m61054
[EE13.50 Test 2] Trisoup Variable Node Size Extension

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Overview

Problem statement

- Current Trisoup can choose only one node size for each slice.
- Variable node size extension has been studied in this EE.

Proposed Method in m57368

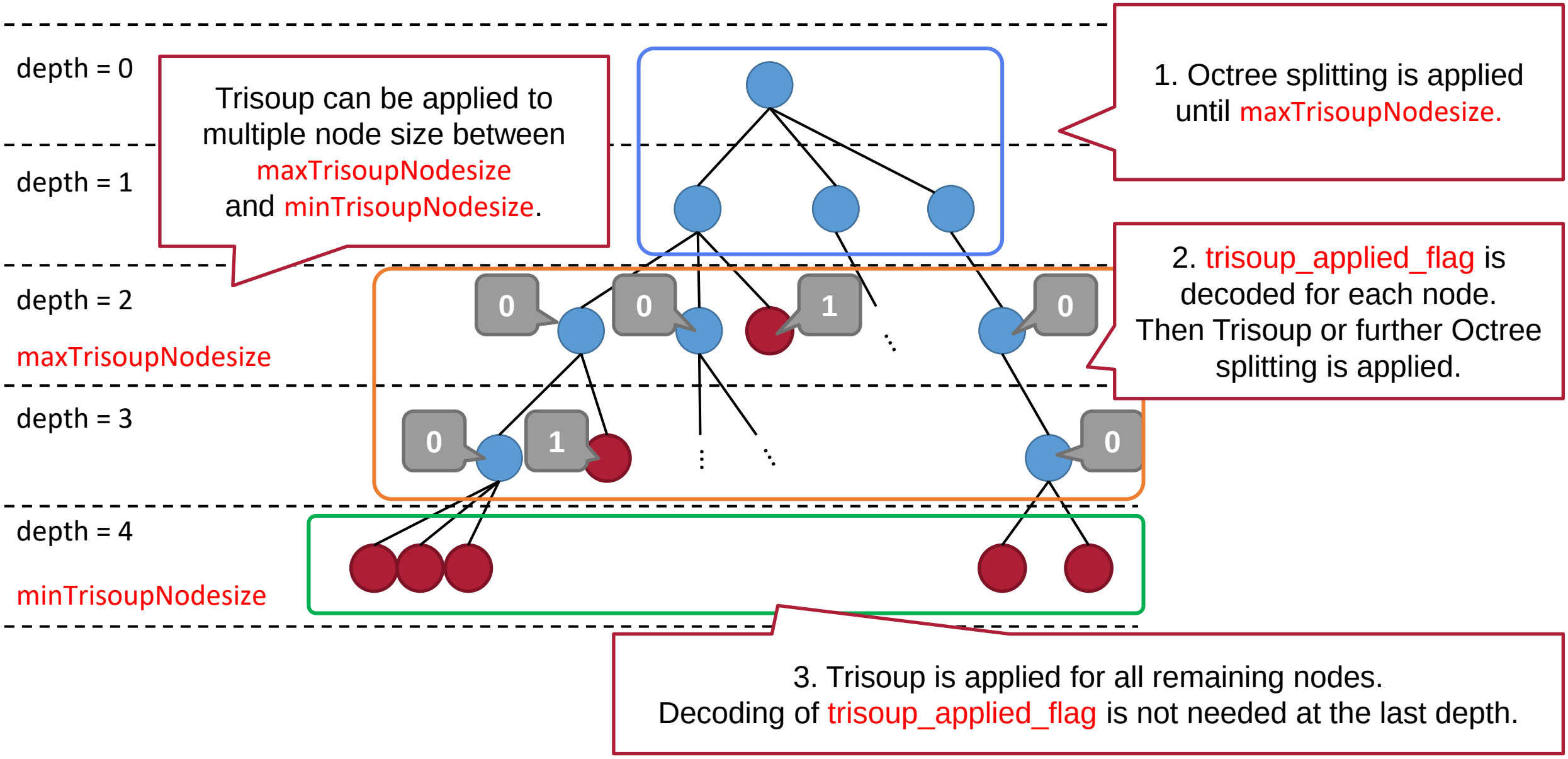
- maxTrisoupNodesize and minTrisoupNodesize are defined for each slice.

Harmonization with Trisoup Improvements is proposed.

