

# David E. Boyle

B.Eng., PhD, MIEEE

## Employment:

Since 10/2012: **Research Fellow, Imperial College London**  
Dept. of Electrical and Electronic Engineering

Since 2014: **Consultant & Scientific Expert, Imperial Consultants**  
IC Consultants Ltd, 58 Prince's Gate, Exhibition Road, London SW7 2PG

10/2010 – 10/2012: **Postdoctoral Researcher, Tyndall National Institute, University College Cork**, Ireland  
Microelectronics Applications Integration & Wireless Sensor Networks Groups, Microsystems Centre;  
Embedded Systems Research Group, Dept. of Electrical and Electronic Engineering, University College Cork

11/2009 – 10/2010: **Postdoctoral Research Engineer, Orange Labs**, Grenoble/Meylan, France

08/2009 – 11/2009: **Visiting Postdoctoral Scholar, Universidad Politécnica de Madrid**, Madrid, Spain

## Academic Qualifications:

- 2009 PhD in Electronic and Computer Engineering, University of Limerick, Ireland
- 2005 B. Eng. (Hons) in Computer Engineering, University of Limerick, Ireland

## Evidence of Esteem:

- £2M (approx.) research and complementary funds raised
- Author of ~40 scientific publications, including world leading refereed international journals, conference proceedings, book, book chapters, and patent; more than half of which as Lead, Institutional Lead and/or Senior Author
- Organizing Committee member 11<sup>th</sup>/12<sup>th</sup> ACM Conferences on Embedded Networked Sensor Systems (ACM SenSys)
  - Workshop Chair (2014) & Web Chair (2013)
- Member of over 50 Technical Programme Committees spanning more than 22 international technical conferences, including numerous Chair positions
- Peer reviewer for 17 scientific journals, including numerous leading IEEE and ACM transactions
- Invited international talks and seminars, notably:
  - Speaker & panellist at IEEE International Conference on Sensing, Communication and Networking (SECON 2016)
  - Core lecturer at the Cyber-Physical Systems Summer School at KTH, Stockholm (2015)
  - International domain expert in Wireless Sensor Networks, Technical University of Madrid, Spain; delivered seminar as a 3-day short-course to the Masters in Industrial Electronics course (2013)
- Editorial Board Member of International Journal on Advances in Telecommunications (2009-2013) and International Journal on Advances in Networks and Services (2009-2013)

## Funding & Awards:

	Year:	Value <sup>1</sup> :
• <b>Principal Investigator:</b> <i>Sky Swarm</i> . UK Missile Defence Centre	2017	£49,250
• <b>Principal Investigator:</b> <i>Intelligent Integrated critical Infrastructures for smarter future Cities – I3C</i> . EC European Institute of Innovation & Technology	2015	£536,000
• <b>Recognised Investigator:</b> <i>Autonomic Home Area Network Infrastructure – AUTHENTIC</i> . Enterprise Ireland and IDA Ireland. (PI: Professor O'Hare, University College Dublin; Co-I: Professor O'Mathuna, Tyndall National Institute, UCC)	2014	£497,000
• <b>Co-Investigator:</b> University College Cork Strategic Research Fund (PI: Dr Popovici)	2012	£870,000
• <b>Recognised Investigator:</b> Science Foundation Ireland (SFI) Women in Engineering Grant (PI: Dr Popovici)	2011	£8,300
• <b>Supervising Investigator:</b> SFI Eureka Scholar	2011	£4,150

### Donations & Other Awards:

• Urban Prototyping London Festival (RCUK DE Sustainable Society Network+, RCUK DE NEMODE Network+) – 50 node WSN test bed	2013	£5,000
• Enterprise Ireland FP7 Travel Grants	2011	£4,000
• Sun Microsystems – Sun SPOT Development Kit	2008	£1,250
<b>Total</b>		<b>£1,979,100</b>

<sup>1</sup> Values are approximate & rounded after currency conversion

**Professional Memberships & Community Activities:**

- Member, IEEE (since 2007), IEEE Computer Society (since 2008), IEEE Communications Society (since 2016)
- Member, London Node EIT ICT Labs/Digital – Strategy Committee (2013-2016)
- Member, British Standards Institute ‘Smart Urban Infrastructure Metrics’ Committee (since 2013)
- Member, Cyber-Physical Systems Engineering Network of Excellence Steering Group (since 2014; Chairs: Professor Sutton, Imperial College London & Professor Isbell, University of Warwick)

