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Spectrum Allocation Policies for Flex Grid Network with Data Rate Limited Transmission

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Abstract - *The bit rate and the noise occurring while on transmission limit the maximum transmission length of the optical path. The crosstalk is the important noise that limits this maximum distance coverage in the multicore fiber. The tradeoff between the data rate on the media and the allocated frequency slots are made in order to make the choice of the offered bandwidth and the multi bit rate capable transponders.*

The modulation format also has to be considered. On consideration of the media provisioning the constant data rate all through the channel makes the chances of maximum utilization of the frequency slot as the 40Gbps demand will not be using the 400Gbps bandwidth. But when there is a higher demand for the larger data rate the guard bands have to be inserted between the channel as the penalty. If the bandwidth is available but the transmission is not reachable also the same penalty occurs. Thus the important issue in the frequency slot allocation is the routing and the spectrum allocation methods. BPSK transponder with multicore capability yields the better results.

Key Words: **Flex grid network, Optical Network, Optical Path, Spectrum Allocation**.

1. INTRODUCTION

The future trend of the fiber optics domain has been the Spatial Division Multiplexing (SDM) and is the topic of research in today's world. The two types of SDM are Mode-Division Multiplexing (MDM) and Multi-Core Fibers (MCF). These two techniques are challenging the today's technique. The mutual orthogonality between the propagation modes of a waveguide are used in the MDM which can be used as a independent medium. The MDM makes use of this advantage.

Flex-Grid networks are in high demand in current scenario as it provides very large bandwidth and efficiently incorporates together low bit rate optical paths and high data rate super channels. When considering the single core of MCF the optical paths are allotted continuously between the source and the destination.

There is no anticipation of the super channels in the work. In the Flex-grid network any of the incoming spectral allocated optical path can be switched any other path on the outgoing spectral path in the single core i.e it can be said that spatial multiplexing and demultiplexing happens at every intermediate nodes. consider that the main intention of this work is to equate multiple standard Single Core Fibers (SCF) and Multi Core Fibers(MCF) on the network link to a Flex-Grid Network. When this is done there will be much impairments due to coupling of the cores which will result under performance of transmission reach of the optical signals

1.1 Related Work

For the various traffic demands the sub-wavelength accommodation can be achieved by Orthogonal Frequency Division Multiplexing (OFDM) based Elastic Optical Network (EON). The EON is considered because of its advantages of bandwidth allocation, adaptive channel rate demands can be met and high spectrum efficiency [1].

To solve the problem of service connection and the holding time of the optical path in slice network traffic is time scheduled and heuristic algorithm which is time-aware spectrum efficient is used [2].

With the use of distance adaptive modulation format the utilization of bandwidth in SLICE is improved significantly compared to that which does not use the distance adaptive modulation format [3].

For the high traffic service the WDM networks with the data rate of 10Gbps, 40Gbps and up-to 100Gbps is used but these grid networks may not be able to give data rate of 400Gbps or more. To realize that the EON was proposed which can be used to service the high traffic service rate. When EON is combined with OFDM the results improve significantly [4].

To solve the complexity introduced in SLICE network due to sub wavelength level of allocation can be solved by the use of shortest path and balanced lode spectrum allocation [6,2].

For the problems of RSA numerous optimization techniques like interger Linear programming, Simulated Annealing , Genetic Algorithms are used. In SLICE networks to avoid the chromatic dispersion impairments and polarized mode dispersion(PMD) the OFDM is used [7].

Thus there are many modulation formats used for this purpose, but when the demand is high the performance may not be to the expected.

2. OBJECTIVES

The objective of the proposed work is to :

- Identify optical path with end to end connectivity.
- Discover the path length of the signal from source to destination.
- Choose the best suited modulation scheme for the RSA.
- Make a comparative study to find out the optimal route with effective modulation scheme providing maximum utilization of bandwidth.

