 – 923.5 MHz
IEEE802.15.4 Channel Plan	2MHz Spacing 10Ch	600kHz (868-868.6MHz) only	400/600kHz Spacing 12/8ch	2MHz Spacing 4 Ch	----
Available Channel	250kHz>w/t FH50>25kHz w/o FH> 500kHz	w/t FH 100kHz w/o FH 600kHz-3MHz	200-400- <u>600kHz</u> (w/o FH)	No restriction (8MHz)	w/t FH 200kHz W/o FH 2MHz
( Reference )	FCC15.247/249	ERC 70-03/ETSI EN300-220	ARIB T96	Doc. # 6326360786867187500	Korean Regulations 2008-137
Max TX Power	250mW/1W (4Weirp)	25mW	<u>1mW / 10mW (limited Ch)</u> (*)	10mW	10mW/3mW or less
Channel Mask Requirement	Out of Ch : -20dB/100kHz	Ch-edge : -30dBm/1kHz Edge + 200kHz : -36dBm/1kHz Edge+400kHz : -36dBm/10kHz Edge+600kHz : -36dBm/100kHz	Ch-edge : -20dBc Adjnt: -26dBm/200kHz(1mW) Adjnt:-18dBm/200kHz(10mW) Out of Ch : -39dBm/100kHz	---	Spurious emission strength TX state : within -36dBm RX/standby state : within 54dBm (Reference bandwidth 100kHz)
Channel Access Requirement	Ch-BW<250kHz : 50 Hop Ch Ch-BW>250kHz : 25 Hop Ch Ch-BW>500kHz : 1 or more	Ch-BW>=100kHz : >47 Hop Ch (LBT or 0.1% LDC) Ch-BW>=600kHz w/t DM (1% LDC or LBT w/t AFA) Ch-BW>=3MHz w/t DM (0.1% LDC or LBT w/t AFA)	<u>LBT (10ms)</u> w/o LDC  LBT (128us) w/t 10%LDC (1mW only)  No LBT w/t 0.1%LDC or when ACK / Beacon (1mW only)  TX Pause control 100ms min.  TX Duration Control 100ms max. 1s max. (w/t 10ms LBT)	(No restriction)	Frequency hopping use at least 16 or more non-duplicated channels Maximum hopping time : 0.4 sec  Carrier sense time shall be 5ms or more at -65dBm or less Sending duration : 4sec or less Pause duration : 50ms or more  Duty cycle : below 2% in 20sec duration
Other Requirement		Frequency Error +- 20ppm (Ch. Space<25kHz ) +- 100ppm (All other)	Frequency Tolerance +- <u>20ppm</u>	Frequency Tolerance 75kHz	Frequency Tolerance +-40ppm
(*) Remarks		ETSI is figuring out measurement method wrt spectrum mask.	TX PSD is varied lowered as modulation bandwidth increases	Available band other than 780MHz is considered and planned	Assigned for RFID devices and Wireless Sensor Networks.

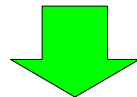
# UHF (950MHz) 帯制度改定への期待

- 国際的な利用制度との調和 (SRD: Short Range Device ≈ WSN)
- 特に欧州 SRD 制度 (863-870MHz) との共通性



- 送信電力(密度)
- 変調帯域幅
- アクセス制御
- バンド幅

- 世界共通利用 + 広いアプリケーション統合
- 日本を含む国際共用の低消費電力 LSI 化の好機



IEEE802.15.4g PAR : Outdoor, 700MHz-1GHz / 2.4GHz, Reliability

(Back Up 資料参照)

# Back Up

# IEEE802.15.4g PAR: スコープ

- This Standard defines an amendment to IEEE 802.15.4. It addresses principally **outdoor** Low Data Rate **Wireless Smart Metering Utility Network** requirements.
- It defines an alternate PHY and only those MAC modifications needed to support its implementation.
- Specifically, the amendment supports all of the following:
  - Operation in any of the regionally available license exempt frequency bands, **such as 700MHz to 1GHz**, and the 2.4 GHz band.
  - Data rate of **at least 40 kbps but not more than 1000 kbps**.
  - Achieve the optimal energy efficient link margin given the environmental conditions encountered in Smart Metering deployments.
  - **Principally outdoor communications**
  - **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.
- Provides mechanisms that enable coexistence with other systems in the same band(s) including IEEE 802.11, 802.15 and 802.16 systems.

# IEEE802.15.4g PAR: 目的とニーズ

- **Purpose:**

- To provide a global standard that facilitates **very large scale process control applications** such as the utility **smart-grid network**. This amendment supports large, geographically diverse networks with minimal infrastructure.
- Smart Metering Utility Networks can **potentially contain millions of fixed endpoints**.
- The **communication range, robustness, and coexistence characteristics** required for this class of application have not been met with existing 802 standards.

- **Need for the Project:**

- The need for a standard to promote orderly and quick evolution of smart-grid networks has been recognized in the recently passed energy legislation by the U.S. Congress (**EISA 2007**; Energy Independence & Security Act of 2007), which calls on National Institute of Standards and Technology (**NIST**) to work with standards bodies (such as IEEE) to develop protocols and standards for the smart-grid network. In the European Union, the need is no less urgent and similar standardization mandates, such as the **EU's 20/20/20 plan**, are in process worldwide.
- The responses received by and presented to the 15.4g Study Group indicate an already large and rapidly growing market for wireless Smart Metering applications that fit the objectives of 802.15, but are not satisfied by existing IEEE 802 standards.
- Utility networking and very large scale industrial applications have requirements to keep infrastructure to a minimum, scale to millions of nodes across diverse geographical environments, and **do so with carrier grade reliability**. To reach every node in the network a Wireless Smart Metering Utility Network needs the capability to **vary radio range while providing for high spectral reuse**.

End