The Internet of Things Beyond Covid-19, a CDAIT Perspective

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Acknowledgments

Most of the material presented here is based on information provided by the National Spectrum Consortium and work done at the Georgia Tech Research Institute (GTRI) as well as my involvement with the Georgia Tech Center for the Development and Application of Internet of Things Technologies (CDAIT).
Overview of Discussion

- IoT Day – (https://www.iotday.org/), which is about recent and ongoing recognition of IoT Technologies for the benefit of the economy and society as a whole

- Georgia Tech Center for the Development and Application of Internet of Things Technologies (CDAIT pronounced “sedate”) (www.cdait.gatech.edu)

- Sample of Georgia Tech IoT programs

- Example of IoT to 5G with AI – a Department of Defense program via the National Spectrum Consortium

- Also – Please see the Biweekly CDAIT IoT News Digest [*] for general IoT research and information as well as ideas and perspectives for IoT technologies supporting COVID-19 response.

[*] Most recent: https://cdait.gatech.edu/sites/default/files/gt_cdait_biweekly_iot_news_digest_032020_2.pdf
CDAIT’s Objectives

CDAIT can be viewed as a technological think tank (a “think-and-do tank”, i.e., action-oriented), an incubator of bottom line impacting IoT-related ideas.

- To drive general awareness about the Internet of Things’s huge potential and transformational capabilities.
- To bridge sponsors with Georgia Tech faculty and researchers as well as industry members with similar interest.
- To efficiently identify, understand and solve challenges and problems that may arise along the whole IoT value chain.
# The Three Stages of the Internet of Things

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<th>STAGE I</th>
<th>STAGE II</th>
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<td><strong>Monitoring &amp; Control</strong></td>
<td><strong>Data Optimization</strong></td>
<td><strong>Interconnection of Intelligent Things</strong></td>
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- Remotely Connecting, Measuring, Tracking and Tracing (telemetry; telematics; M2M; LBS; RTLS; and ICS) [*]
- Data captured at the edge transformed into actionable and valuable ($) information (modeling & simulation; descriptive, predictive, and prescriptive analytics)
- “The grand vision of the Internet of Things (IoT) is a world of networked intelligent objects.” *(Harvard Berkman Center)*; see also the emerging concepts of “Massive IoT” and “Critical IoT” in the telecom industry, and “Intelligent Connectivity” at GSMA.

[*] **Telemetry** is the automatic measurement and wireless transmission of data from remote sources; [Vehicle] **telematics** refers to the gathering, storing, and transmitting of data about a vehicle(s) for monitoring purposes; **M2M** = Machine-to-Machine communications; **LBS** = Location-Based Service; **RTLS** = Real-time Locating System; **ICS** = Industrial Control Systems [including supervisory control and data acquisition (SCADA) systems, distributed control systems (DCS), and other control system configurations such as Programmable Logic Controllers (PLC)].
IoT = Core to Business Digital Transformation

3 EMERGING DISRUPTIVE BUSINESS FORCES

- Foster Operational Efficiencies
- Create New Revenue Streams
- Generate Competitive Advantage
- Deliver Long-lasting Value to All Stakeholders
Recycle, reuse, remanufacturing, i.e., regenerative practices and processes to minimize waste and foster sustainability

Outcome
Product is no longer a physical output but an ongoing relationship based on customer needs and wants

Integration
Interconnection of intelligent things to create and maximize value throughout the whole value-chain and product lifecycle

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CDAIT Working Groups - Charters

**IoT Education and Training**
Recognizing that the Internet of Things is a fast-paced and rapidly changing industry that requires a wide range of knowledge and expertise, and related skills and competencies must be tightly aligned with the evolving demands from businesses in general and the CDAIT members in particular, the proposed Working Group’s overall objective is to determine the needs in terms of educational and training content (including not only technological and non-technological domains but also assessment and testing) and format (regular courses, continuing education, online, on site, etc.) in order to develop a competitive and productive workforce well adapted to the IoT challenges.

**IoT Security and Privacy**
The possibilities offered by Internet of Things (IoT) technologies are countless. They have the potential to bring about a positive economic and social change. However, these technologies cannot be accepted and applied if security and privacy are not guaranteed, or at least maximized. As a result, IoT Security and Privacy are widely recognized as critical building blocks of any IoT-focused undertaking. The purpose of the GT CDAIT Working Group (WG) on IoT Security & Privacy is to monitor efforts around the world that aim to identify, manage, and mitigate related risks, and to provide useful and actionable perspectives and recommendations to the CDAIT members. Monitored efforts may take, without limitation, the form of policy and regulation discussion and implementation, and/or standardization and research work. While essentially an observatory of the IoT Security and Privacy global landscape, the WG may decide to contribute technical research work. While essentially an observatory of the IoT Security and Privacy global landscape, the WG may decide to contribute technical research work. While essentially an observatory of the IoT Security and Privacy global landscape, the WG may decide to contribute technical research work.