3. METHODOLOGY

To approximate the allocation of the spectrum of the Optically Amplified Single- core fiber optic channel one has to consider number of factors. The special purpose processors used compensate for both CD and PMD. It also corrects the faults that are intra channel nonlinear effects but fails to compensate for the interchannel nonlinear effects. This is the biggest limiting factor. To overcome this the power transmitted is made constant considering constant baud rate and spacing between the channel. The maximum distance covered with the spectrum allocation considering the ASE noise using Erbium Doped Fiber Amplifiers are

$$\frac{Ps\ Lspan}{SNRmin\ h\ f\ G\ NF\ Rs} \qquad (1)$$

The required SNR at the receiver side considering the average optical power per transmitter channel is the distance between the amplifiers is as table 4.1

Table 4.1 SNR at BER of 10^{-2}

BPSK	QPSK	16QAM	64QAM
4.2db	7.2db	13.9db	19.8db

The transmission through the MCFs is also affected by the coupling of the multicores and the values for intra-core XT is as shown in table 4.2. theintracore XT wavelength dependency is considered to be 1550nm.

Table 4.2Worst Aggregate Of Inter Core XT

7 cores	12 cores	19 cores
-84.7 db	-61.9 db	-54.8 db

The distance which is limited by the inter-core XT is as follows

$$Lmax,XT = 10^{\frac{XT\ dB,max - XT\ dB,1km}{10}}\ Km \qquad (2)$$

The XT $_{dB,\,max}$ depends on the modulation format use and the table 4.3 highlights the XT Values.

Table:4.3 In-Band XT Values For 1db-Penalty

BPSK	QPSK	16QAM	64QAM
-14db	Db	13.9db	19.8db

4. IMPLEMENTATION

The implementation part of this work is presented briefly as described in the algorithms show in this section.

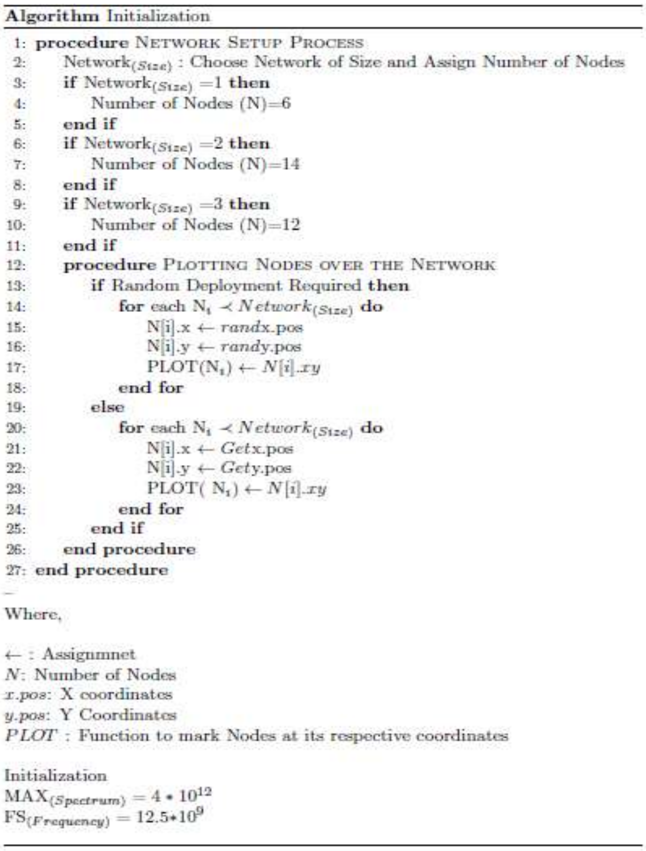
The first part of the algorithm deals with the initial network setup starting from choosing the network size, plotting the nodes, connecting the nodes and initialize frequency level as shown in algorithm-1.

The second algorithm deals with the finding the shortest path between N nodes using KPATH shortest path algorithm. Using this shortest path between the nodes is identified and the same will be depicted in the graph as shown in algorithm-2.

The third algorithm deals with the candidate path algorithm using the source, destination, nodes, path, w and other parameters as shown in algorithm-3

The fourth algorithm aims in allocation of the spectrum between chosen nodes which is having shortest path with the subcarrier path allocation as shown in algorithm-4.