**Invited Seminars/Talks:**

- **Boyle, D.** (2017) ‘A new generation of sensing systems at the intersection of unmanned aerial vehicles and sensor networks’, 1st International Winter School on Energy Efficient Sensor Interfaces and Networked Sensors, University of Zagreb, Croatia. 11 December 2017.
- **Boyle, D.** (2016) ‘Early lessons from taking an entrepreneurial approach to bringing the Internet to important things’, IEEE International Conference on Sensing, Communication and Networking (SECON) Panel on ‘Emerging Technologies and Business Innovations in Digital Cities of the Future’. London, UK. 28 June 2016.
- **Boyle, D.** (2015) ‘Control under constraints: tackling emerging challenges in pervasive computing systems’, Sixth Annual Digital Economy Meeting – DE2015, The IET, London, UK. 10 December 2015.
- **Boyle, D.** (2015) ‘Cyber-physical Systems: CPS in the City?’ Cyber-Physical Systems Summer School – Core Lecture. KTH Royal Institute of Technology, Stockholm, Sweden. 3 July 2015.
- **Boyle, D.** (2013) ‘Convergence and Next Generation Analytics: Sensing in the City’. 1<sup>st</sup> Centre of Research Excellence for Advanced Cooperative Systems (ACROSS) Workshop on Cooperative Networked Embedded Systems. University of Zagreb, Croatia, 20 November 2013.
- **Boyle, D.** (2013) ‘Ad hoc electronics for industrial applications of wireless sensing systems’, *Specialized Seminars: Wireless Sensor Networks*. Technical University of Madrid, Spain (UPM-CEI). 11-12 April 2013.
- **Boyle, D.** (2012) ‘Novel Hardware for Longevous Wireless Structural Health Monitoring’, *Second GENESI Workshop*. Catania, Sicily. 12 June 2012.
- **Boyle, D.** (2012) ‘Practical considerations for the implementation of coding and cryptography in current generation networked embedded systems: An applied perspective’, *Claude Shannon Institute Workshop on Coding and Cryptography* – University College Cork, Ireland. 22 May 2012.
- **Boyle, D.** (2012) ‘Green sSensor NETworks for Structural monitoring (GENESI)’, *Challenge Your Imagination Workshop* – University College Cork, Ireland. 24 February 2012.
- **Boyle, D.** (2011) ‘Towards Sustainable and Persistent Wireless Sensor Network Enabled Structural Health Monitoring’ *EU FP7 CONET Summer School (Participants Workshop)*. Bertinoro, Italy. 27 July 2011.
- **Boyle, D.** (2011) ‘Wireless Sensor Networking Solutions for Structural Health Monitoring? The GENESI Node v1.0’ *First GENESI Workshop*. Amsterdam, Netherlands. 11 March 2011.

**Collaborative Research Project Participation:**

- UK MDC Sky Swarm (2017-2018)
- EPSRC Managing Air for Green Inner Cities (MAGIC; 2016-)
- EC EIT ‘Intelligent Integrated critical Infrastructures for smarter future Cities’ (I3C; 2014-2015)
- RCUK/EPSRC Digital City Exchange (DCE; 2011-2016)
- EC FP7 Green sSensor NETworks for Structural monitoring (GENESI; 2010-2013)
- French Ministry for Higher Education and Research: Sencity (2010-2012)

**Periodical Peer-Reviewer:**

- IEEE Transactions on Industrial Informatics
- ACM Transactions on Sensor Networks
- IEEE Transactions on Mobile Computing
- IEEE Transactions on Power Electronics
- IEEE Transactions on Human-Machine Systems
- IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems
- IEEE Internet of Things Journal
- IET Circuits, Devices & Systems
- IEEE Sensors Journal
- IEEE Communications Magazine
- The Computer Journal (Oxford Press)
- Sensors and Actuators A: Physical (Elsevier)
- IEEE Transactions on Vehicular Technology
- IEEE Wireless Communications Magazine
- Sensors (MDPI), among others

