C-RAIL®
Planning Guide

Foreword:
This document describes all those major steps that planners are recommended to follow to correctly quantify the requested volume of major C-RAIL® system components.

Incoming data:
The planning process must be based on realistic and precise numeric data of the planned network:
- Length of the network
- Number of poles
    - Number of start/end poles,
    - Number of breaking points (over 10º)
    - Number of road crossings (spanning)
- Access closure locations
- Over length creation concept (where and what quantity)
- Cable type(s) (fibre count) selection

Source of data:
Some of above data are generated by geographical conditions, but some of them depend on customer request, like access closure number and locations, over length creation concept, fibre count of optical cable. All these questions have to be answered before starting to design the C-RAIL® system.

Recommended sequence of planning:
1. Planning C-Rail-Messenger length
2. Planning C-Rail-Cable length & fibre capacity
3. Planning of required C-Rail-Anchor dead ends
4. Planning of required C-Rail-Brackets
5. Planning the numbers of customer access points
6. Planning the required C-Rail-Closures, accessories and C-Rail-Over length-Storages

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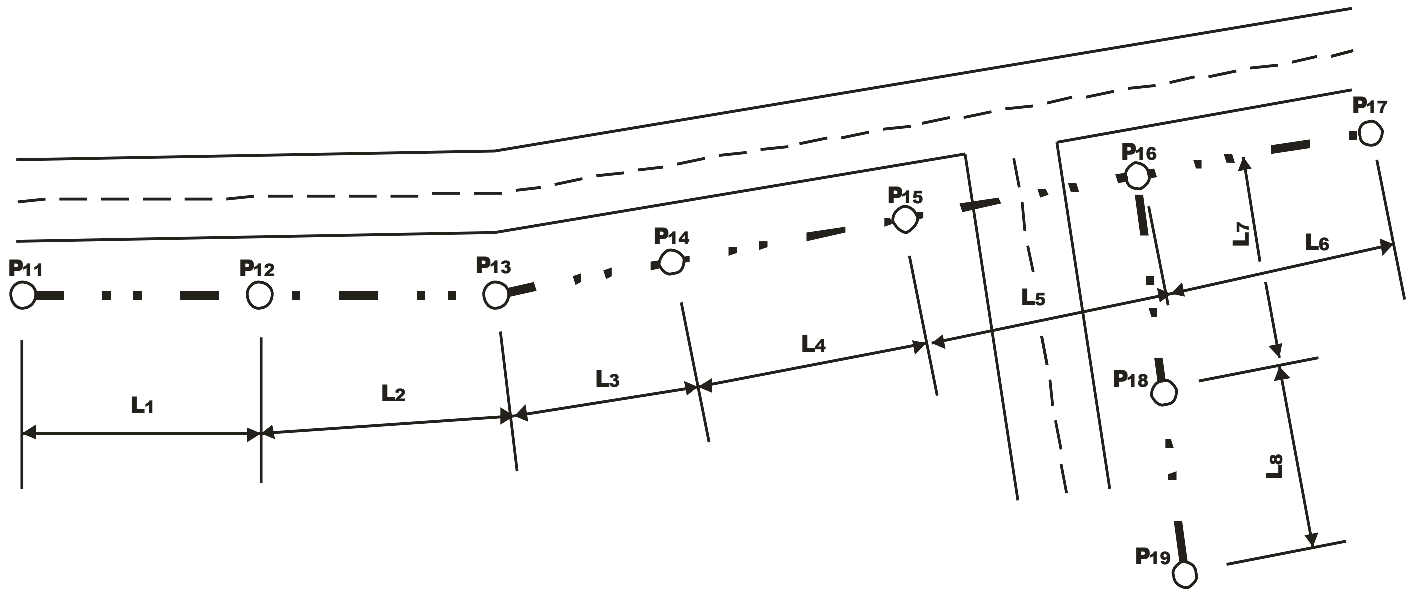
Planning the length of C-Rail-Messenger

Procedure: The length of the messenger depends on the length of the network, which can be calculated by adding sectional lengths (streets) to each other or by adding all pole distances. Working with pole distances is a more time consuming activity, but helps the designer to identify those problematic areas like L_3 and L_4 in the following drawing.