Algorithm 1



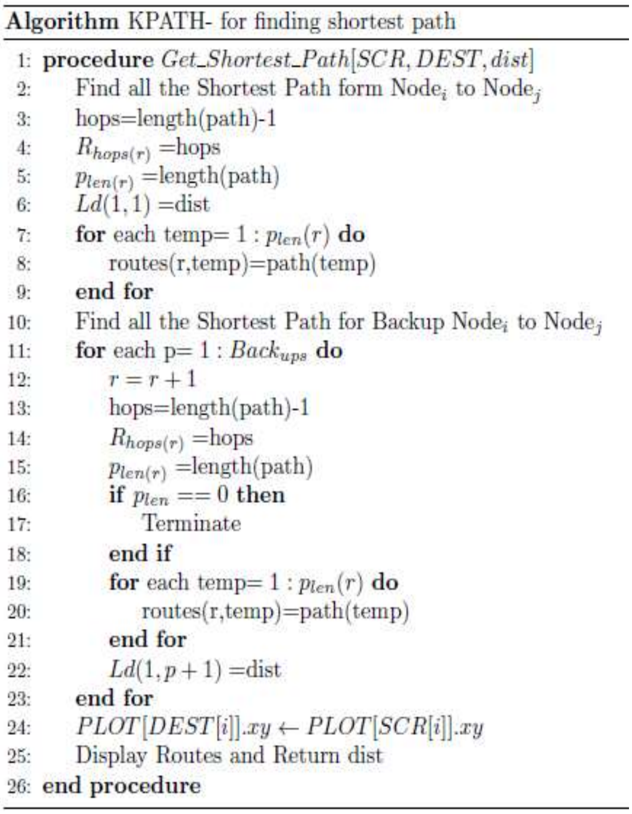
```
Algorithm Initialization
procedure NETWORK SETUP PROCESS
    Network$_{(Size)}$ : Choose Network of Size and Assign Number of Nodes
    if Network$_{(Size)}$ =1 then
        Number of Nodes (N)=6
    end if
    if Network$_{(Size)}$ =2 then
        Number of Nodes (N)=14
    end if
    if Network$_{(Size)}$ =3 then
        Number of Nodes (N)=12
    end if
    procedure PLOTTING NODES OVER THE NETWORK
        if Random Deployment Required then
            for each $N_i \prec Network_{(Size)}$ do
                N[i].x ← randx.pos
                N[i].y ← randy.pos
                PLOT(N_i) ← N[i].xy
            end for
        else
            for each $N_i \prec Network_{(Size)}$ do
                N[i].x ← Getx.pos
                N[i].y ← Gety.pos
                PLOT( N_i) ← N[i].xy
            end for
        end if
    end procedure
end procedure
```

Where,

← : Assignmnet
N: Number of Nodes
x.pos: X coordinates
y.pos: Y Coordinates
PLOT : Function to mark Nodes at its respective coordinates

