Arrow Platform

Resource Managers

Resource Managers define the modeling inputs and assumptions that Arrow uses when performing an optimization

| Resource Selection			What does it define / What is it used for?	When to adjust from defaults?	Details
Price Book	Default Price Book ⌄	✎	All network build costs *(e.g., equipment, fiber labor and cable cost)*	When accurate network cost is needed	See p. 4
Telecom Spend Matrix	Default Telecom Spenc ⌄	✎	How to calculate Enterprise revenues	When Enterprise revenue is estimated using A|S' Telecom Spend Matrix approach	See p. 5
Competition	Default Competition ⌄	✎	How to translate available competition information into target endpoints' fair share	When Arrow is used to determine fair share of target endpoints *(and revenue-side business case calculation is needed)*	See p. 6
ROIC Manager	Default ROIC Manager ⌄	✎	Revenue-side business case inputs	When revenue-side business case calculation is needed *(e.g., IRR targets or NPV-maximizations)*	See p. 10
ARPU Manager	Default ARPU Manager ⌄	✎	ARPU assumptions	When revenue-side business case calculation is needed *(e.g., IRR targets or NPV-maximizations)*	See p. 13
Impedance Manager	Default Impedance Ma ⌄	✎	Wireless signal loss characteristics	Only when planning Fixed Wireless networks that factor in clutter information	See p. 14
Rate Reach Manager	Default Rate Reach Ma ⌄	✎	Addressability thresholds for FTTN/DSL equipment	Only when planning FTTN/DSL networks	See p. 15
Network Architecture Manager	Default Network Archit ⌄	✎	Equipment properties for each network architecture *(e.g., max cabinet size)*	When additional information on equipment sizes and fiber length constraints is available *(To further improve network cost estimation)*	See p. 16
Fusion Manager	Default Fusion Manage ⌄	✎	Interaction rules between conduit networks *(e.g., where can a route jump from a road to a ducts)*	Only when intricate interactions between conduit types are required	See p. 22
Planning Constraints Manager	Default Planning Const ⌄	✎	Optimization constraints, reporting settings, and technology-specific parameters	Generally, only when directed by the Customer Success team, based on specific project or configuration needs	See p. 23

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Resource Managers are managed via their respective management windows

Managing Resource Managers

1. **Open Settings** – Click Settings button to open the pane and navigate to "Resource Selection" tab

   You can also manage Resource Managers from Global Settings -> Resource Managers menu accessible via the header bar

2. **Manager Edit** – click the edit icon to the right of relevant resource manager. This will open popup screen with a list of Resource Managers

3. **Clone / Edit** – Select Clone to create new resource manager or Edit to begin editing its contents.

4. **Permissions** – Click on the + sign on expand a list of permission holders for the manager.

   Your permissions level for each manager determines available actions (e.g., Viewer can clone and use the manager in a plan, but only Modifier and above can change manager's values)