As it is seen, L_4 distance is significantly longer than L_3, consequently, if just a simple holding bracket is planned for pole number P_{14} much higher cable sag will be generated in section L_4 than in L_3. If the higher sag is problematic - a pair of dead end frames must be used at P_{14} to isolate tensile strengths values of the opposite directions. In this case, higher strength must be applied on section L_{14} in order to guarantee the same sag value.

In general, calculating the network length by using sectional data - is a faster process, but above described possibly problematic areas may remain hidden from planner.

Example:



Length calculation: L_{mess}= (L1 + L2 + ... + L8) x 1,05

P_{xx} = Pole number
L_x = Pole distance
L_{mess} = The required messenger length

Planning length of C-Rail-Cable

Procedure: The previously calculated messenger length is the major incoming data for the cable length calculation. It must be increased by the total length of different excess cable lengths generated by the followings:

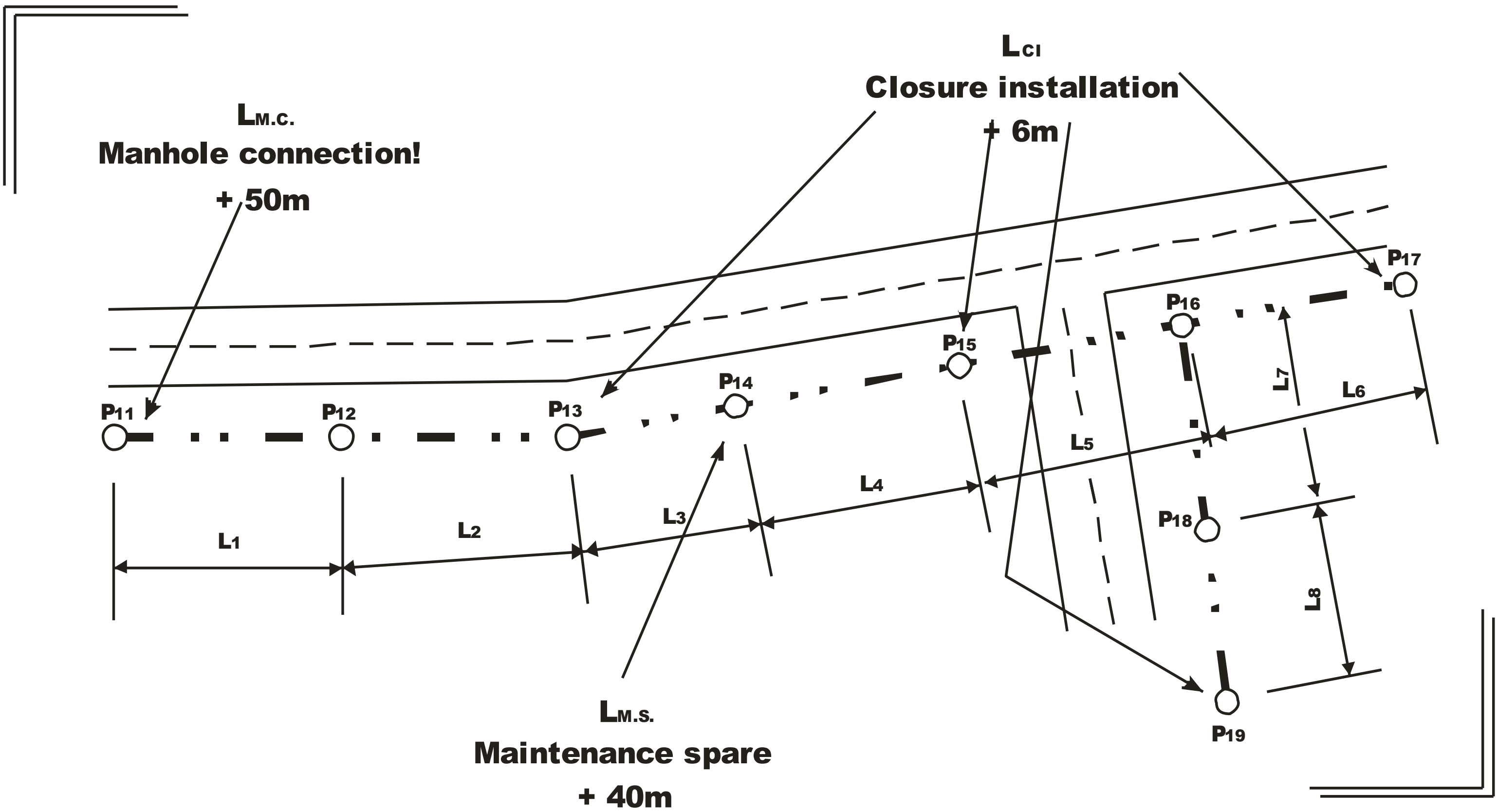
-excess length created at access closures for installation and maintenance purposes
-excess length at substructure / aerial transition points for maintenance purposes
-excess length near road crossings for maintenance purposes
-any other reasons generated by local circumstances