### Technical Programme Committees Memberships:

- Design, Automation and Test in Europe (DATE) 2014, 2015 (Track Co-Chair), 2016 (Track Chair), 2017 (Track Chair), 2018
- IEEE Conference on Local Computer Networks (LCN) 2015, 2016, 2017
- IEEE International Conference on Communications (ICC) 2015, 2016, 2017, 2018
- IEEE Consumer Communications & Networking Conference (CCNC) 2017
- IEEE Global Communications Conference (GLOBECOM) 2016, 2017
- IEEE International Conference on Sensing, Communication and Networking (SECON) 2016, 2017
- EAI International Conference on Sensor Systems and Software (s-cube) 2015 (TPC Chair), 2016, 2017
- IEEE Conference on Energy Conversion (CENCON) 2015
- International Conference on Mobile Systems and Pervasive Computing (MobiSPC) 2015, 2016
- International Conference on Future Network Systems and Security (FNSS) 2015, 2016
- IEEE International Conference on Selected Topics in Mobile and Wireless Networking (MoWNet) 2014, 2016, 2017, 2018
- IEEE Sensors 2013-2017
- International Conference on Sensor Technologies and Applications (SENSORCOMM) 2014-2016
- IEEE Innovative Smart Grid Technologies Conference-Asia (ISGT-ASIA) 2014
- IEEE 8<sup>th</sup> International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP) 2013
- IEEE Workshop on Global Trends in Smart Cities (IEEE GoSmart) 2012-2014
- IEEE Symposium on Industrial Electronics and Applications (ISIEA) 2012, 2014
- 1<sup>st</sup> International Workshop in Sustainable Monitoring through Cyber-physical Systems (SuMo-CPS 2013)
- 4<sup>th</sup> International Workshop on Performance Control in Wireless Sensor Networks (PWSN) 2012
- IEEE International Conference on Power and Energy (PECON) 2012, 2014
- IEEE Symposium on Wireless Technology and Applications (ISWTA) 2012
- International Conference on Wireless and Mobile Communications (ICWMC) 2008-2017

### Recent Consultancy Services:

- GSMA (2017)
  - Co-led consulting project to develop insight for the GSMA with regard to utility and economic viability of Low Power Wide Area (LPWA) communications technologies (SigFox, LoRA, NB-IoT, LTE-M, etc.) for emerging sensing and control applications at the metropolitan scale
- Innovate UK Future Cities Catapult (2016)
  - Member of consulting team with Professor Knottenbelt (Dept. of Computing, Imperial College London)
  - Led the study concerning the application of optimisation techniques to the design, implementation and evaluation of Internet of Things technologies suitable for implementation in future cities
- Rio Tinto (2014)
  - Member of a consulting team with Professor Yeatman and Dr Kiziroglou (EEE Dept., Imperial College London)
  - Contributed to successfully delivering a study concerning opportunities for the mining industry to exploit sensors in 'Big Data' and data analytics applications
- Innovate UK Future Cities Catapult – Urban Systems Laboratory Imperial College London (2014)
  - Member of Project Reference Group
  - Contributed to report "Connecting Research with Cities – mapping the UKs research landscape on future cities and technologies", led by Professor Polak, Dept. of Civil and Environmental Engineering, Imperial College London

### Media and Outreach Activities:

- Imperial Fringe: Cities of the Future – 'An Urban Sensory Experience' (October 2015)
  - Themed open event engaging with and explaining my research to a general public audience, including live demonstrations
- IEEE Industrial Electronics Society Technology News (ITeN) feature on 'Extended Wireless Monitoring through Intelligent Hybrid Energy Supply' (December 2013)
- Urban Prototyping London Festival (February - April 2013):
  - Deployed wireless sensor network to produce real (curated, web-hosted) data in support of the 'Hackathon' event held during the festival
  - Organising committee volunteer and judging panel member
- Open Data and Smart Cities, 'teacamp' event on (February 7, 2013)
  - Panel member: open 'round-table' on data and cities (with GDS, Cabinet Office)
- Discovery Festival, Cork City Hall, Ireland (November 2010) – interactively demonstrated how networked sensors can be used to improve peoples' lives (audience: primary and secondary level students, and families)

