Efficient Downlink Scheduling For The Narrowband Internet of Things

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Abstract- *The NB-IoT proposes a cellular architecture based low power wide area technology option for low data rate massive IoT applications. NB-IoT is the leading technology that fits the requirement of IoT. The improper scheduling decision will affect the radio resources waste, the intent is to reduce the used radio resources while each devices data requirement can be satisfied. The approach shown in the NB-IoT network reduce the delay & increase data rate. The proposed algorithm is then evaluated to investigate the impact of repetition factor, time offset and intercell interference on the NB-IoT data rate and energy consumption. The simulation results that cooperative scheme provides up to 8% rate improvement and 17% energy reduction as compared with non-cooperative scheme.*

Keywords- Narrowband Internet of Things (NB-IoT), radio resource allocation, power allocation, repetition factor, system-level evaluation.

I. INTRODUCTION

The Narrowband Internet of Things was introduced in July 2016 by the 3rd Generation Partnership project (3GPP) in its Release 13 specifications. The Narrowband Internet of Things (NB-IoT) is one of the most promising technologies that fits the requirements of the low-power wide area networks (LPWAN). It has drawn many researchers and working groups attention. The working group 3GPP has started to work on the specifications for NB-IoT since 2014. Initially, the specification of NB-IoT focuses on low-end, low-power devices called Cat NB1. The NB-IoT specification also enables devices to send in parallel tiny amounts of information. From a technical point of perspective, NB-IoT is intended for low-cost devices operating on a 180 kHz low-frequency bandwidth to provide network coverage of more than 160 dB with a latency of about 10 seconds. NB-IoT can target IoT devices with these characteristics that are delay-tolerant or situated in fields where signal transmission is poor. With the huge deployment in those distant regions of multiple batteries powered IoT devices, NB-IoT is better suited to reaching them. Therefore, when it comes to LPWAN techniques, NB-IoT is regarded a better option. NB-IoT's deployment in these fields promotes a number of IoT facilities such as intelligent farming, smart city, smart home, intelligent metering, etc. In release 14 of the 3GPP requirements, further improvements will be suggested [2]. Although NB-IoT has these benefits, problems still need to be addressed. For instance, work on optimization was suggested to cope with possible information. Low power wide Area organize (LPWAN) is one of the remote interchanges for huge IoT gadgets.NB-IoT design is based on the LTE functionalities, it is possible to reuse the same hardware and also to share the spectrum without coexistence issues. This architecture allows low cost and fast deployment of NB-IoT using existing infrastructure. The scheduling algorithms are Maximum delay tolerance; UE with early-transmitted time is served first based on the maximum delay tolerance [1].

II. PROPOSED SYSTEM

The scheduling problem for next generation cellular 3GPP NB-IoT downlink, we examine the 3GPP NB-IoT downlink planning issue for cutting edge cell systems. The target is to limit the expended radio asset while every gadget's information prerequisite can be fulfilled. In NB-IoT systems, a base station should utilize a downlink control indicator (DCI) conveyed by narrowband physical downlink control channels (NPDCCH). The interval between the two starts of NPDCCH subframes is called an NPDCCH period (NP) where an NP can be determined by the two NB-IoT parametersTo assess our suggested algorithm, we created a simulation based on realistic parameter environments based on 3GPP requirements. Compared to a baseline, the suggested NB-IoT scheduling algorithm, known as Network and Information System. First, the baseline discovers an apparatus that was not satisfied and served in an NPDCCH period. After that, layer choice (Mac or Physical) is needed where we want to operate. Then, each applicant with each scheduling delay value is sequentially used by the algorithm to discover an unused NPDSCH begin subframe. The algorithm allocates continuous NPDSCH subframes to the device from the start of the NPDSCH subframe until the device is satisfied or the maximum number of NPDSCH subframes is allocated to the device. The