For a correct cable length calculation, the planner must calculate the total additional length required by above listed excess sub-volumes, then it should be added to the messenger length requested base cable length.

Example: The following sample drawing shows, that the network developer wants to realise excess lengths due to three reasons: Access closure installation, substructure / aerial transition, general maintenance spare at certain points.

Cable length is calculated in the following way:

$$L_{cab} = L_{mess} + L_{M.C.} + (n \times L_{C.i.}) + (m \times L_{M.s.})$$



$L_{M.c.}$ = excess cable length for manhole connection
$L_{M.s.}$ = excess length created for service purposes
$L_{C.i.}$ = excess length for closure installation
n = number of fibre access closures
m = number of service excess lengths

Planning the volume of dead end frames
C-RAIL-ANCHOR

Procedure:

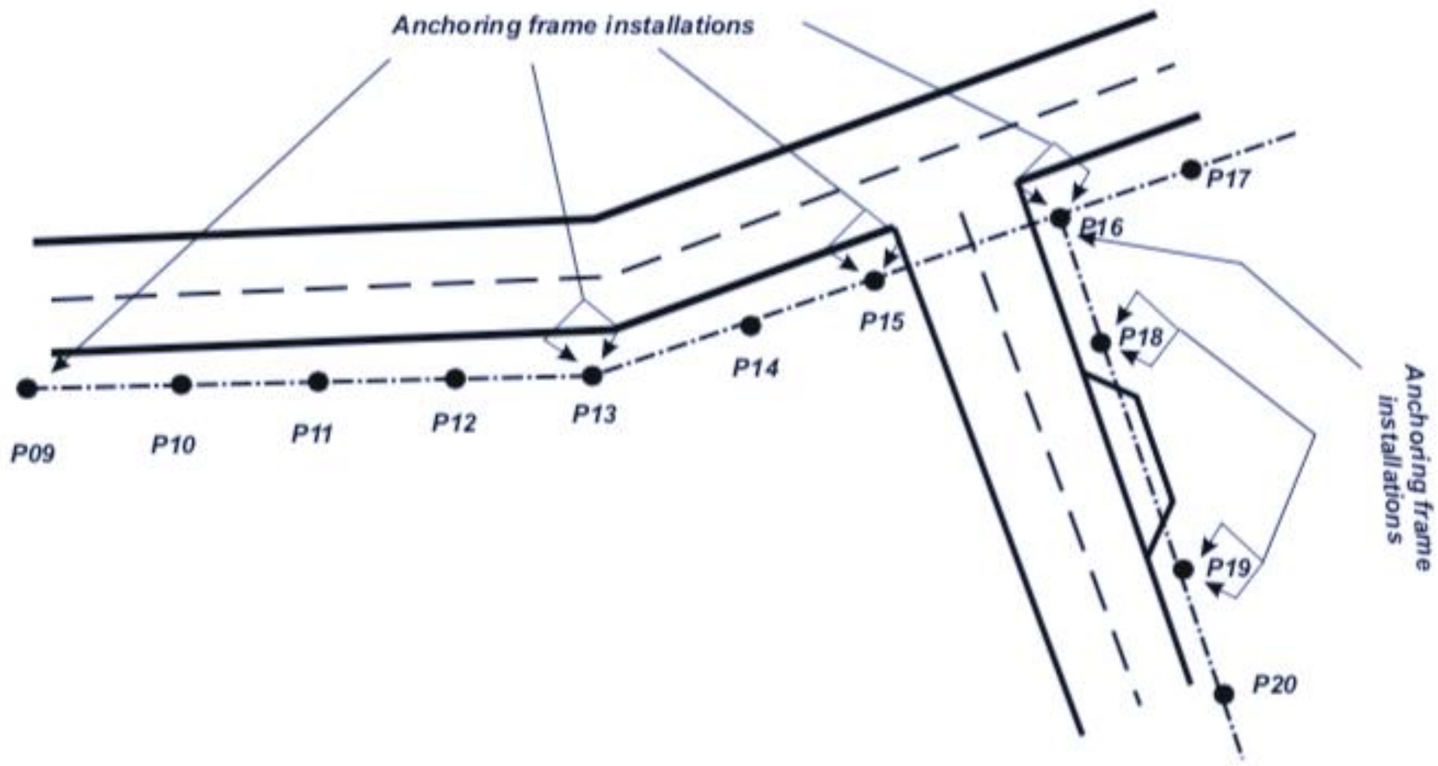
There are six major reasons to use a C-Rail-Anchor:

