

## IOT BASED IMPLEMENTATION OF E-LEARNING SYSTEM

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### **Abstract**

*This paper exhibits a model for leading Internet of Things (IoT) classes in light of a web-benefit situated cloud stage. The objective of the composed model is to furnish college understudies with learning about IoT ideas, potential outcomes, and plans of action, and enable them to create fundamental framework models utilizing broadly useful microdevices and a cloud and administration foundation. The model depended on a cloud framework sent at the E-Business Department at the Belgrade University, and some usage points of interest are given. The model was tried and assessed in a pilot course.*

**Keywords:** *Internet of Things, Raspberry Pi, Arduino, Cloud Computing.*

### **I Introduction**

The expression "Web of Things" portrays the presence of various different things or articles like labels, sensors, actuators, cell phones, equipped for collaborating with a specific end goal to accomplish a shared objective (Atzori et al. 2010). Such shrewd gadgets can take various structures and parts, and the organization of such frameworks can be balanced powerfully, as indicated by the requirements of the clients. This gives IoT a practically boundless zone of use inside both business and industry (handle administration, astute transport, computerization), and in addition in homes and open situations (shrewd homes, e-wellbeing, helped learning). The term IoT includes an unbounded, developing arrangement of gadgets and advancements, and as the IoT advances pick up footing universally, the requirement for specialists that consolidate learning from different specialized fields increments. IoT ventures are probably going to require originators, framework integrators, designers and specialists keeping in mind the end goal to take a

thought from beginning to execution. Such differing prerequisites can make an understanding hole between business-arranged people and their thoughts, and the real implementers that arrangement with practical requirements. Preferably, a person with an IoT business thought would have the capacity to comprehend the conceivable outcomes and work in a little group, developing a model utilizing off-the-rack parts. Bringing IoT into a situation is proficient by presenting and interconnecting keen gadgets and, basically, making a domain shrewd and steady of any human movement. Utilizations of IOT are thusly as assorted as human exercises and situations seem to be. It is difficult to anticipate the specifics of future IoT advancement, however some as of now pertinent, expansive spaces of utilization incorporate transportation, coordination's, human services, shrewd homes/workplaces/plants, and individual and social areas (Atzori et al. 2010). Web of Things speaks to a propelled worldview, one that requires innovation, learning and framework, accessible in rich, created nations. In any case, IoT arrangements and particularly IoT instruction can gigantically profit developing nations, offering a method for getting up to speed quicker, and in addition a productive industry for outsourcing, with expectations of IoT showcase being worth 22 to 50 billion dollars in 2020 (Schlautmann et al. 2011). On account of the modest small scale gadgets like Raspberry Pi and Arduino, it is conceivable to create different frameworks with less speculation into foundation. The Raspberry Pi is of extraordinary enthusiasm, since it speaks to a whole PC the extent of a charge card,

and a few frameworks based around it can be found in (Raihan 2013)(Kaloxyllos et al. 2014). Raspberry Pi and comparable gadgets are for the most part supplemented by programming APIs that conceptual low-level operations, permitting successful usage from a higher point of view, which is appropriate for people with a foundation in business informatics. Customary educating in down to earth building ranges generally has a twofold structure, where the initial segment presents hypothetical establishments, and the second presents certifiable issues and applications. An alternate approach investigated by a few organizations gives more flexibility to understudies, enabling them to pick the course, expansiveness, and profundity of their instruction, and additionally consolidate their pre-learning from different zones of study (Director et al. 1995). These stipulations can in any case conceivably be connected even with regards to a solitary IoT course, particularly in the event that it is not entirely equipment arranged. Little classes contained business informatics understudies could create an inspiring and individual experience for each understudy by exploiting their assorted foundation. Incorporation of innovation into advanced education is appropriate for models in light of constructivism and socialization, and can change the instructive procedure by making it more viable and alluring to understudies (Bustos Andreu and Nussbaum 2009). IoT classes can capitalize on this impact since they naturally manage innovative contraptions and data correspondence advancements. A few sorts of situations additionally endeavor to create an exploratory setting consolidating individuals and innovation with a specific end goal to inspire advancement, improvement and research. A few cases of such situations and methodologies are given in (Chin and Callaghan 2013), where "living labs", "iCampus", "brilliant box", and Pervasive-