**IoT Startup Ecosystem**
This Working Group is to help CDAIT sponsors interface with promising new Internet of Things (IoT) entrepreneurial ventures (startups) and the venture firms that are active in IoT. In this process, the role of the WG is to act as an effective bridge and a vetting mechanism.

**IoT Standards and Management**
Given the many links that are integral to the IoT value chain, there is a plethora of related standards, which, albeit helpful, adds another layer of confusion in an already complicated space. The WG aims to help the CDAIT members sort out the flood of possibilities (including from open source communities) and fill in possible information gaps. As a result, while in a non-standard-forming capacity, its main task is to monitor the global IoT standards picture and provide meaningful observations, perspectives, and recommendations to the CDAIT members with an eye on the all-important connection between standards and business performance. In addition, the WG has the potential to become a venue for voicing concerns and issues, making recommendations to existing standards bodies, and suggesting specifications that are not being developed by IoT-centered standards groups. The Working Group’s output should consist of reports to the CDAIT Executive Advisory Board, conferences, seminars, and workshops, as well as communications to standards bodies and general media.

**IoT Thought Leadership**
While there are many technological challenges that are inherently tied to the development of the Internet of Things (IoT), there are also a number of non-technological, yet critical, issues that must be addressed for IoT to succeed at any level. The CDAIT IoT Thought Leadership Working Group is tasked with exploring these dimensions and hurdles, which are rooted in the radical business, economic and societal transformation the Internet of Things is bringing about. Business models; monetization; technology awareness, acceptability, and accessibility; and ethical, legal, policy and regulatory frameworks are only a few examples of such potential research areas. This is a multidisciplinary undertaking, which encompasses a host of perspectives, including especially those found in social sciences and humanities. By focusing on these crucial issues, the IoT Thought Leadership Working Group strives to ensure IoT is implemented in a seamless, sustainable, and impactful way. The output is position paper(s) to be first shared among members and then distributed to a wider audience.

**IoT Research**
Research at CDAIT is a means towards an end, i.e., through the investigation of a specific IoT use case, members seek to better grasp the IoT space in its many dimensions. As a result, it is expected that the research process will lead to the identification and understanding of IoT challenges as a whole, and encompass technological and non-technological issues (holistic). The projects must meet the following criteria: reflect a common interest among the CDAIT members; and be impactful (fill an IoT gap) actionable (i.e., have a clear goal line [results and timeframe]), and connected to business concerns.
Ongoing IoT Research Challenges

Autonomous concepts an overarching Imperative Property

- Self-establishing, self-healing, proprietary and open-standards networks
- **Secure communications** on the edge with dynamic spectrum
- **Security across the network** – many pathways for indirect access to information
- Massive changes end-to-end architecture: Network Slicing, Dynamic RAN and SDR, Massive MIMO, Geo-localization technologies with timing are critical
- **Scalability and standards interoperability**
- Analytics of massive data
- **AI** – Semantic Web (common framework that can be processed by machines)
- **Machine learning/Artificial intelligence**
- Privacy of data
CDAIT and GT in General: Ongoing IoT Research Efforts

- Smart Communities Challenge -- 8 projected funded to date; Debra Lam as lead. ([https://smartcities.gatech.edu/georgia-smart](https://smartcities.gatech.edu/georgia-smart))
  - Example project is Savannah with IoT/Sensors integrated to provide data on water levels under bridges; informs emergency response, etc. (Dr. Russ Clark)
- CDAIT funded research for Digital Twins, Edge Computing, and several other areas
- Recent programs for North Avenue Corridor and deployment of IoT sensor platforms (in collaboration with MetroLabs)
- Numerous DoD programs, including the National Spectrum Consortium 5G initiative
- Integrated sensors for Marine Corps Logistics Smart Warehouse in Albany
- Numerous programs, lab-based initiatives across GT
- CDAIT Papers and working groups as defined earlier
Our current efforts with DoD and Smart Warehouse:

- Optimize the work flow and logistics flow (and model)
- Implement certificate-based classes in Logistics, inventory, warehousing, etc
- Develop Additive Manufacturing, particularly for long lead items or obsolete parts
- Implementing autonomous inventory capability (next add retrieval with real-time/low latency control)
- Ensure interoperability to primary and legacy data systems
- Add advances in Maintenance (AR/VR/Mixed reality)

**Ultimately** – a seamless integration from location and health of items across the supply chain with optimized storage and maintenance and predictive awareness. Thus, IoT-5G-AI&ML
Mission: The NSC mission is to foster collaboration between Government and Industry to identify, develop and demonstrate the enabling technologies necessary to broaden the military and commercial access to and use of the electromagnetic spectrum.