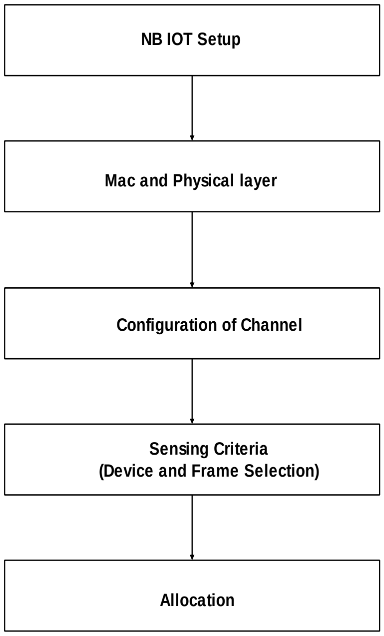

Fig.1 Proposed System

parameter settings for NB-IoT systems are based on 3GPP specifications. A base station's bandwidth is 180 kHz. A number of machines ranging from 200 to 1200 must be served by the base station. Each NB-IoT device requires a tiny information size of about 125 bytes. The NPDSCH requirement of each device can be randomly chosen from 1 to 60 depending on the transport block size given by the 3GPP. One of the values, 1, 2, 4, 8, 16, 32, or 64, is chosen randomly for the amount of NPDSCH repetitions for a device. The NPDCCH period (NP) duration is set to 256, where Rmax= 64 and G= 4. The amount of subframes of NPDCCH is set to 64. The number of applicants in an NP is set to 8 and the amount of repetitions of NPDCCH is set to 8. The number of subframes of NPDSCH is set to 196 The number of values of scheduling delay is set to 8. The set of scheduling delay values is IDelay = f0; 4; 8; 12; 16; 32; 64; 128g [4]. Theset of data NPDSCH subframe numbers that can be allocated to a device in an NP is ISF = f1; 2; 3; 4; 5; 6; 8; 10g. $t\,(k_0^1$,c)+2 based on Equation (1). Because NPDSCH subframes in an NP are located between subframe Rmax +1 and subframe L, Rmax < $t\,(k_0^1$,c) <= L, feasible. If the base station allocates total three NPDSCH subframes to device m, device m has to receive subframes . $t\,(k_0^1$,c) . $t\,(k_0^1$,c)+1,and $t\,(k_0^1$,c)+2 and subframe $s_t^p\, t\,(k_0^1$,c),m $s_t^p\, t\,(k_0^1$,c),+1, m and $s_t^p\, t\,(k_0^1$,c)+2,m are set as 1. The scheduling decision is feasible if the following constraints are met: Resource Constraint: Each subframe can be allocated to only one device.

A. NB-IoT Scheduling Algorithm

Input: $M, N_m, I_{SF}, \psi_m, R_{max}, \xi, t(k_0^i, c), R, L, S_{max}, I_{Delay}$
Output: $\mathcal{C}^P_{c,m}, \mathcal{S}^P_{s,m}, P$

$P = 1$
while True **do**
  LastCandidateFlag $= 0$
  for $\varsigma = 1$ to ξ **do**
    Select_Candidate_and_k_0^i()
    Find_TheLast_NPDSCHStartSubframe()
    Select_Device()
    Allocate_NPDSCHSubframes()
  if $\psi_m = 0, \forall m$ **then**
    break
  else
    $P = P + 1$
return $P, \mathcal{C}^P_{c,m}, \mathcal{S}^P_{s,m}, \forall c, s, m$

Procedure 1: Select Candidate and $\mathbf{k_0^1}$

Procedure 1 : Select_Candidate_and_k_0^i
min $= \infty$
for $c = 1$ to ξ **do**
  for all $k_0^i \in I_{Delay}$ **do**
    if $\mathcal{C}^P_{c,m} = 0, \forall m$ and $\mathcal{S}^P_{t(k_0^i,c),m} = 0, \forall m$ and $t(k_0^i, c) <$ min **then**
      $k' = k_0^i$
      $c' = c$
      min $= t(k_0^i, c)$

Procedure 2: Find the Last NPDSCH StartSubframe

max $= -\infty$
LastPoint $= -\infty$
for $c = 1$ to ξ **do**
  for all $k_0^i \in I_{Delay}$ **do**
    if $\mathcal{C}^P_{c,m} = 0, \forall m$ and $R_{max} < t(k_0^i, c) \leq L$ and $t(k_0^i, c) >$ max and $c \neq c'$ **then**
      LastPoint $= t(k_0^i, c)$
      max $= t(k_0^i, c)$

Procedure 3: Select Device

if LastCandidateFlag=1 or candidate c' is the last one in this NP **then**
  $m' = \max_{\forall m}\{N_m \times \psi_m | \mathcal{C}^P_{c,m} = 0, \forall c\}$
  LastCandidateFlag= 1
else
  for $m = 1$ to M **do**
    if $\psi_m > 0$ and $\mathcal{C}^P_{c,m} = 0, \forall c$ **then**
      $m' = m$
      break

Procedure 4: Allocate NPDSCHSubframes

$x = -1$
$\delta = 0$
$h = 0$
while $\delta < \psi_{m'} \times N_{m'}$ and $h < H$ **do**
  $x = x + 1$
  if $\mathcal{S}^{P}_{t(k',c')+x,m} = 0, \forall m$ and $t(k',c') + x \leq L$ **then**
    $\delta = \delta + 1$
    if LastPoint$= t(k',c') + x$ and LastCandidateFlag=0 and $L -$ LastPoint $> \psi_{m'} \times N_{m'} - \delta$ **then**
      LastCandidateFlag $= 1$
      break
    if $\delta = N_{m'} \times N_{SF}^{(h+1)}$ **then**
      $h = h + 1$
  else if $\mathcal{S}^{P}_{t(k',c')+x,m} = 1, \exists m$ or $t(k',c') + x > L$ **then**
    break
if $h \geq 1$ **then**
  $\psi_{m'} = \psi_{m'} - N^{h}_{SF}$
  $\mathcal{C}^{P}_{c',m'} = 1$
  for $x = 0$ to $N_{m'} \times N^{h}_{SF} - 1$ **do**
    $\mathcal{S}^{P}_{t(k',c')+x,m'} = 1$

V. RESULT

The number of utilized NPs increments, when the quantity of gadgets increases. This is on the grounds that more gadgets have more information demands so that the base station needs to devour more NPs to fulfill the necessities of the considerable number of gadgets. The proposed calculation can outflank benchmark on the grounds that the proposed calculation can effectively utilize the NPDCCH and NPDSCH subframes to serve the gadgets. Additionally, the proposed calculation can stay away from the waste of the subframes behind the last NPDSCH begin subframe.