Price Book is used to define all network build costs
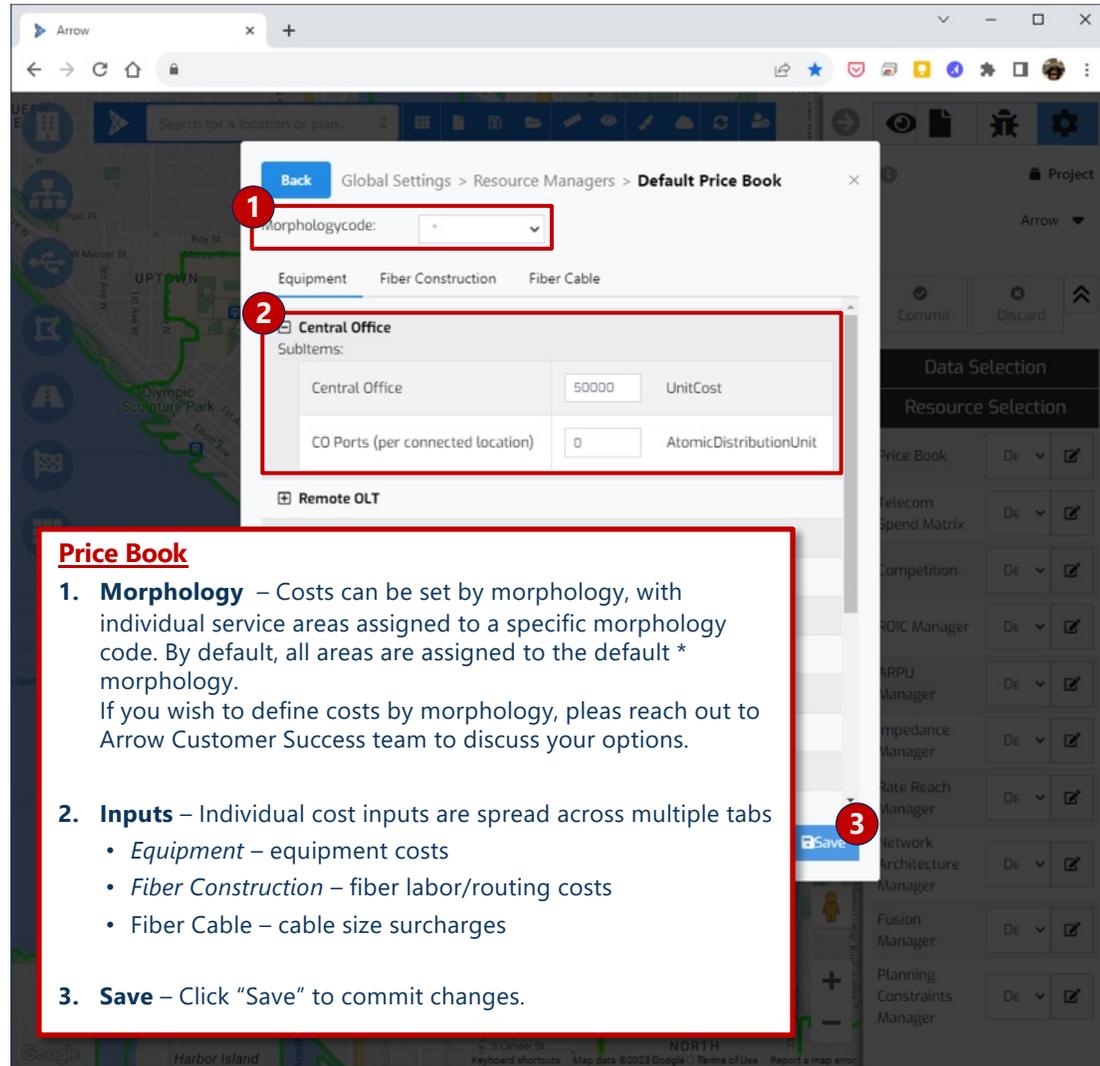
Price Book

1. **Morphology** – Costs can be set by morphology, with individual service areas assigned to a specific morphology code. By default, all areas are assigned to the default * morphology.
   If you wish to define costs by morphology, pleas reach out to Arrow Customer Success team to discuss your options.

2. **Inputs** – Individual cost inputs are spread across multiple tabs
   • *Equipment* – equipment costs
   • *Fiber Construction* – fiber labor/routing costs
   • Fiber Cable – cable size surcharges

3. **Save** – Click "Save" to commit changes.

The Following Costs can be set in the Price Book:

Input Field	Units
Central Office	Unit Cost and/or per Premise Passed
Remote OLT	Unit Cost and/or per Premise Passed
Splice Point	Unit Cost and/or per Premise Passed
Fiber Distribution Hub	Unit Cost and/or per Premise Passed
FDT Terminal 1x12	Unit Cost and/or per Premise Passed
MDU ONT	Unit Cost and/or per Premise Passed
Drop Coil / Bulk Distribution Terminal	Unit Cost
FW Cell Node (New Tower)	Unit Cost
FW Cell Node (Use Existing Tower)	Unit Cost
Remote Terminal (DSLAM)	Unit Cost
(Junction) Splitter	Unit Cost
Location Connector	Unit Cost
Network Anchor	Unit Cost
Slack Loop	Unit Cost
Network Connector	Unit Cost
Subnet node	Unit Cost
Install [by conduit type] - [by placement type]	Cost Per Meter
Fiber Cable [by size]	Cost Per Meter

Placement type cost is only used when road segments have explicitly assigned placement type. Otherwise, average cost, computed from assigned percentages, will be used

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The TSM Manager is used to determine enterprise spend of target businesses when the Telecom Spend Matrix strategy is enabled in the ARPU Manager