Initialization
$MAX_{(Spectrum)} = 4 * 10^{12}$
$FS_{(Frequency)} = 12.5*10^{9}$

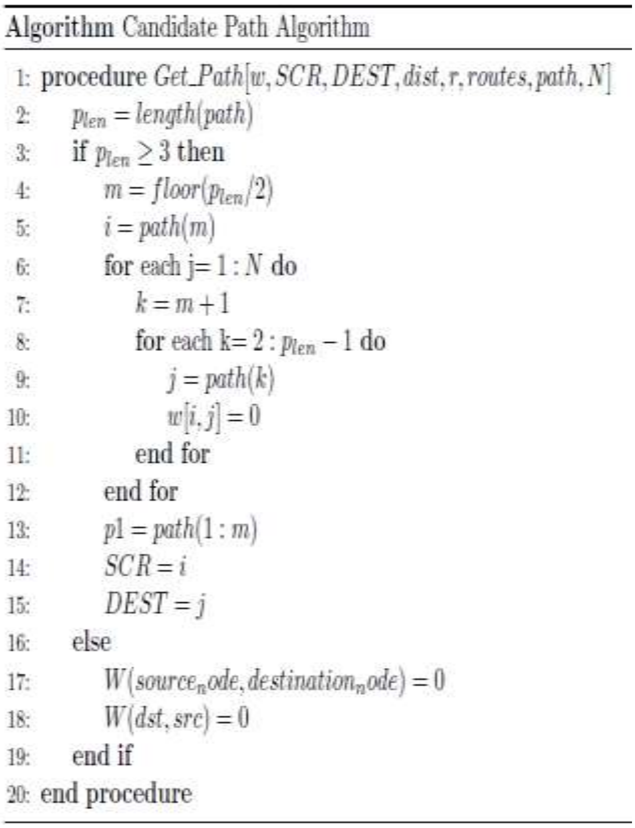
Algorithm 2



Algorithm KPATH- for finding shortest path

```
procedure $Get\_Shortest\_Path[SCR, DEST, dist]$
    Find all the Shortest Path form $Node_i$ to $Node_j$
    hops=length(path)-1
    $R_{hops(r)}$ =hops
    $p_{len(r)}$ =length(path)
    $Ld(1,1)$ =dist
    for each temp= $1 : p_{len}(r)$ do
        routes(r,temp)=path(temp)
    end for
    Find all the Shortest Path for Backup $Node_i$ to $Node_j$
    for each p= $1 : Back_{ups}$ do
        $r = r + 1$
        hops=length(path)-1
        $R_{hops(r)}$ =hops
        $p_{len(r)}$ =length(path)
        if $p_{len} == 0$ then
            Terminate
        end if
        for each temp= $1 : p_{len}(r)$ do
            routes(r,temp)=path(temp)
        end for
        $Ld(1, p + 1)$ =dist
    end for
    $PLOT[DEST[i]].xy \leftarrow PLOT[SCR[i]].xy$
    Display Routes and Return dist
end procedure
```

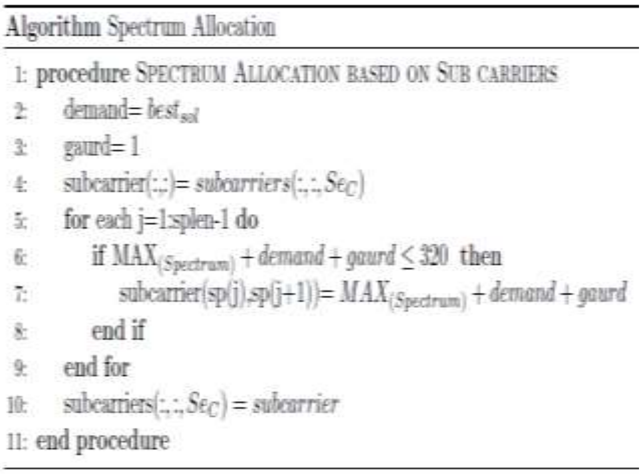
Algorithm 3



Algorithm Candidate Path Algorithm

```
procedure $Get\_Path[w, SCR, DEST, dist, r, routes, path, N]$
    $p_{len} = length(path)$
    if $p_{len} \geq 3$ then
        $m = floor(p_{len}/2)$
        $i = path(m)$
        for each j= $1 : N$ do
            $k = m + 1$
            for each k= $2 : p_{len} - 1$ do
                $j = path(k)$
                $w[i, j] = 0$
            end for
        end for
        $p1 = path(1 : m)$
        $SCR = i$
        $DEST = j$
    else
        $W(source_node, destination_node) = 0$
        $W(dst, src) = 0$
    end if
end procedure
```

Algorithm 4



Algorithm Spectrum Allocation

```
procedure SPECTRUM ALLOCATION BASED ON SUB CARRIERS
    demand= $best_{sol}$
    gaurd= 1
    subcarrier(:,:)= $subcarriers(:, :, Se_C)$
    for each j=1:splen-1 do
        if $MAX_{(Spectrum)} + demand + gaurd \leq 320$ then
            subcarrier(sp(j),sp(j+1))= $MAX_{(Spectrum)} + demand + gaurd$
        end if
    end for
    $subcarriers(:, :, Se_C) = subcarrier$
end procedure
```

5. RESULTS

Above algorithms are combine to form a balanced modulation technique. In this technique firstly it search a network in that it finding the shortest path.

The system is implemented for a 6 node network with the demand matrix of 6X6 and 30 valid requests. The 12 and 14 node NSFNET is also used for the validations.thedemand requests considered are 250Gbps to 1500Gbps. For high bandwidth requirement M-ary encoding is used. The fig 6.1 shows the 14 node network