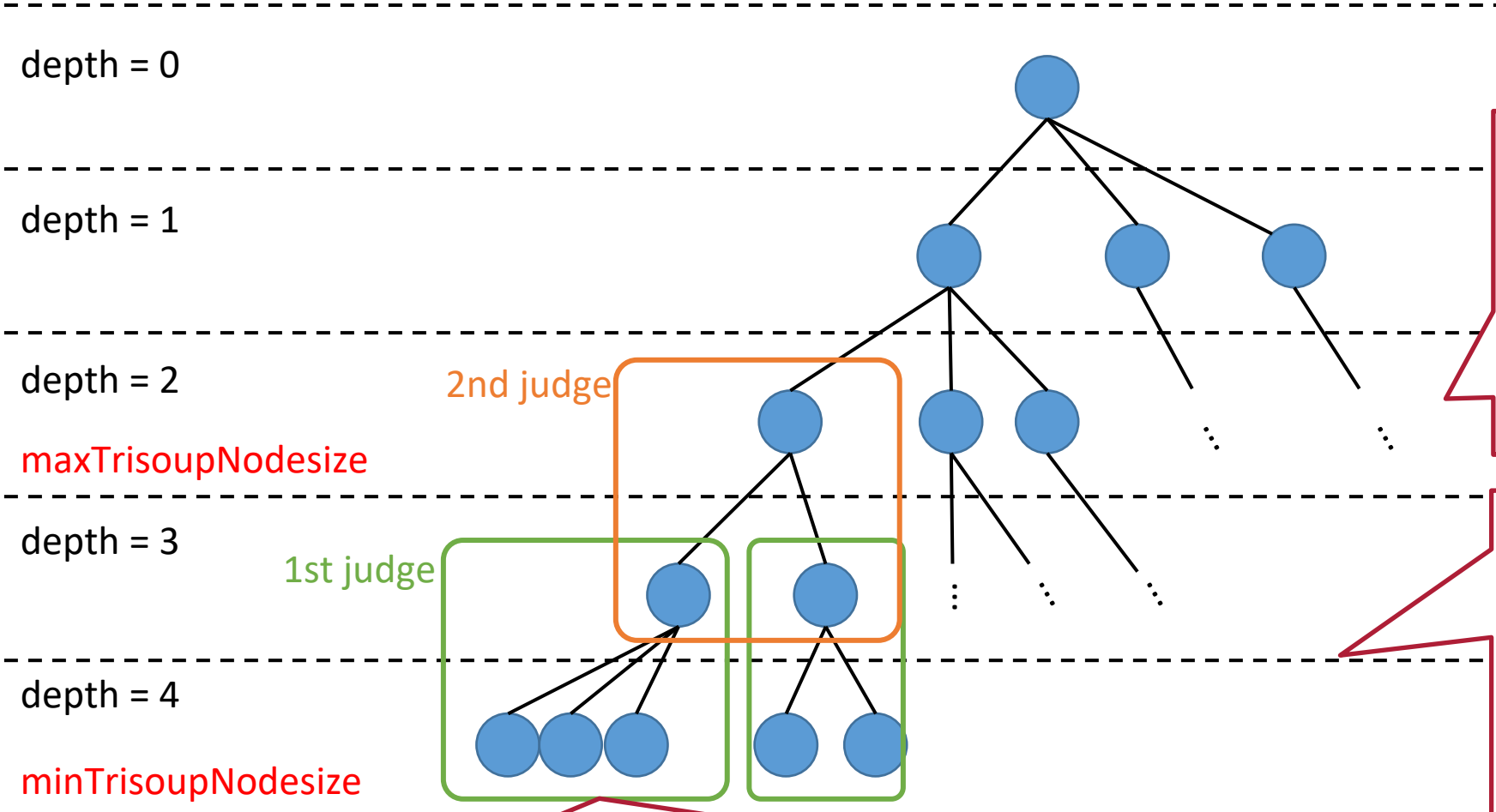
Experimental results

- BD-rates are 4.2%/12.2% (D1/D2) compared with TMC13-v19
- Ref.: BD-rate are -7.5/0.7% (D1/D2) compared with TMC13-v14 reported in m57368.
- Further study is needed.