1. Use C-Rail-Anchor dead end termination at start and end poles of each line
2. Use C-Rail-Anchor dead end termination at road crossings (at the nearest left and right side pole)
3. Use C-Rail-Anchor dead end termination at the breaking point of the line, if breaking angle reaches or exceeds 10°.
4. Use C-Rail-Anchor dead end termination at each pole of steep hills or slopes, if steepness reaches 10°.
5. Use C-RAIL-C-Rail-Anchor dead end termination at the vertical breaking point of the line (i.e starting point of a hill), if breaking angle reaches or exceeds 10°.
6. Use C-Rail-Anchor dead end termination at those poles of the line, where left and right side distance (to neighbouring poles) deviate from each other by more than 15%.

Addition: In case of extreme steep hills (steepness ≧ 15°) use C-Rail-Hook-Base-Adapter for angle mounting of the C-Rail-Hook product. It supports the messenger installation for steepness up to 40°.

Planning the volume of dead end frames
C-RAIL-ANCHOR

Sample map section:



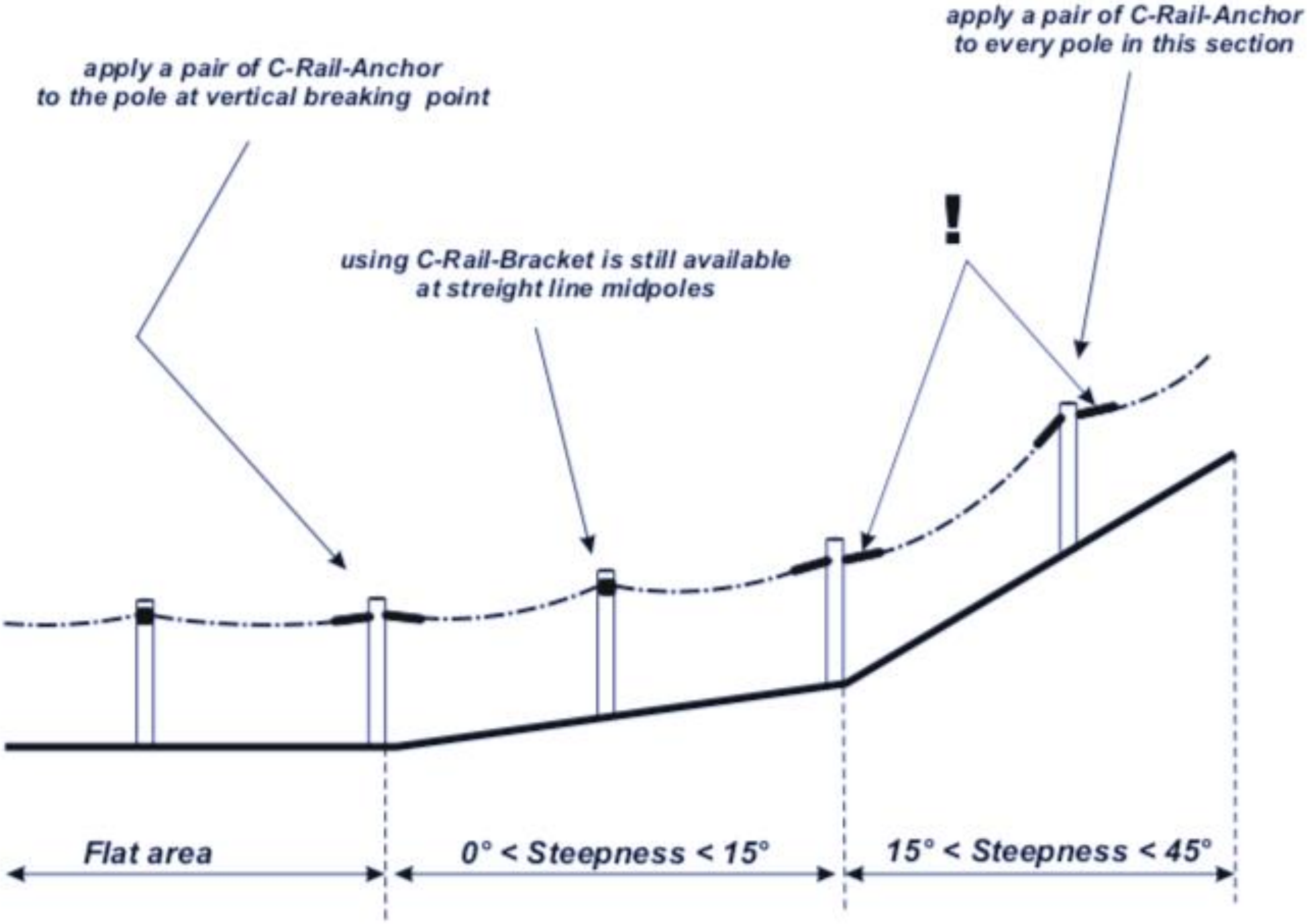
Volume calculation based on above map is the following (from left to right):