intuitive writing computer programs are consolidated to create an exceedingly propelling and viable instructive condition. Contingent upon the instructive setting, a few ways to deal with showing IoT can be received. At the most reduced level are individual IoT gadgets, and understanding them requires the information of hardware and low-level microcontroller programming. The center level is informatics-arranged, enveloping correspondence conventions, framework joining, web administrations, human interfaces, and so on. At the largest amount are the plan and business parts of developing IoT applications. Showing IoT accompanies an arrangement of issues for both the understudies and the teachers, particularly while focusing on the larger amounts of IoT. The principle issues are (Callaghan 2012): the absence of electronic plan mastery among understudies; the requirement for complex equipment and programming instruments; the tedious nature that cutoff points intricacy; and understudy fabricated equipment ordinarily has settled usefulness and excessively basic, making it impossible to give practical item advancement encounter. One approach in showing IoT is the utilization of recreation devices to mimic the gadgets or the earth in which they are conveyed. An illustration can be seen in (Yilmaz 2011) where the creators used a test card fit for handling computerized and simple information sources and recreating home apparatuses, a model of a home, and a basic control interface with 3D models of house inside. In this approach, the instructing can be performed even without a few or the majority of the equipment, and it enables the course to focus more on the product part of IoT. Be that as it may, the recreation can't supplant the advantages of really working with the IoT gadgets and conceivably obliges the understudies' creative energy, making them think inside the cutoff points of the reenacted situation.

Working in the wide field of IoT innovations can require abilities, for example, critical thinking, collaboration, and administration, and additionally handy involvement with real "things" utilized. The dynamic learning approach is appeared to be extremely successful in such conditions, and a blend of joint effort, rivalry and associate learning in a hands-on condition fortifies the understudies' transversal aptitudes (collaboration, correspondence, basic investigation) (Panadero et al. 2010). The primary point of this paper is to enhance the way toward learning IoT utilizing present day advancements and a hands-on approach. A model for directing hands-on IoT classes with business informatics understudies, bolstered by a cloud framework and web administrations is exhibited. The model depends on the presence of shoddy, broadly useful programmable gadgets like Raspberry Pi microcomputer and the Arduino microcontroller sheets. Utilizing these gadgets, it is conceivable to effectively create somewhat less proficient IoT arrangements that don't require specific parts or master learning to fabricate. A pilot class was performed with a little gathering of intrigued understudies as a trial of attainability, and this paper, as needs be, speaks to a beginning stage for additionally look into that will be performed on bigger gatherings of understudies.

## II. MODEL FOR TEACHING IOT

The bland model of stage for showing IoT is appeared in figure 1 and portrays the required hardware and supporting foundation. The model is part into three layers – the gadget layer, the administration layer, and the application layer. A few parts utilized as a part of the real execution at the Department for E-Business of the Faculty of Organizational Sciences at the Belgrade University are additionally said underneath. In a perfect world, the hardware for an IoT class ought

to be as rich as could be allowed, enabling the understudies to plan a huge number of arrangements. In all actuality, money related impediments can be extreme, particularly in poorer nations, and the hardware ought to be chosen precisely. The fundamental segments at the gadget layer ought to be multifunctional, shoddy microcomputers and microcontrollers, equipped for taking numerous parts as indicated by client programming. Such gadgets are promptly accessible, the cases being the Raspberry Pi and Arduino which were utilized as a part of the pilot usage. Temperature, light, clamor, and different sensors are normally straightforward and shabby, while costly actuators and controllable apparatuses can be reproduced by utilizing diodes and basic circuits (Yilmaz 2011). The working rationale can be disseminated between gadgets, however a less demanding arrangement is to unify it behind an all around characterized web benefit API. Gadgets that perform estimations (i.e. sensor hubs) can infrequently answer to web administrations which go up against the part of the middleware in the framework. The gadgets can get their guidelines either by surveying foreordained administrations, or by running their own web administrations for input on the off chance that they are sufficiently effective. The web benefit approach is particularly valuable in an instructive, helpful condition. Understudies can build up their own administrations and offer them with different understudies; more unpredictable administrations can be worked by coordinating understudies' administrations with cloud-gave and outside web APIs. Customer applications, regardless of whether web, desktop, or portable based, communicate just with the web administrations and need not fret about gadget particular learning. The center part for IoT class usage was the web facilitating administration unreservedly given to the understudies, which was