Proposed decoding process (Octree part)



Proposed node size determination (encoder)



1. Point clouds are reconstructed by single-level Trisoup for each depth, respectively.

2. Costs of a parent node and child nodes are compared and retain lower cost nodes recursively from bottom to top.

Previously, four variations of cost function are tested.
(1) D1 MSE, (2.1) D1+D2, (2.2) D1+4*D2, (3) D1+4*D2+λR

Harmonization with Trisoup Improvements

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- **Trisoup improvements proposed by Xiaomi are adopted to TMC13-v19.0**
  - **Harmonization is necessary to obtain the original effect of variable node size.**

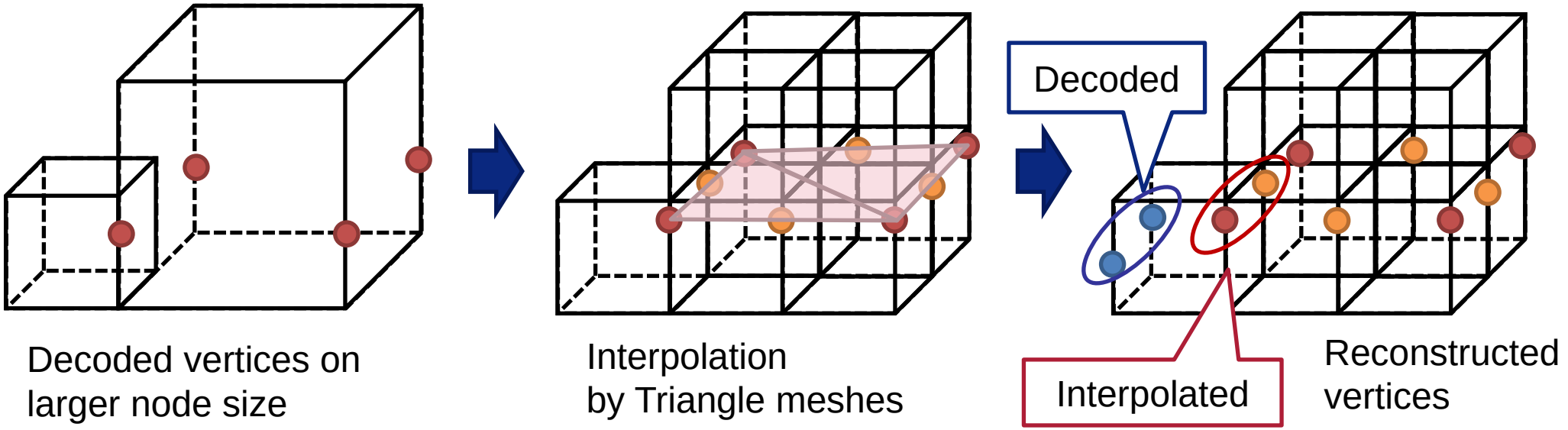
Reference: Experimental results in July meeting (m60159)

Method	Anchor and Base method	Cost function	D1 BD-R	D2 BD-R	EncT	DecT
Test 2.2 in July meeting	Trisoup Improvements	$D1 + 4 * D2$	3.1 %	6.5 %	206 %	107 %
Test 3 in July meeting	Trisoup Improvements	$D1 + 4 * D2 + \lambda R$	6.1 %	13.9 %	208 %	109 %
Test 2.2 in m57368	TMC13-v14	$D1 + 4 * D2$	-1.5 %	2.5 %	196 %	101 %
Test 3 in m57368	TMC13-v14	$D1 + 4 * D2 + \lambda R$	-7.5 %	0.7 %	195 %	97 %

- **We add the following changes to harmonize with the improvements**
  1. **Skip segment indicator and vertex position coding by interpolation of vertices from larger node size**
  2. **Using neighboring information from nodes in different node sizes**
  3. **Extension of parameter settings**

Proposed Harmonization

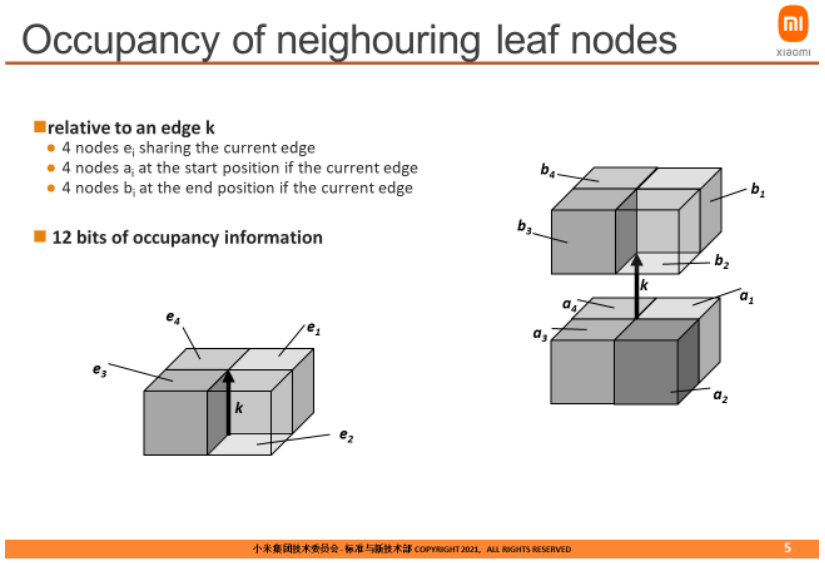
1. **Skip segment indicator and vertex position coding by interpolation of vertices from larger node size**
   - **Vertices are decoded from larger nodes to smaller nodes.**
   - **When the current node size is larger than the min. node size, vertices on min. node size grid are interpolated.**
   - **If an interpolated vertex is on an edge, segment indicator and vertex position coding is skipped.**