Vision: Government, Industry and Academia working side by side on the common challenge of satisfying the vastly increasing demand for the use of electromagnetic spectrum; thereby, stimulating U.S. innovation and economic growth and removing obstacles to U.S. military operations both domestically and overseas.

Scope: 5-year, $1.2B Section 815 Other Transaction with OUSD(R&E) through ACC-NJ to develop prototype hardware, software, and system technologies for:
  • Technology Development & Maturation
  • Technology Demonstration
  • Technology Experimentation
  • Technology Analysis to Inform Requirements and Policy Consideration
DoD 5G Engagement with Industry

• National Spectrum Consortium
  - Established in 2013 as a public/private partnership
  - Now has over 300 industry members
  - Over 250 5G technical concepts received
  - Over 1500 comments on draft 5G RFPs from 50 companies
  - Final 5G RFPs to be issued in February 2020

• Information Warfare Research Program (IWRP) Consortium
• 4 initial experimentation sites with 3 initial use cases
  - Hill AFB, UT
    – dynamic spectrum sharing between 5G and high-power military radars
  - Joint Base Lewis-McChord, WA
    – AR/VR for high-fidelity training
  - Naval Base San Diego, CA
    – smart warehouse and logistics
  - Marine Corps Logistics Base Albany, GA – smart warehouse

• Site attributes include
  - Streamlined access to site spectrum bands for experimentation
  - Wireless & wired infrastructure
  - Support for infrastructure requirements
  - Congested communications environs
  - Ability to experiment with dynamic spectrum sharing
• Smart Warehouse
  - Digitization, automation, and optimization
  - Autonomous systems
  - AR/VR systems
  - Machine vision
  - Integration Navy logistics systems

• Naval Base San Diego
  - Design and deploy 5G infrastructure in and around warehouse test site
  - Employ and test advanced 5G features
• Smart Warehouse
  - Digitization, automation, and optimization
  - Autonomous systems
  - AR/VR systems
  - Machine vision
  - Integration Marine Corp logistics systems

• USMC Log Base Albany
  - Design and deploy 5G infrastructure in and around warehouse test site
  - Employ and test advanced 5G features
5G Standards Engagement

• **Ongoing participation in 5G standards - 3GPP, ATIS, IEEE**
  - DoD wide membership access
  - Monitoring standards working groups/proposals
  - Example: Supply Chain Working Group with industry via ATIS

• **Developed DoD 5G Standards Engagement Plan**
  - Established cross-Department SME team to represent DoD
  - Prioritizing standards relevant to DoD
  - Organizing technical teams - Physical layer (spectrum), security, networking, and 5G services such as IoT, V2X, SAT5G, AR/VR
  - Expand coordination to FVEY and international partners

• **Ongoing interagency coordination**
  - Led by National Security Council and National Economic Council
  - Manage common effort with NTIA, NIST, DoT, DoJ, FCC, DHS, ...
Georgia Tech is researching IoT and smart “system” deployments via testbeds, thought leadership, education, and industry/government collaborations and Smart City/Smart Base. And the POTENTIAL to address health crisis such as COVID-19

- 5G will enable rapid expansion of IoT deployment
- Federal Government sees a critical need and thus development of projects via the National Spectrum Consortium (NSC)
- Targeted use cases are for example: spectrum sharing, integration of sensors, edge computing, AI, security, and a range of applications including visualization & Mixed Reality, smart warehouses/bases/ports, etc.
- At CDAIT, for the balance of 2020, we plan to stay away from big events (difficult to plan in this type of environment) and focus on online interactions and research.
- Research topics may be influenced by current events (a sample of examples only) 1) role of IoT technologies in business continuity planning; 2) IoT and digital divide; 3) research related to IoT and 5G (public and private networks); and 4) others to be selected by the CDAIT Working Group on IoT Research.

- YOU MAY HAVE OTHER IDEAS – JOIN US!