executed utilizing the ISPCconfig programming permitting the sending of understudy web administrations and web applications. Revealing of sensor readings was perceived as a typical situation in IoT applications, so a basic API was given to the understudies to this reason, permitting the putting away, utilize, and sharing of sensor readings, and also bringing in or producing outer information for use in reproductions of some particular conditions. SMS sending/accepting administration was additionally given to the understudies, and different administrations could be given relying upon the current foundation of the instructive establishment. All administrations that need client represents their operation can, for enhanced interoperability, depend on the brought together store of understudy certifications. In the real execution, the OpenLDAP index utilized by the learning administration arrangement of the Department was utilized for this reason. The usage of the exhibited model can conceivably be exceptionally intricate, with an extensive number of interconnected administrations, some of them potentially coordinated with existing learning frameworks keeping in mind the end goal to permit less demanding following and evaluating of understudy movement. Despite the fact that a bit much, an ideal arrangement in such conditions is to use a cloud stage, giving high adaptability and repetition, with better use of accessible preparing assets (Beaty 2013; Sultan 2010). The reasonableness of using cloud foundation in advanced education is displayed in various research papers (Despotović-Zrakić et al. 2013; Ercan 2010). The pilot class depended on the current, OpenStack based cloud framework utilized by the E-Business Department.

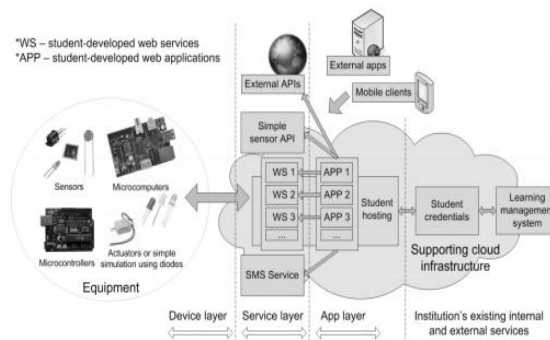


Figure 1. Model of infrastructure layers  
**III. COURSE STRUCTURE**

The objective of the IoT pilot course is to present and teach understudies with a foundation in business informatics in utilizing the equipment, working frameworks, programming, and devices for robotization of keen conditions. The course comprises out of four units (figure 2):

- Introduction to advances utilized,
- Defining situations,
- Developing web administrations,
- Developing web and versatile applications

The understudies are first acquainted with the greater part of the components of frameworks utilized for keen condition mechanization. This basic part incorporates an audit of equipment segments, situations of their utilization, plans of action for their application, and effective existing frameworks. The course is acknowledged basically through research center activities. The understudies ought to be isolated into groups, and the activities done as workshops. Amid the semester, understudies ought to get a particular undertaking for each activity. These errands portray the setting of utilization and the strategy for practice finish. Each group ought to get various client demands for advancement of a wise situation. In light of these solicitations, the understudies need to imagine a situation and outline two schematic portrayals indicating equipment parts that would fulfill these prerequisites. The main plan should give a specialized introduction of

sensors and actuators and their associations with microcomputers and microcontrollers. The understudies can, for example, utilize a free, open-source application called Fritzing for this reason. The other plan is to show the whole keen condition with the areas and associations of bigger units including the arrangement, and the understudies can make it utilizing any standard programming for drawing graphs. The usage of the equipment condition ought to be founded on the beforehand composed plan for interconnecting sensors and different gadgets. For this errand, the understudies are to be given gadgets like Arduino microcontrollers, Raspberry Pi microcomputers, and different sensors, actuators, and different parts. To make it simpler for the understudies to survey their insight at home, without real gear, an arrangement of video cuts demonstrating diverse parts of taking care of the equipment and different devices can be given to them. After the usage of the equipment foundation, the understudies should plan and actualize a product framework to supplement their past arrangement. Arduino microcontroller utilizes an adjusted variant of C++ programming dialect, while the Raspberry Pi stage best backings the Python programming dialect, and the understudies ought to use any past information accessible and take a shot at those parts they are most acquainted with. The understudies can use Xively in their activities, general society cloud benefit for gathering and getting to information from different sensors, or create comparable arrangements littler in scope. As beforehand specified, the activities are performed as workshops, where each group gets a particular setting and an undertaking to actualize a situation for utilization of brilliant gadgets in said setting. The cases of a portion of the fundamental settings/errands incorporate the accompanying:

➤ Smart home setting - Arduino or Raspberry Pi are to be utilized as a part of blend with temperature sensor. On the off chance that the temperature surpasses a specific esteem, a SMS message ought to naturally be sent to the proprietor of the shrewd home. Utilizing a web or portable application, the proprietor has a constant knowledge into the deliberate temperature.

