

Internet of Things

Presentation of Course Plan

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Lecture 1: Presentation of Course Plan



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AC75: IoT optimized America's Cup

- 46,000 Construction Hours
- > 90,000 Design Hours
- 75,000-100,000 CNC Machine Hours
- 17,300 Individual parts
- 140 sensors onboard
- 240 metres of hydraulic pipes onboard
- 50+ Knots estimated top speed (93 KM/H, 57.5 MP/H)
- Weight: 6.450 tonnes
- Crew: 11
- Crew weight: Max 990KG

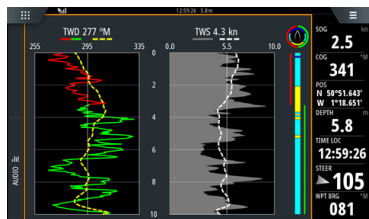
<https://youtu.be/H98nH-dvNUE>

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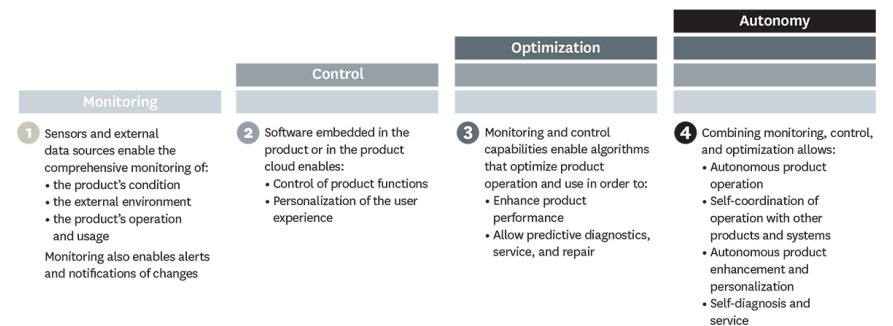
AC75: Data driven optimization



Epsilon Optics – Fiber optic sensors embedded in race boat foils can be used to measure the lift, drag and horizontal force generated by the foil in real time.

Internet of Things – Introduction

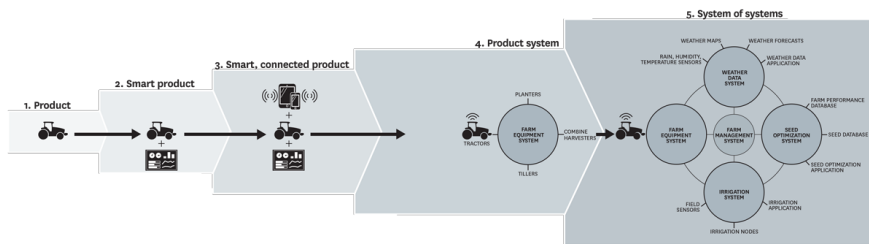
Capabilities of Smart, Connected Products



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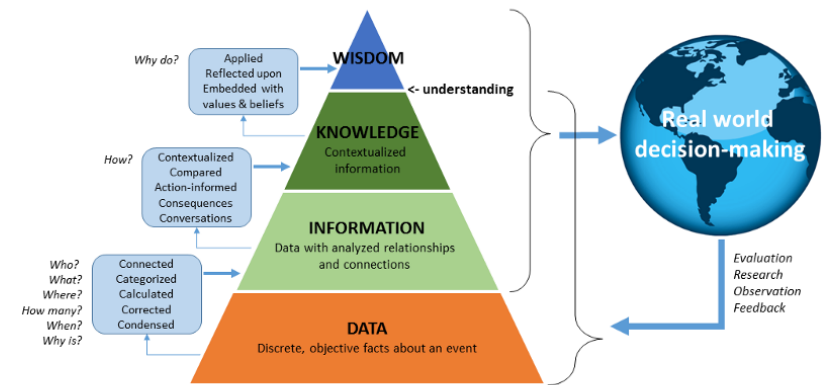
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Redefining Industry Boundaries



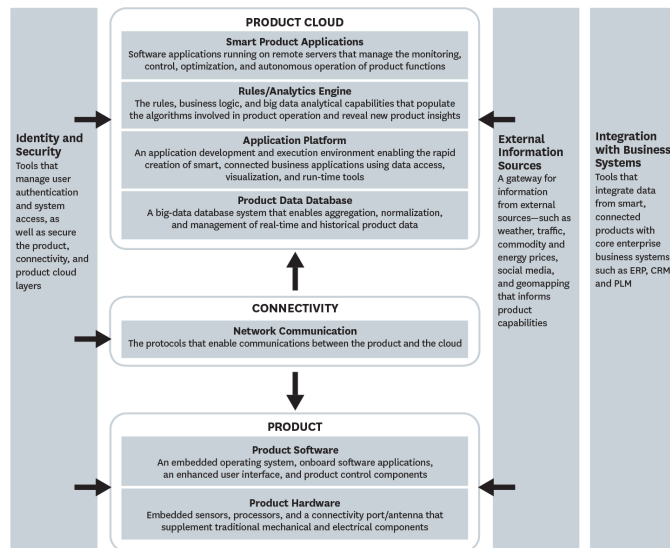
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The Value of Sensor Data