P09:	+ 1 pc of C-Rail-Anchor as for starting pole
P13:	+ 2 pcs of C-Rail-Anchor for breaking point
P15 + P16:	+ 4 pcs of C-Rail-Anchor for road crossings
P16 (drop direction):	+ 1 pc of C-Rail-Anchor as for starting pole of drop direction
P18 + P19:	+ 4 pcs of C-Rail-Anchor to fix sag value at exceptionally long pole distance

Number of C-Rail-Anchors = 12 pieces

Planning the volume of dead end frames
C-RAIL-ANCHOR

Application of C-RAIL-Anchor in the area of steep hill sides:
Use of C-Rail-Hook-Base Adapter Plate



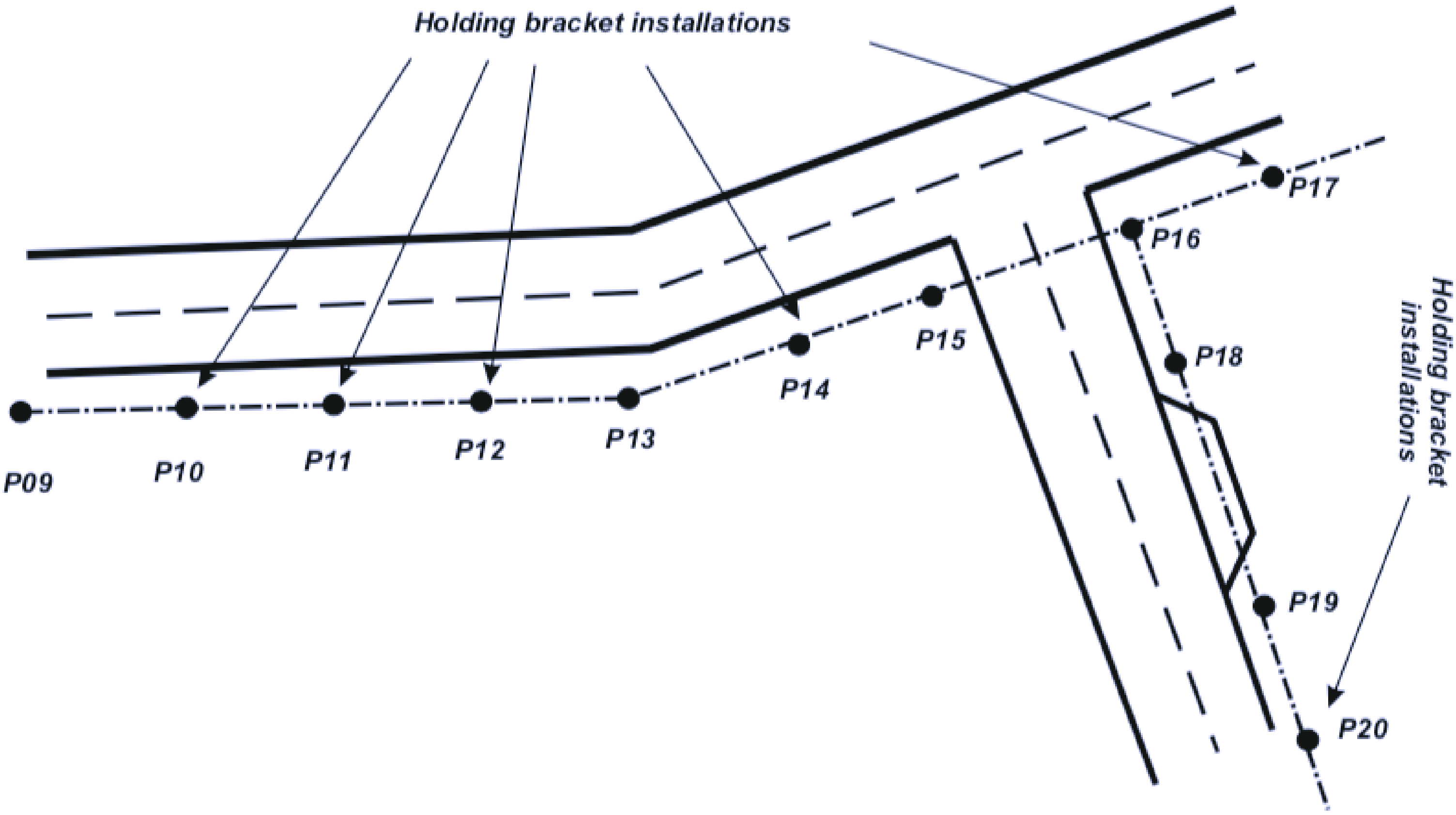
! - if steepness if hills exceeds 15°, the upper side C-RAll-Anchors must be installed in combination with C-Rail-Hook-Base Mounting Plate. This addition supports angle mounting of C-Rail-Anchor

Planning the volume of

C-Rail-Bracket holding brackets

<u>Procedure:</u> Thanks to the unique feature of C-RAIL® system *(messenger and the cable are two physically independent components)* the messenger remains uncut along the whole line, even at those poles where cable excess length need to be created. Consequently, a simple holding bracket (C-Rail-Bracket) can be used at every middle pole where dead end frames are not requested.

Example: **All** poles must be applied with holding brackets where there is no request to use one or a pair of anchoring frames.



The calculation is the following:

There are 6 middle poles (P10, P11, P12, P14, P17, P20)) which do not request dead end frame installation.
6 pcs of C-Rail-Brackets have to be used in this part of the network.

Planning the volume of customer access points (Access Closures)