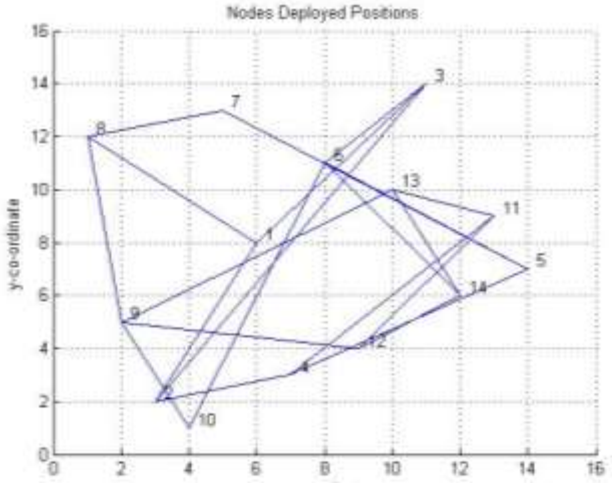


Fig 6.1: 14 node network

The demand is considered between 40Gbps to 400Gbps and the multiplicity of cores are 7,12,19. The fragment number increments as the demand increments buthe for some of the core fibers it is constant. The amount of modulator used is uniform for all the core options as the designed network uses the BPSK modulators.

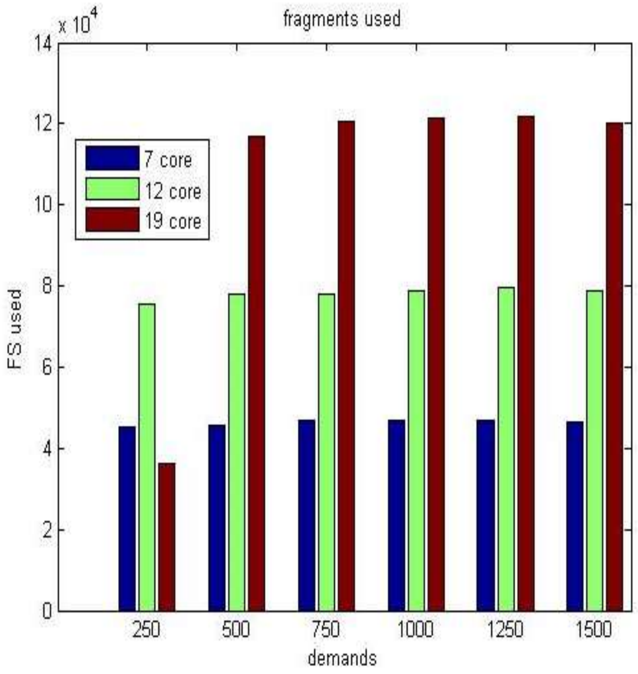


Fig 6.2. A 14 node N/w fragments usage per 7, 12, 19 core

The fig 6.2 shows that there is less fragments usage at the low demands and very high usage as the demands increase along with requests.

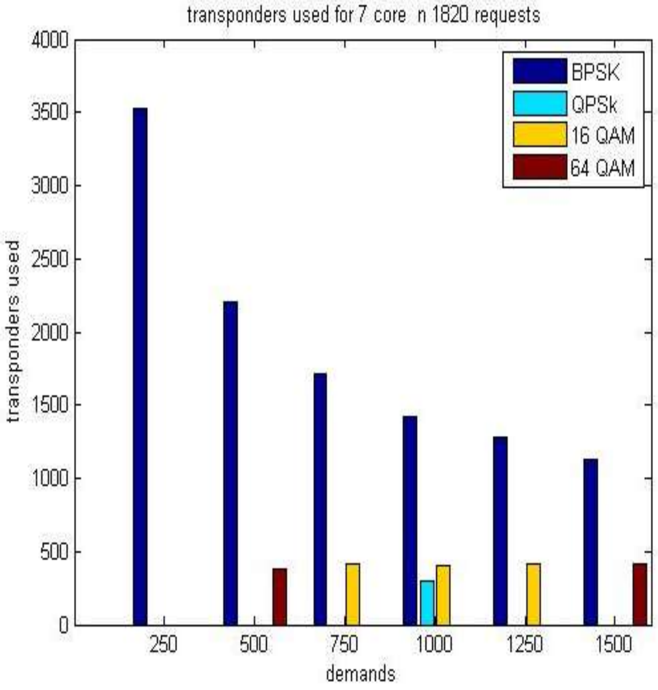


Fig.6.3 A 14 node N/W fragments usage for 7core

The number of transponders used is dependent on the demand requirements and the slot availability. The fig 6.3 shows the A 14 node N/W fragments usage for 7core. It shows that as the number of requests increase higher rate transponder are used more.