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The New Technology Stack



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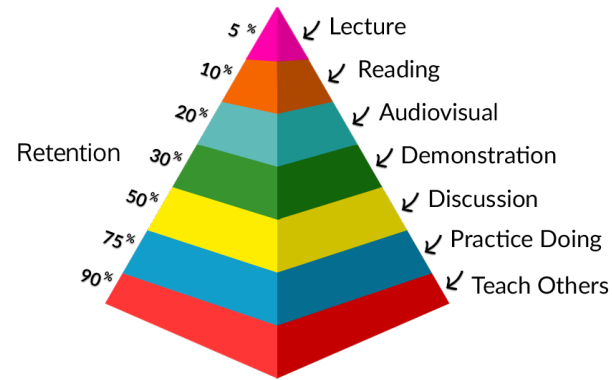
Goal of Course

- ① Designing Applications for the Internet of Things.
- ② Embedded Operating Systems and Hardware Platforms.
- ③ Networks, Protocols and Security.
- ④ Data, Analysis and Privacy.
- ⑤ Performance Evaluation.



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Teaching Approach



Course Plan

- Plan, schedule & material **already available** at web page: ichatz.me/Site/InternetOfThings2021
- Course is organized in 5 Modules.
 - Reading: Each module is linked to 2 Research Papers.
- Lecture material:
 - Lecture notes,
 - Links to research papers,
 - Demonstration & Video tutorials,
 - Hands-on activities.
- Announcements, Discussions and Q&A will be carried out over Slack: <https://iot2021diag.slack.com/>
- Assignments will be handled via Google Classroom: 372j6wc



Module 1: Designing Applications

- Main concepts and design aspects of IoT platform enabled applications.
- Specific IoT application: study of specific use cases.
- Introduction to research areas.

Reading List

- Connected Things Connecting Europe, Communications of the ACM, March 2019.
- Digital Ubiquity: How Connections, Sensors, and Data Are Revolutionizing Business, Harvard Business Review, November 2014.



Module 2: Embedded Operating Systems

- Overview of IoT operating systems.
- Hardware prototyping platforms.

Reading List

- The Future of Sensing is Batteryless, Intermittent, and Awesome, 15th ACM Conference on Embedded Network Sensor Systems (SENSYS), November 2017.
- Internet of Things (IoT) Operating Systems Support, Networking Technologies, Applications, and Challenges: A Comparative Review, IEEE Communications Surveys & Tutorials, Vol. 20, No. 3, 2018.



Module 3: Networks, Protocols, Security

- Low-Power Wireless Networks.
- Low-Power Wide-Area Networks.
- Machine-to-Machine (M2M) communication.
- Securing the Internet of Things.

Reading List

- 1 Application Domain-Based Overview of IoT Network Traffic Characteristics, ACM Computing Surveys, Vol. 53, No. 4, July 2020.
- 2 A Survey of Enabling Technologies of Low Power and Long Range Machine-to-Machine Communications, IEEE Communications Surveys & Tutorials, Vol. 19, No. 4, 2017.



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Module 4: Performance Evaluation

- Network performance, power consumption and energy efficiency.
- Tools for conducting performance evaluation.
- Experimentation-as-a-service: IoT Lab.

Reading List

- 1 Flexible experimentation in wireless sensor networks, Communications of the ACM, January 2012.
- 2 A Framework to Implement IoT Network Performance Modelling Techniques for Network Solution Selection, MDPI Sensors, 16(12), article 2038, 2016.



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Module 5: Data, Analytics, Privacy

- Data processing architectures.
- Amazon Web Services for the Internet of Things.
- Blockchain for IoT.
- Privacy Preserving Computation.

Reading List

- 1 Analytics for the Internet of Things: A Survey, ACM Computing Surveys, Vol. 51, No. 4, July 2018.
- 2 Applications of Distributed Ledger Technologies to the Internet of Things: A Survey, ACM Computing Surveys, Vol. 52, No. 6, November 2019.



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Hands-on Activities

- A series of connected hands-on activities covering topics:
 - 1 Embedded Operating Systems,
 - 2 Sensors and Actuators,
 - 3 Wireless Communications and Networking,
 - 4 Cloud-based IoT Analytics,
 - 5 Edge Computing.
- STM32 Nucleo-64 F401RE Development Board.
 - Each student attending lectures will get 1 for free.
 - **Provided by ST Microelectronics – Thank you !**
- You will need to buy:
 - 1 Electronics Components Kit,
 - 2 Sensors and Actuators