➤ Smart classroom setting - Arduino or Raspberry Pi are to be utilized as a part of blend with a NFC label peruser and an advanced show. Amid the passage into the classroom, each understudy should tap his NFC card on the peruser, which will enlist his nearness in the present address. Since the limit of the classroom is restricted, if all seats are taken, the show outside of the classroom should demonstrate a proper notice. The understudies can utilize a web or a portable application to check the quantity of free seats in the classroom.

➤ Smart library setting - for brilliant library computerization, the understudies ought to use clamor sensors and a speaker in blend with the standard Arduino or Raspberry Pi gadgets. On the off chance that the clamor sensors record a measure of commotion over a specific point of confinement, a voice message ought to be played utilizing the speakers in the library. The executives ought to have the capacity to check clamor levels utilizing a web or versatile application.

The ultimate result of this course ought to be the reconciliation of all research center activities into a solitary venture. The last grade is made out of evaluations for errands finished in works out, the review for an electronic test, and a review for fulfillment of the venture, with the assignments and the venture making up to 80% of the review. The venture ought to characterize client prerequisites, situations, extend documentation, web administrations, and a web or portable application for robotization of the shrewd condition.

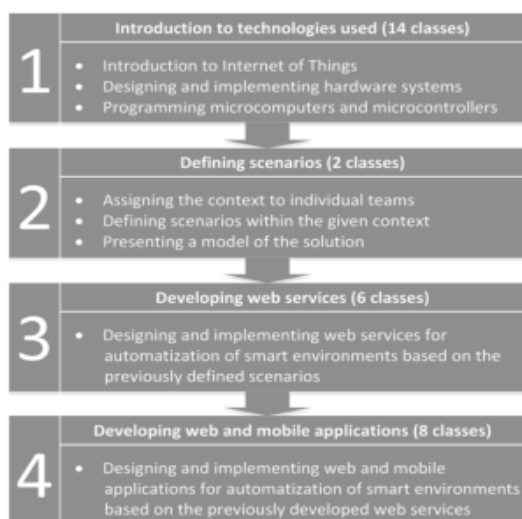


Figure 2. IoT course structure

**IV. PILOT CLASS**

**IMPLEMENTATION AND RESULTS**

The pilot course was actualized at the Laboratory for E-Business as indicated by the course structure illustrated in the past part, with 8 understudies of ace investigations taking it as an elective class. The majority of the understudies were in the vicinity of 20 and 25 years old, all had comparable foundations in business informatics, with just slight varieties in their general vicinity of specialization and intrigue, and that half of the understudies were utilized in some shape (low maintenance or full). The pilot course was shorter long contrasted with the beforehand depicted structure and comprised out of 12 classes altogether, four covering the presentation and staying eight the other, pragmatic areas. After the finish of the whole course, the understudies were given a survey with questions gathered into five areas: statistic information, opinions about course structure and execution, opinions about workshop content, understudy's inspiration, and understudy's view of claim learning. Understudies were additionally reviewed by their finished undertakings, venture, and test, and out of eight understudies taking an interest, three had the last grade 8, four had the review 9, and one had the most extreme review of 10, for a normal of 8.75.

The inquiries from the primary gathering concerning the course structure and execution were to discover whether the course structure was all around adjusted, if the errands were excessively troublesome and the designated time adequate, and what was the understudies' opinion of the cooperation show between the understudies and instructors, and additionally the collaboration between understudies themselves. Here, 62.5% understudies felt that the ideal length of a solitary class inside the course was three hours, while the rest of the understudies endorsed the real length utilized (1.5 hours). All understudies, notwithstanding, concurred they had adequate time to finish the errands they were appointed. The undertakings were for the most part set apart as being of medium trouble (87.5%), however a large portion of the understudies (75%) believed that the associate's assistance was required, and 25% idea it was important. The majority of the understudies concurred that the intensity between the gatherings was a spurring component. The third piece of the poll was worried with the genuine substance of workshops and was to learn as to which parts of the workshop were best preferred by the understudies, which were viewed as the most troublesome, and which were viewed as the most vital. These inquiries were to give knowledge into the adjust of the course. As needs be, the movement of concocting IoT situations was for the most part positioned as normal (62%), with every single other answer going over that. The understudies likewise thought this action was of normal intriguing quality (half), and that the best possible comprehension of the situations was critical for finishing the given assignments. The vast majority of the understudies didn't have any preknowledge about IoT, yet didn't surmise that managing the equipment was excessively troublesome. This piece of the assignments was evaluated for the most part as