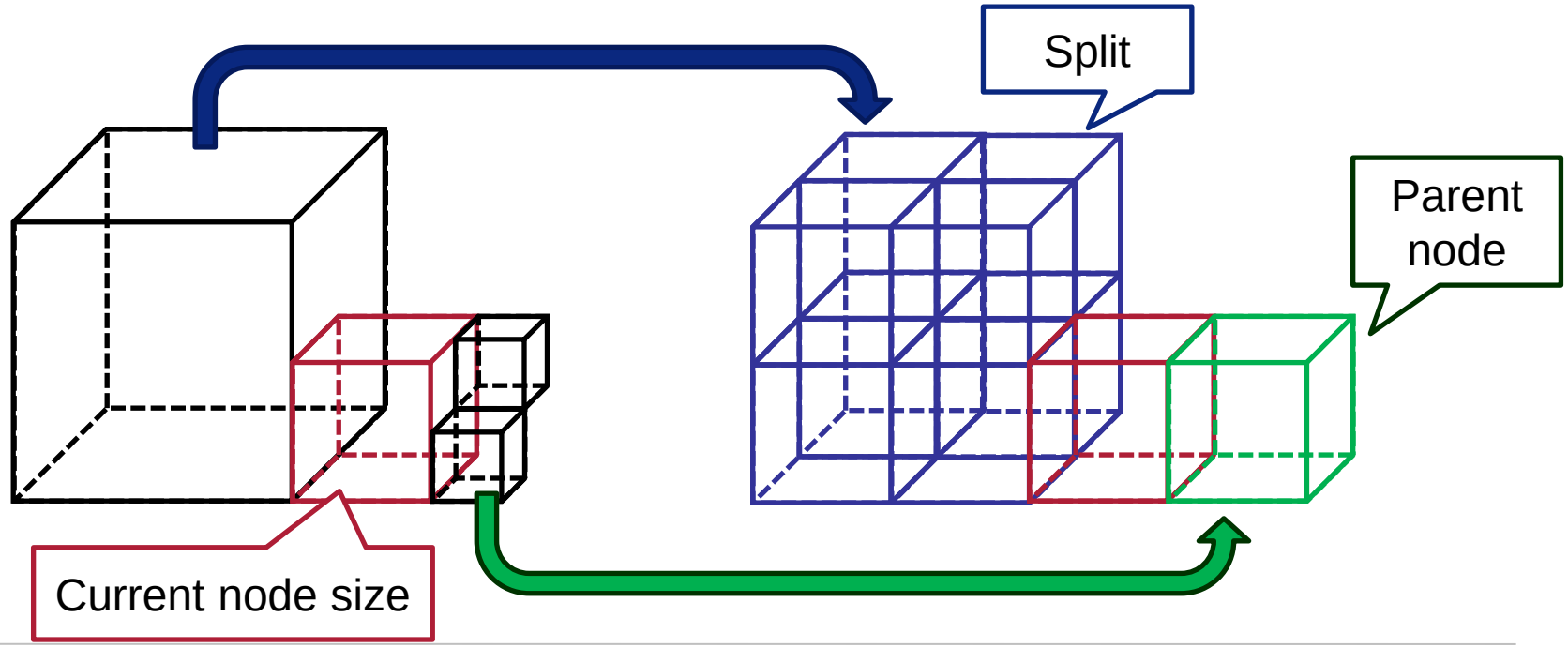


Proposed Harmonization

2. Using neighboring information from nodes in different node sizes

- **Conventional: Segment indicators are coded independently for each node size**
- **Proposal: Nodes with different size are converted to the current node size, then they are used as neighboring nodes for context coding.**
  - Larger nodes are split into the current node size.
  - Parent nodes of smaller nodes are preserved in Octree process and use it.