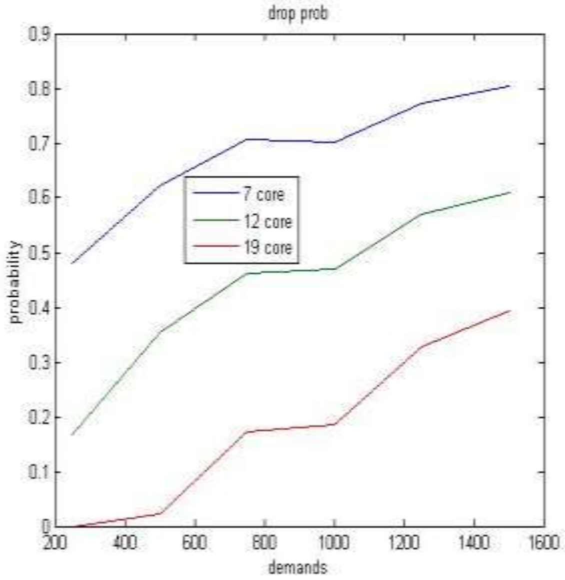


Fig 6.4:A drop probability for 7, 12, 19core fiber Network

As the core number increases the number of transponder required also increases. The same study is done for the 12 core and 19 core. It is seen from the experiments that if the number of request are dropped the fragments varies and the changes is uniform across different cores under study. The fig 6.4 shows the 14 node 1820 requests probability of requests drops at every core level. It betters with the increasing cores.

6. CONCLUSIONS

The multiple core multi demand requests for various small as well as large networks implemented and results are analyzed.

Hence it is also called as Balanced Core Modulation Technique(BCMT). For very low demand since the fragments are more than sufficient no effects of higher core usage as well as higher rate transponders observed. But as there is an increase the demand as well as number of requests higher rate transponders are used judiciously.

Also it is observed that higher number of cores provide cushion to use BPSK transponders more needing less power in case of SNR requirements. And the requests drop rates are less for higher core fibers. The reach length is mostly limited by the noise more than cross talk in case of multi core fibers.

REFERENCES

[1]. Bingbing Li and Young-Chon Kim “Efficient Routing and Spectrum Allocation considering QoT in Elastic Optical Network” International Journal of Advances in Telecommunications, Electrotechnics, Signals and Systems. 2016

[2] Yang Qiua, Zheyu Fan b, Chun-Kit Chan b “Efficient routing and spectrum assignment in elastic opticalnetworkswith time scheduled traffic”OpticalFiberTechnology 30 (2016) 116-124.

[3] T.Takagi1, H. Hasegawa1, K. Sato1, Y. Sone2, B. Kozicki2, A. Hirano2, and M. Jinno2

“Dynamic Routing and Frequency Slot Assignment for Elastic Optical Path Networks that Adopt Distance Adaptive Modulation”.Optical Fiber Communication Conference and Expositionand the National Fiber Optic Engineers Conference.2011

[4]R.-J. Essiambre et al., “Capacity Limits of Optical Fiber Networks”, IEEE/OSA J. Lightwave Technol., vol. 28, no. 4, pp. 662-701, Feb. 2010.

[5]P. J. Winzer, “Spatial Multiplexing in Fiber Optics: The 10x Scaling of Metro/Core Capacities”, Bell Labs Tech. Journal, vol.19, pp. 22-30, Sept. 2014.

[6]Howard R. Stuart, “Dispersive Multiplexing in Multimode Optical Fiber”, Science 289 (5477), 281, July 2000.

[7]N.K. Fontaine, et al, "30×30 MIMO transmission over 15 spatial modes," in Proc. OFC 2015 , March 2015.

[8]J. Sakaguchi et al., “Space Division Multiplexed Transmission of 109-Tb/s Data Signals Using Homogeneous Seven-Core Fiber”, IEEE/OSA J. Lightwave Technol., Vol. 30, no. 4, p. 658665, Jan. 2012.

[9]Sano et al., “409-Tb/s + 409-Tb/s crosstalk suppressed bidirectional MCF transmission over 450 km using propagation-direction interleaving”, Opt. Express, vol. 21, pp. 16777-16683, Jul. 2013.