**Publications:**Journal Articles:

- Kiziroglou M.E., **Boyle, D.E.**, Wright, S.W., Yeatman, E.M., 2017. Acoustic Power Delivery to Pipeline Monitoring Wireless Sensors. *Ultrasonics*. Volume 77, May 2017, pp.54-60.
- Kiziroglou, M.E., **Boyle, D.E.**, Yeatman, E.M., Cilliers, J.J., 2017. Opportunities for sensing systems in mining. *IEEE Transactions on Industrial Informatics; Special Section on Industrial Sensing Intelligence*. 13(1), pp.278-286. doi: 10.1109/TII.2016.2636131
- **Boyle, D.E.**, Kiziroglou, M.E., Mitcheson, P.D. and Yeatman, E.M., 2016. Energy Provision and Storage for Pervasive Computing. *IEEE Pervasive Computing; Special Issue on Energy Harvesting and Power Management*. 15(4), pp.28-35.
- Kolcun, R., **Boyle, D.E.**, McCann, J.A., 2016. Efficient Distributed Query Processing. *IEEE Transactions on Automation Science and Engineering; Special Section on Advances and Applications of Internet of Things for Smart Automated Systems*, 13(3) pp. 1230-1246.
- **Boyle, D.**, Kolcun, R., Yeatman, E.M., 2015. Devices in the Internet of Things. *The Journal of the Institute of Telecommunications Professionals*, 2015, 9(4), pp. 27-31.
- Magno, M., **Boyle, D.**, Brunelli, D., Popovici, E., Benini, L., 2014. Ensuring Survivability of Resource-Intensive Sensor Networks Through Ultra-Low Power Overlays. *IEEE Transactions on Industrial Informatics*, 10(2), pp.946-956.
- Magno, M., **Boyle, D.**, Brunelli, D., O'Flynn, B., Popovici, E., Benini, L., 2014. Extended Wireless Monitoring Through Intelligent Hybrid Energy Supply. *IEEE Transactions on Industrial Electronics*, 61(4), pp.1871-1881.
- **Boyle, D.E.**, Yates, D.C., Yeatman, E.M., 2013. Urban Sensor Data Streams: London 2013. *IEEE Internet Computing, Special Issue on Smart Cities*, 17(6), pp.12-20.
- **Boyle, D.E.**, Newe, T., 2009. On the implementation and evaluation of an elliptic curve based cryptosystem for Java enabled Wireless Sensor Networks. *SENSORS AND ACTUATORS A: Physical*, 156(2), pp.394-405.
- **Boyle, D.**, Newe, T., 2008. Securing Wireless Sensor Networks: Security Architectures. *Journal of Networks*, 3(1), pp.65-77.

Refereed International Conference Proceedings:

- Qin, Y., **Boyle, D.E.**, and Yeatman, E.M. 2018. Novel Protocol for Data Links between Wireless Sensors and UAV Based Sink Nodes. *Proc. WF-IoT 2018* [to appear]
- Mitcheson, P.D., **Boyle, D.E.**, Kkelis, G., Arteaga, J.M., Aldhaher, S., and Yeatman, E.M., 2017. Energy Autonomous Sensing Systems Using Drones. *Proc. IEEE Sensors 2017* [to appear]
- Kiziroglou, M.E., Cowell, M., Kumaravel, B.T., **Boyle, D.E.**, Evans, J.W., Wright, P.K. and Yeatman E.M. 2017. Speed vs Efficiency and Storage Type in Portable Energy Systems. *Proc. PowerMEMS 2017* [to appear]
- Mitcheson, P.D., Kkelis, G., Aldhaher, S., Arteaga, J.M., Yates, D.C., **Boyle, D.E.** and Yeatman, E.M., 2017. Power Electronics for Wireless Power Delivery in Synthetic Sensor Networks. *Proc. PowerMEMS 2017* [to appear]
- Magno, M., **Boyle, D.**, 2017. Wearable Energy Harvesting: From body to battery. In *2017 12th International Conference on Design & Technology of Integrated Systems in Nanoscale Era (DTIS)*, Palma de Mallorca, 2017, pp. 1-6.
- Kolcun, R., **Boyle, D.**, McCann, J.A., 2016. Efficient In-Network Processing for a Hardware-Heterogeneous IoT. In *Proceedings of the 6th International Conference on the Internet of Things* (pp. 93-101). ACM, New York, NY, USA. 7-9 Nov. 2016. Stuttgart, Germany.
- **Boyle, D.**, Kolcun, R., Yeatman, E., 2016. Towards Precision Control in Constrained Wireless Cyber-Physical Systems. In *Internet of Things. IoT Infrastructures: Second International Summit, IoT 360° 2015, Rome, Italy, October 27-29, 2015, Revised Selected Papers, Part II* (pp. 292-306). Springer International Publishing.

