Internet of Things course

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1 Introduction

In this document, I go through different concept assigned in the course i.e. the ideas of internet of things (IoT), web of things and machine to machine communications. IoT is fundamental ideas for the other two, therefore the document begins with that and proceeds with web of things and machine to machine communications. The time spend for this document was around 16 hours that includes reading material and preparing this document.

2 A network for all: Internet of Things

Originally "little data" sensors are equipping with a digital processor and a communication device. There accessories provide capabilities for the nodes to communicate with a central cloud and/or with each other to synchronize data collection. The big data generated by the sensors can be analyzed through data mining and machine learning techniques [1] to aid in decision making and management. If number of sensors are enough to monitor every detail of a process in a factory for example, an unprecedented opportunity arises to optimize the process and prevent failure, which might not be feasible with having a large data set of each and every part of the machineries. In case of environment, a large network of sensors, eases large scale monitoring of wildlife, forests and even cities. The collected data provides real time information on which how different sections of a large-scale environment affect each other (e.g. correlative measures), which part requires attention, what is exactly happening right now.

Stillthere are multiple issues that needs to be resolved. First the IoT nodes generally are energy constrain, i.e. placed in remote or hard to access area. Their number for a particular network easily can be a few thousands. Hence, using battery powered devices is out of question, since large number of battery replacement, or charging is too costly, and batteries are susceptible o environmental factors such as pressure and high or low temperatures. Also, due to dangerous ingredients of batteries, their disposal in environment is dangerous for humans and the nature. Second, the communication channels for IoT networks are not guaranteed to be reliable [2], i.e. not all the nodes are in cities where network coverage is close to 100 percent, e.g. mobile vehicles such as

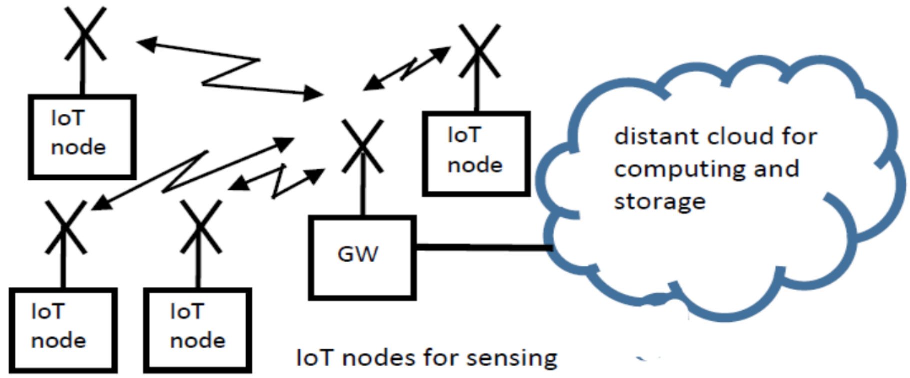

Figure 1: IoT nodes communicate with each other and an central node/cloud

vessels. The durability of the IoT devices, low cost, security [3] are issues that currently are of interent for extensive research.

3 Making things compatible: Web of Things

Although internet of things might provide optimum infrastructure to be used for connecting billions of devices out there, however the incompatibility of all platforms, data formats, communication protocols will hinder further development and expansion of the IoT networks. For example, consider you want to connect all of devices in your factory to a central node and all the machines and sensors support IoT framework, however each are from different brand and each generate data with different type and formats. Now in the central now your work doubles since you have to make all the data compatible. Also you must be able to support all communication protocols at the same time which might necessitate hardware infrastructure modifications or redesign [4]. These problem already was present in development stage of Internet itself and already was solved through introduction of WEB [5]. The same solution is applied here, we add another layer and make sure all the nodes no matter how they work internally and which protocol they are using, communication in a standard In this context, WEB is actually some form of standardization. Each device can have an URL through which other nodes in network can access its data and communicate with it. Though adding Web concept increases overhead in network hardware and software but it is believed it basically provides ease of access and hence unlocks the potential of the IoT networks. There is ongoing effort to make a lighter Web version for IoT applications for example Constrained Application Protocol (CoAP) recently was approved for light-wight variant of HTTP [1] Currently multiple companies and organizations developing and providing infrastructure to support programmers, among which one can name Mozilla Web of Things API. Mozilla WT API provides basic software framework for development and integration of things web. The platform supports programming languages such as micro-python (for embedded application), python, java, etc.

4 Machine to Machine Communication: A subset of IoT

It is estimated there are more than 50 billion machines currently operating in the world and this number even grows further due to population growth and development of the communities all over the world. Using already established communication infrastructures we can connect all this machine to each other. The immediate application of M2M can be timely maintenance, more accurate surveillance over operation and remote production (i.e. machines cooperation). An example (from my own research) of machine to machine communication is in big engines in wind turbines or vessel engines. At least one sensor is mounted on various parts of the big engine and transmit information to a edge or to each other. These sensors, report strain, temperature, relative position and speed to the central node. Also, to tackle dynamic behavior of the channel they communication with each other to find a establish a reliable communication channel through learning the optimum behavior of the channel.

In the simplest form this machine can use regular communication infrastructures such as regular cellular networks. This of course results in communication devices on the machine that can be as complex as a those of a mobile phone. However, M2M has unique features that let's simplification of the platform and device at the same time.

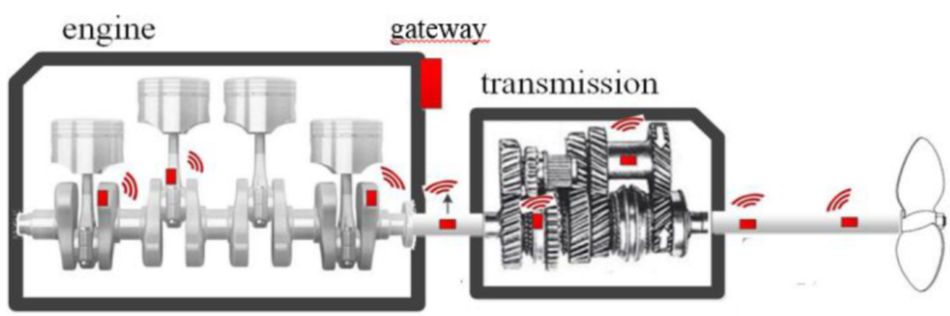

Figure 2: A big engine equipped with IoT nodes communicate with each other

The rate of information that is send by machines to servers and clouds expected to be higher than the rate of the information they receive, hence it is said that downlink to uplink ratio in M2M is low. This makes sense, since machines mostly send some information they measure through the sensors and mostly receive instruction on an event. For example, and diesel engine that generates electricity necessary for a remote village constantly sends its information (fuel level, temperature, . . .) to some central cloud and based on the predicted need of the network might receive some instruction on how much power it must generate. Humans actions are versatile, e.g. a user might watch a video on YouTube for a minute, then try to receive GPS signal and then call someone. This necessitates a general-purpose communication platform (from coding to RF components). Also, humans are mobile creatures and paging and mobility management must be considered in the network. On the contrary, except for machine for surveillance usually machine only send some sensor data like metering information, state. Furthermore, machines usually are stationary. Authors of Reference [6] took advantage of this and propose to simplify the network architecture. Unique features of M2M communications such as low downlink to uplink ratio, wide distribution (huge number of machines and parts), wide density deployment and small packets of transmitted information.

References

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