extremely fascinating (half), and a comparable opinion was gotten concerning the significance of these innovations in the more extensive errand. The understudies had, overall, best preknowledge in the space of web administrations, since this was a piece of their prior training (half stamping it as normal), yet most likewise felt that managing administrations was of medium and high trouble. This can be clarified by the way that it was relied upon for the understudies to have a specific preknowledge around there, and the necessities were as needs be stricter. The understudies likewise suspected that web administrations were a significant part of their answers (25% - vital, 75% - vital). The primary slant was that the Android improvement was not very troublesome, and that this action was extremely intriguing (half). Some of these outcomes are given in Table 1

.Table 1. Questions concerning the perceived interestingness and difficulty of dealing with IoT hardware and web services

Question	Answer	# responses	Question	Answer	#
How interesting was dealing with software and hardware components?	Very boring	0	How difficult was dealing with software and hardware components?	Very easy	
	Boring	1		Easy	
	Average	2		Average	
	Interesting	4		Difficult	
	Very interesting	1		Very Difficult	
How interesting was dealing with web services?	Very boring	1	How difficult was dealing with web services?	Very easy	
	Boring	1		Easy	
	Average	1		Average	
	Interesting	2		Difficult	
	Very interesting	3		Very Difficult	

The fourth piece of the survey was short, and contained inquiries regarding how the understudies were roused to keep enhancing their insight into the advances secured amid the class. 75% of understudies were propelled to do as such, with 12.5% inspired incompletely, and staying 12.5% not spurred. The last part was worried with the understudies preknowledge and about how they saw their change in specific regions. Understudies did not have much learning about IoT in advance, but rather had a normal level of information with

programming and working with web administrations. The understudies for the most part had just a basic level of information about Android OS, with just some of them having finished an elective course in Android programming. The understudies imagined that the gave instructive materials were adequate (75%), and that they have picked up a palatable measure of information about IoT and other connected advances.

Furthermore, the understudies were gotten some information about the class and about conceivable upgrades. The greater part of the opinions were exceptionally positive, and some of them are given beneath:

- "Intriguing, intuitive, and fun. Spurring."
- "It's extremely intriguing to see the down to earth aftereffects of programming"
- "It enabled me to audit critical things"
- "There ought to be more classes this way. Taking a shot at a solid case, whose state can be altered through PHP or Android was a top-class involvement"
- "No complaints. The workshop was fascinating and inspiring. Additionally, to see the outcomes enhances the dry programming knowledge a great deal.

### V.CONCLUSION

The introduced show has a few focal points - it is shabby, viable, versatile, and appropriate for understudies not originating from an equipment foundation. The model requires some supporting foundation and building up various programming administrations, yet all well inside the abilities of any business informatics or programming focused educational modules. The understudies partaking in the pilot class were very much propelled, however the short class length and modest number of members did not enable us to make any broad conclusions,

and further research will be performed in future classes. The principle inadequacy of the pilot class was the way that lone eight understudies took an interest. Still, there is as of now very few research papers concerning the course structure and execution of IoT classes, and some broad comments, potentially helpful for future research and bigger IoT classes can be given in light of the acquired outcomes and experience. The understudies evaluated the assistance from the associates as vital for the finishing of their assignments; this particularly should be considered if future classes are performed with a bigger number of understudies. IoT practices that endeavor to incorporate both the equipment and programming parts of IoT should likely be of longer length, as the understudies were generally for 3 hour classes over those twice as short. The SMS benefit that was given to the understudies to sending and getting SMS messages was extremely all around preferred, despite the fact that it was not a center piece of the IoT classes. This is most likely the case since the SMS messages are an exceptionally recognizable idea, and it enabled the understudies to imagine IoT joining in a more sensible way. The instructive foundation ought to subsequently endeavor to give the understudies however many different administrations as would be prudent so as to enlarge the potential outcomes and increment understudy inspiration. Understudies likewise felt that seeing the consequences of programming quickly was inspiring, and IoT activities ought to be outlined in such an approach to give straightforwardly evident outcomes, and ideally an immediate effect on the physical world somehow.

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