- Kiziroglou, M.E., **Boyle, D.E.**, Wright, S.W., Yeatman, E.M., 2015. Acoustic energy transfer in cast iron pipelines, in (*Micro and Nanotechnology for Power Generation and Energy Conversion Applications, 15<sup>th</sup> International Conference on – PowerMEMS 2015*) *Journal of Physics: Conference Series*, 2015, 660 (2015) 012095, pp.1-5. 1-4 Dec. 2015. Boston, MA, USA.
- Kolcun, R., **Boyle, D.**, McCann, J.A., 2015. Optimal processing node discovery algorithm for distributed computing in IoT. In *Internet of Things (IOT), 2015 5th International Conference on the* (pp. 72-79). IEEE. 26-28 Oct. 2015. Seoul, Korea.
- O'Flynn, B., Wörsching, H., **Boyle, D.**, 2014. Next generation Structural Health Monitoring using Wireless Sensor Network Technology. *Civil Engineering Research In Ireland (CERI 2014)*
- O'Connell, E., O'Flynn, B., **Boyle, D.**, 2014. Energy & reliability optimal MAC for WSNs. In *Design of Reliable Communication Networks (DRCN), 2014, 10th International Conference on the* (pp. 1-8). IEEE. Ghent, Belgium. April 1-3, 2014.
- O'Connell, E., O'Flynn, B., **Boyle, D.**, 2013. Clocks, latency and energy efficiency in duty cycled, multi-hop Wireless Sensor Networks. In *Advances in Sensors and Interfaces (IWASI), 2013 5th IEEE International Workshop on* (pp. 199-204). IEEE. 13-14 June. Bari, Italy.
- Barta, L., **Boyle, D.**, Brendan, O. and Popovici, E., 2013. Simplified Commissioning and Maintenance for Wireless Sensor Networks: a Novel Software Tool. In *Architecture of Computing Systems (ARCS), Proceedings of 2013 26th International Conference on* (pp. 1-6). VDE.
- **Boyle, D.**, Srbinovski, B., Popovici, E., O'Flynn, B., 2012. Energy analysis of industrial sensors in novel wireless SHM systems. In *Sensors, 2012 IEEE* (pp. 1-4). IEEE.
- Buckley, J., O'Flynn, B., Loizou, L., Haigh, P., **Boyle, D.**, Angove, P., Barton, J., Popovici, C.M.E., O'Connell, S., 2012. A novel and miniaturized 433/868MHz multi-band wireless sensor platform for body sensor network applications. In *2012 Ninth International Conference on Wearable and Implantable Body Sensor Networks* (pp. 63-66). IEEE. 9-12 May 2012, London, England.
- **Boyle, D.**, Magno, M., O'Flynn, B., Brunelli, D., Popovici, E. and Benini, L., 2011. Towards persistent structural health monitoring through sustainable wireless sensor networks. In *Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2011 Seventh International Conference on* (pp. 323-328). IEEE. 6-9 Dec. 2011. Adelaide, Australia.
- (33 Citations, Google Scholar) **[Best Paper Award]**
- Popovici, E., **Boyle, D.**, O'Connell, S., Faul, S., Angove, P., Buckley, J., O'Flynn, B., Barton, J., O'Mathúna, C., 2011. The s-Mote: A versatile heterogeneous multi-radio platform for wireless sensor networks applications. In *Circuit Theory and Design (ECCTD), 2011 20th European Conference on* (pp. 421-424). IEEE. 29-31 Aug. 2011, Linköping, Sweden.
- O'Flynn, B., **Boyle, D.**, Popovici, E.M., Magno, M., Petrioli, C., 2011. GENESI: Wireless sensor networks for structural monitoring. In *35th International Conference of IMAPS-CPMT IEEE Poland, Gdansk-Sobieszewo, Poland, 21-24 Sep, 2011.*
- **Boyle, D.**, Neue, T., 2008. The Impact of Java and Public Key Cryptography in Wireless Sensor Networking. In *Wireless and Mobile Communications, 2008. ICWMC'08. The Fourth International Conference on* (pp. 288-293). IEEE. 27 July – 1 Aug. 2008, Athens, Greece.
- **Boyle D.**, Neue T., 2008. Embracing a Common Research Platform for the Development of Security Services in Wireless Sensor Networking". *Proceedings of the 11<sup>th</sup> Mechatronics Biennial Conference (Mechatronics 2008)*, 23-25 June, 2008. Limerick, Ireland.
- **Boyle, D.**, Neue, T., 2007. The Magnitude of Communications Protocols in Wireless Sensor Networks. *WLANMesh – Towards an 802.11 standard for Mesh Networking*, 17-20 Apr. 2007, Paris, France.
- **Boyle, D.**, Neue, T., 2007. Security protocols for use with wireless sensor networks: A survey of security architectures. In *Wireless and Mobile Communications, 2007. ICWMC'07. Third International Conference on.* IEEE. 4-9 Mar. 2007. Guadeloupe, French Caribbean.
- **Boyle, D.**, Neue, T., 2007. A Survey of Authentication Mechanisms: Authentication for Ad-Hoc Wireless Sensor Networks. *2007 IEEE Sensors Applications Symposium.* IEEE. 6-8 Feb. 2007, San Diego, CA.