→ **Information available on web page.**



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Embedded Operating Systems

Lecture 3: RIOT

- Tool Chain
- Applications
- Threads
- Timers



Lecture 3: RIOT

- Tool Chain
- Applications
- Threads
- Timers



Lecture 4: RIOT + STM

- Hardware
- I/O
- RTC
- Power



USB



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Cloud-based IoT using AWS

Lecture 7: AWS IoT

- IoT Core
- Device Management
- IoT Analytics



MQTT-SN



MQTT



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Machine-to-Machine (M2M) communications

Lecture 6: M2M

- Networking in RIOT
- MQTT, MQTT-SN
- COAP



Network over USB



Virtual Network



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Low-Power Wireless Mesh Networks

Lecture 9: Mesh Networking

- 802.15.4
- 6LoWPAN
- RPL



Virtual 802.15.4



Virtual 802.15.4



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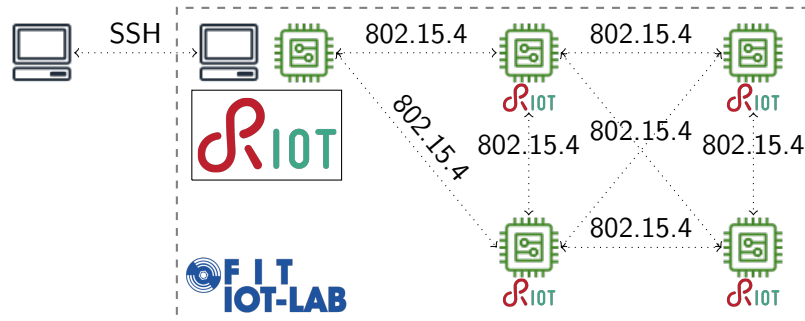
Experimentation-as-a-Service: IoT-LAB

Lecture 10: IoT-LAB

Provisioning

IPv6

RPL



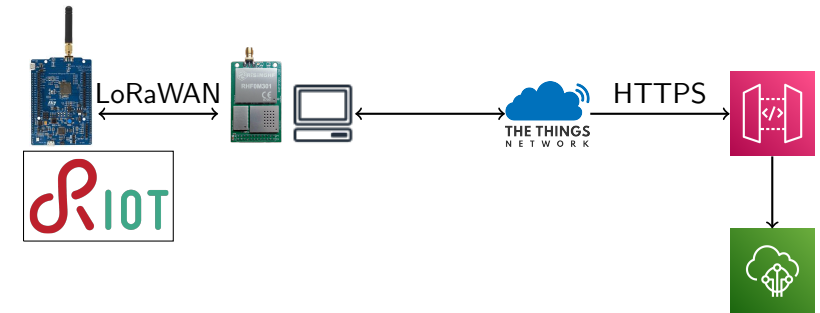
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Low-Power Long-Range Networks

Lecture 13: LPWAN

LoRaWAN

TheThingsNetwork



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Coursework

1 Individual Assignments:

- A total of 3 assignments.
- Based on the Hands-on Activities.
- Use: STM Board + Sensors/Actuators + AWS + IoT-LAB.
- Instructions **already available** on web page.

2 Group Project

- **Propose an IoT application for Blue Growth.**
- 3 people per project.
- User-driven Design.
- Develop the system using appropriate technologies.
- Test & Evaluate in real-world conditions.
- Open-source – Open-design.
- Instructions **already available** on web page.



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Final Marks & Exam

- No Written Exam.
- Individual Mark.
- Mark depends on participation in class.
- Mark depends on quality of individual assignments.
 - 1 Quality of Code,
 - 2 Technical Documentation,
 - 3 Performance Evaluation,
 - 4 Demonstration.
- Mark depends on quality of big-project.
 - 1 Participation in group,
 - 2 System design & research,
 - 3 Quality of Software and Hardware Prototype,
 - 4 Performance Evaluation,
 - 5 Demonstration.



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Individual Assignments Timeline

- 1 First Assignment
 - **Deadline: 29th March 2021**
 - Software: RIOT + AWS.
 - Hardware: STM32 + 2 × Sensors + 2 × Actuators.
 - Technical Documentation.
- 2 Second Assignment
 - **Deadline: 26th April 2021**
 - Mesh Networking.
 - Hardware: IoT-LAB.
 - Performance Evaluation.
- 3 Third Assignment
 - **Deadline: 31st May 2021**
 - Long-Range Low-Power Networking (LoRa)
 - Edge Computing.
 - Hardware: IoT-LAB.
 - Blog Post.
 - Video Demonstration.



Group Project Timeline

- 1 First Delivery: Initial Idea Pitch
 - **Deadline: 8th April 2021**
 - User-driven Research & Idea Formulation.
 - Technical Design.
 - 5 minutes pitch.
- 2 Second Delivery: Intermediate Presentation
 - **Deadline: 20th May 2021**
 - Demonstration of Working Prototype.
 - Technical Documentation & Preliminary Evaluation.
 - 10 minutes presentation.
- 3 Exam: Final Presentation
 - Demonstration.
 - Evaluation.
 - Technical Documentation.
 - Blog post.
 - 10 minutes presentation.