Proposed Harmonization

3. Extension of parameter settings

- **We extend the following parameter settings to node size basis,**
  - trisoupCentroidResidualEnabled
    - In TMC13-v19.0, this option is set based on node size.

Variant	r01	r02	r03	r04
Node size Log2	5	4	3	2
trisoupCentroidResidualEnabled	1	1	1	0

    - It is straightforward that this option is set node size basis in variable node size case.

  - trisoupQuantizationBits
    - Precision of vertex position.
    - It is set to 2 (bits) for all variant in TMC13-v19.0.

Experimental settings

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Conditions

- Anchor : TMC13-v19.0
- Test : TMC13-v19.0 + Proposed method
- Trisoup – RAHT (Only C2 condition, Solid, Dense, Sparse, and Scant Classes)

Parameter settings

- Node size: It can be chosen among CTC and CTC+1.
- trisoupCentroidResidualEnabled: the same settings with TMC13-v19.0 for each size
- trisoupQuantizationBits: 2 bits for the min size, 3 bits for the max size.

Method	Settings			
	r01	r02	r03	r04
Node size	6, 5	5, 4	4, 3	3, 2
trisoupCentroidResidualEnabled	1, 1	1, 1	1, 1	1, 0
trisoupQuantizationBits	3, 2	3, 2	3, 2	3, 2

Experimental settings

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- **Cost function (same as m57368)**
  - **D1 MSE: Symmetrical,**
  - **D2 MSE: Asymmetrical (only use original normal data),**
  - **In test 2.2, D2 MSE is multiplied by four**
    - D1 MSE is roughly four times larger than D2 in CTC.
  - **λ is heuristically set as {372.0, 26.0, 1.8, 0.12} for {r01, r02, r03, r04}.**
  - **Previously, four types of cost functions are tested.**

Test	Cost function
1	$D1$
2.1	$D1 + D2$
2.2	$D1 + 4 * D2$
3	$D1 + 4 * D2 + \lambda R$

- **In this report, we used Test 3 setting.**

Experimental results

- **BD-rates are improved in comparison with July meeting.**
  - **Especially, bit rate on r04 is significantly improved.**
- **However, there is still coding loss.**

Method	Anchor and Base method	Cost function	D1 BD-R	D2 BD-R	EncT	DecT
Test 3	TMC13-v19	$D1 + 4 * D2 + \lambda R$	4.2 %	12.2 %	201 %	106 %
(Ref.) Test 3 in July meeting	Trisoup Improvements	$D1 + 4 * D2 + \lambda R$	6.1 %	13.9 %	208 %	109 %
(Ref.) Test 3 in m57368	TMC13-v14	$D1 + 4 * D2 + \lambda R$	-7.5 %	0.7 %	195 %	97 %