Patent

- **Boyle, D.**, Ramparany, R. 'Data Processing for Managing the Quality of Service in a Machine-to-Machine Network'
    - WO2012080414A2, 21 June 2012
    - Submitted for International Patent (PCT N° PCT/EP2011/072943) 15 December 2011
    - Submitted for European Patent (N° EP-10306454.9) 17 December 2010
- IP Owner: Orange / France Telecom (FT R&D) Patents*

Book

- Holler, J., Tsiatsis, V., Mulligan, C., Avesand, S., Karnouskos, S. and **Boyle, D.**, 2014. *From Machine-to-machine to the Internet of Things: Introduction to a New Age of Intelligence*. Academic Press. Elsevier. ISBN: 9780124076846

Book Chapters

- **Boyle, D.**, Kolcun, R., Yeatman, E.M., 2017. Energy-Efficient Communication in Wireless Networks. In: Fagas, G., Gammaitoni, L., Gallagher, J.P., Paul, D.J. eds. *ICT - Energy Concepts for Energy Efficiency and Sustainability*. InTech. ISBN: 978-953-51-4866-1 [Invited]
- Benazzouz, Y., **Boyle, D.**, 2014. Argumentation-based Conflict Resolution in Pervasive Services. In Lopes, F., Coelho, H. eds. *Negotiation and Argumentation in Multi-agent Systems*. Bentham Science Publishers. DOI: 10.2174/97816080582421140101
- Newe, T., Cionca, V., **Boyle, D.**, 2010. Security for wireless sensor networks—configuration aid. In *Advances in wireless sensors and sensor networks* (pp. 1-24). Springer Berlin Heidelberg. DOI: 10.1007/978-3-642-12707-6\_1

Posters:

- Kiziroglou, M.E., **Boyle, D.E.**, Wright, S.W., Yeatman, E.M. (2015) 'Acoustic energy transfer in cast iron pipelines', in *Micro and Nanotechnology for Power Generation and Energy Conversion Applications, 15<sup>th</sup> International Conference on (PowerMEMS 2015)*. 1-4 Dec. 2015. Boston, MA, USA
- Rosello, V., **Boyle, D.**, Portilla, J., Riesgo, T., O'Flynn, B. (2013) 'Poster Abstract: Route-back delivery protocol for Collection Tree Protocol-based applications'. *10<sup>th</sup> European Conference on Wireless Sensors Networks (EWSN) 2013*. Ghent, Belgium. February 13-15, 2013
- Srbnovski, B., **Boyle, D.**, Popovici, E., O'Flynn, B. (2012) 'Interfacing Industrial Sensors with Ultra Low Power Electronics for Sustainable Wireless SHM', *Clarity Open Day*. Clontarf Castle, Dublin. 21 November 2012.

PhD Thesis:

- **Boyle, D.**, 2009. Investigation and Specification of Efficient Security Solutions for Java Enabled Wireless Sensor Networks