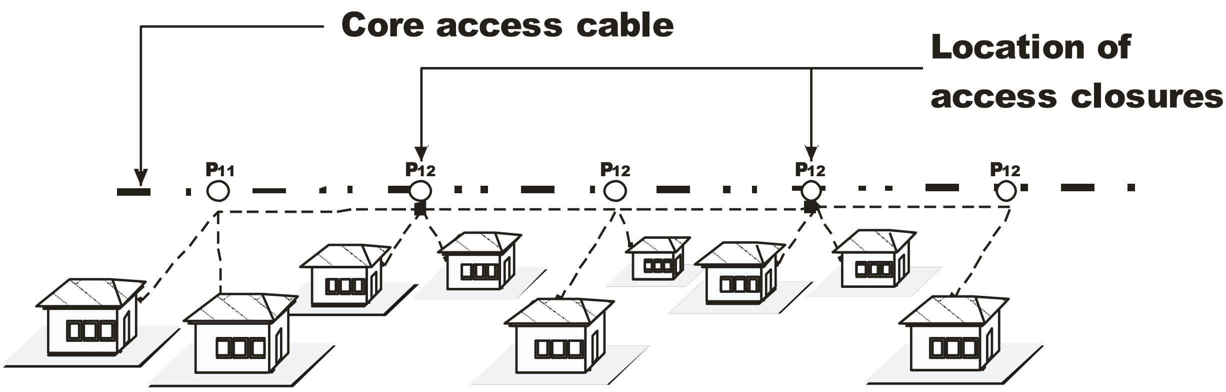
Procedure: The natural goal -to keep core network cost as low as possible- forces planners to design networks with the minimum number of access closures. But on the other hand, the reduced number of access closures increases the average length of customer drop sections, which increases the cost of customer connection. There is a certain point in the network where the higher drop section cost overcompensates the price drop of core network and the overall network cost will be higher than optimal. One important task for designers is to get close to the optimal solution during the planning process. That optimal solution is influenced by several other circumstances, like average number of penetration, penetration change (increase) over time. Sometimes, the owner of poles is different from the communication service supplier and from the communication network owner. Sometimes the pole owner (e.g. electricity company) limits the number of customer drop cables available between poles, consequently a higher number of access closures has to be used as the ideal would be.

Locations of access closure positions and determining the volume is a complex process and mainly independent from the application of the C-Rail® system. The connection point is that the volume of closures and the applied access technology determines the fibre count of the C-Rail-Cable.

The following two drawings show examples for two different pole owner philosophies:

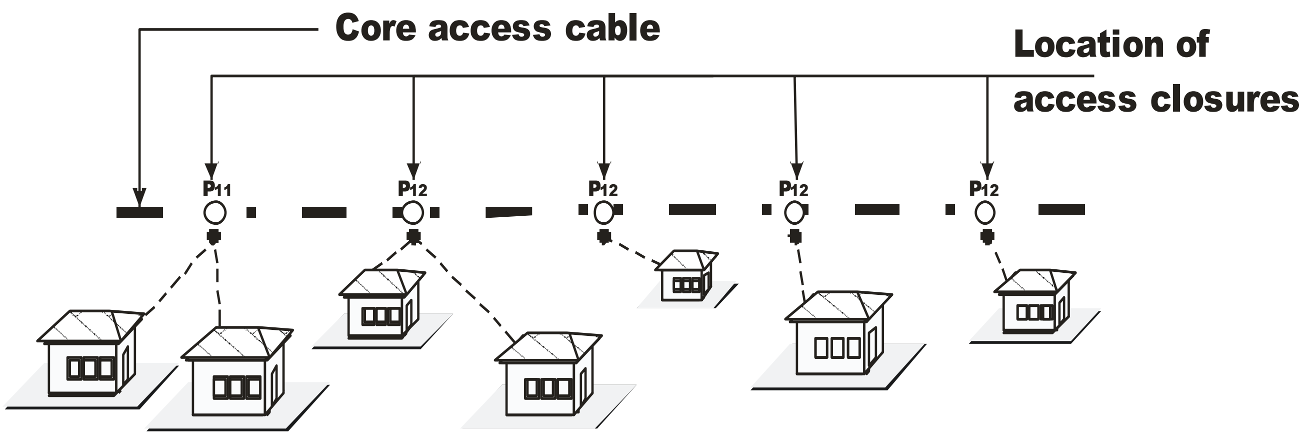
Rule: Application of drop cables between poles is available but limited to two!