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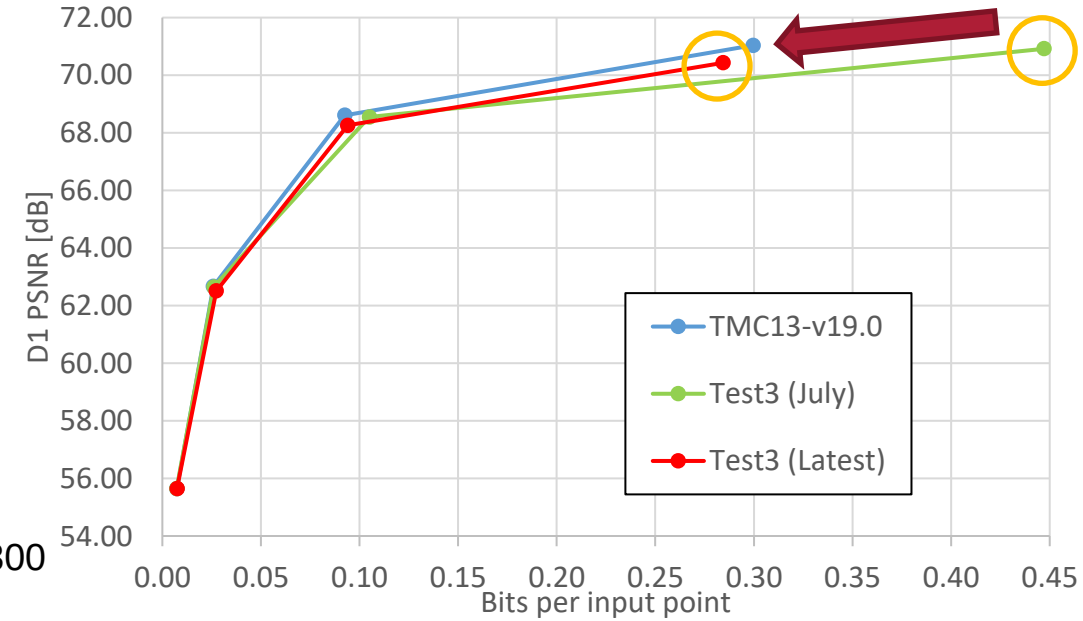
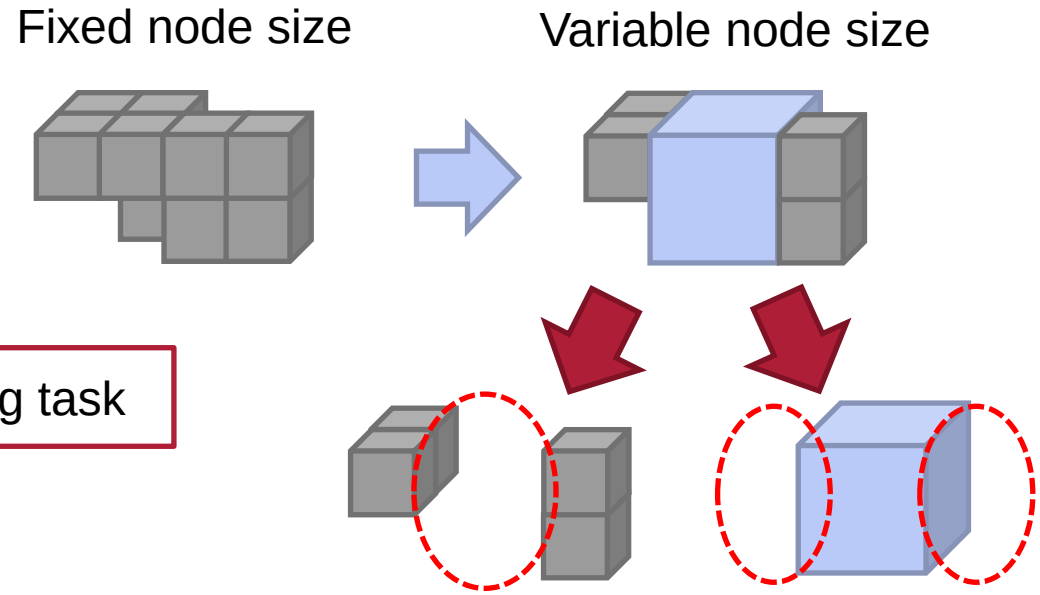


Estimated causes of different behaviors (in July meeting)



1. **Coding losses by variable node size**
   - **Segments and vertices are coded independently for each node size in the variable case.**
   - **Node distributions may become sparser, and it may degrade the coding efficiency of the improved method.**

Done

Remaining task

2. **Coding losses by λR in the cost function**
   - **R (includes bits for segments and vertices) is estimated by assuming fixed-length coding.**
   - **It becomes relatively rough than the actual coding method in improved Trisoup.**
   - **Additionally, values of λ should be tuned for improved coding method.**

Element	Improved method	TMC13-v14	R estimation
Segments	Context coding	Simple context coding	Fixed-length coding
Vertices	Context coding	Fixed-length coding	Fixed-length coding

- **Harmonization with improved Trisoup should be studied to obtain coding gains.**
  - **We have already started studying and confirmed several coding efficiency improvements.**
  - **However, more studies are needed.**

Conclusion

- **Problem statement**
  - Current Trisoup can choose only one node size for each slice.
  - Variable node size extension has been studied in this EE.
- **Proposed Method in m57368**
  - maxTrisoupNodesize and minTrisoupNodesize are defined for each slice.
- **Harmonization with Trisoup Improvements is proposed.**
- **Experimental results**
  - BD-rates are 4.2%/12.2% (D1/D2) compared with TMC13-v19
  - Ref.: BD-rate are -7.5/0.7% (D1/D2) compared with TMC13-v14 reported in m57368.
  - Further study is needed.
- **Recommendation**
  - Continue to study in EE.