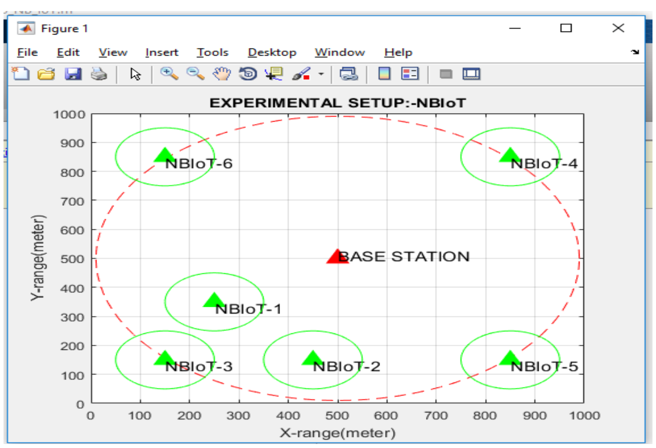

Fig. 2 NB-IoT Setup

NB-IoT proposes a cellular architecture based on low power wide area technology option for low data rate massive IoT applications. The Figure 2 shows experimental setup of NB-IoT we established one base station with six NB-IoT stations.

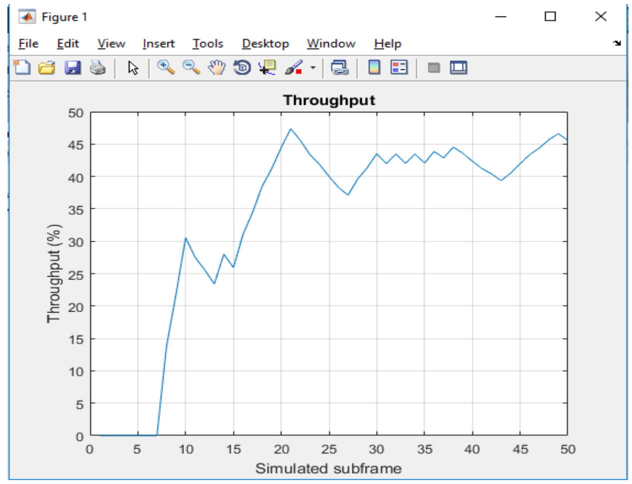

Fig. 3 Throughput in Percentage

Fig.3 We calculate the throughput of the system ,we get the transmitted channel received at the receiver. NB-IoT offers benfits in terms of latency quality of service. The diagram demonstrates the expansion in a subframe in remote correspondence the throughput of the framework additionally increments.

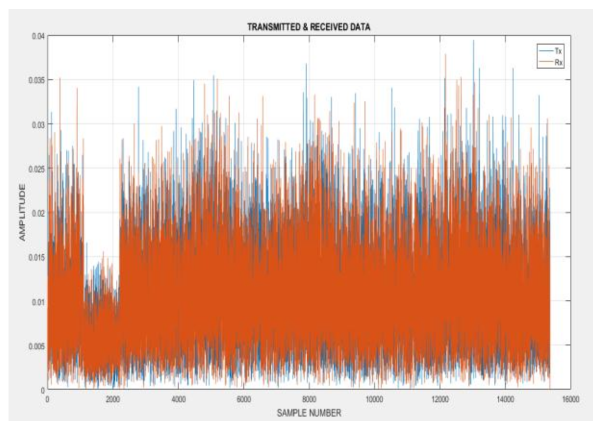

Fig.4 Data Transmission and Received Speed

VI. CONCLUSION

For NB-IoT cellular networks, we have implemented the NB-IoT downlink scheduling issue. We minimize the amount of NPDCCH (NPs) periods used to meet the information requirement of each device.[1] We observe that inappropriate selections will result in unnecessary NPDSCH subframe waste for applicants with scheduling delay values. Then we define in detail the strategy for NB-IoT radio access and formulate our goal issue. Then, based on our findings, we introduce an effective heuristic algorithm.[2] Through simulation, we show that our suggested algorithm is very efficient in decreasing the amount of NPs compared to a baseline algorithm. On the off chance that there is more than one user, the scheduler offers radio assets similarly, by and large, between users. This reasonable sharing standard is accepted autonomously of the radio conditions of the UEs sharing the scheduler assets.[7]

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