Consequence: Access closures need to be installed at every second pole



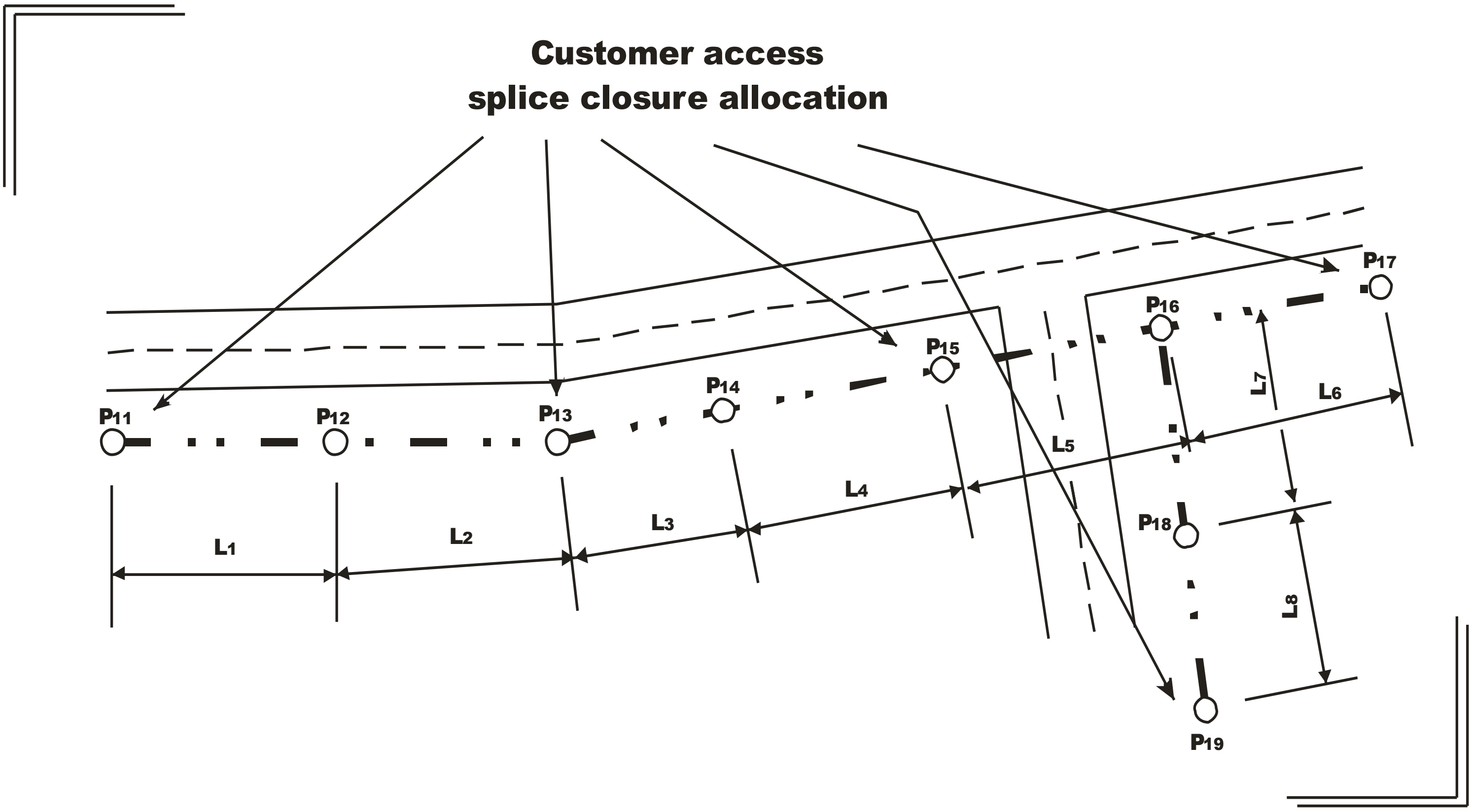
Rule: Application of drop cables between poles is prohibited!

Consequence: Access closures need to be installed at every pole



PLANNING THE VOLUME OF CUSTOMER ACCESS POINTS (ACCESS CLOSURES)

Example: Access closures need to be installed at every second pole.



Number of splice closures = P11 + P13 + P15 + P17 + P19 = 5 pcs

Planning of the required mounting brackets for C-Rail-Closures (C-Rail-Closure-Mount) & holding brackets for excess cable length (C-Rail-Over length-Storage)

Procedure: The number of the closure mounting brackets (C-Rail-Closure-Mount) equals to the calculated number of access closures.

The volume of excess length storing brackets (C-Rail-Over-Length-Storage) has to be calculated in the following way.
The number of access closures should be added to the volume of those maintenance purposed excess length locations where closure installation is not planned.