Fields define addressability of each product, industry and business size
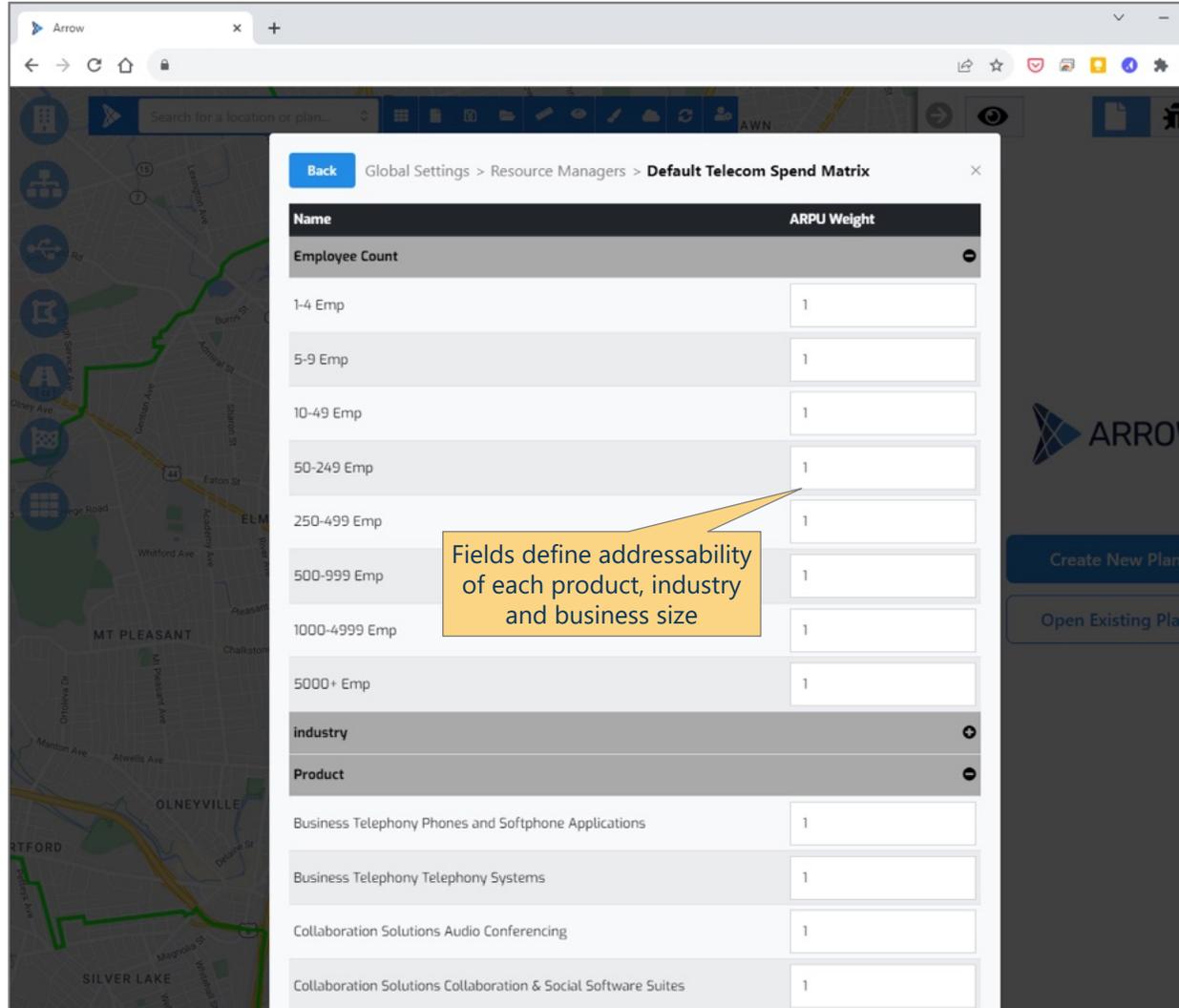
Using Telecom Spend Matrix it is possible to calculate precise telecom expenditure for each target business

Planners can define their target industries, addressable business sizes and products. By doing so Arrow only consider each business' addressable revenues and provides a realistic representation of each location's revenue potential.

Industries, business size and products that are not in current scope can be zeroed out and will result in prospective targets within those industries or sizes registering zero revenues.

Revenue potential is determined via a set of coefficients defining the magnitude of addressability of each item/category contained within:

   ARPU Weight – Coefficient defining the addressability (*1.0 = fully addressable*). Fractional values can also be used to reflect partial addressability

   Employee Count, Industry, Product – Available addressability categories

Each location's revenue is calculated by cross multiplying each Product, Industry and Size coefficient with the estimated expenditure on said products.

Individual Product spend estimates are a specific to the market tier the business is in, its size bracket and the industry the business operates in.

This resource manager is only used then TSM ARPU strategy is selected in the ARPU resource manager.

Telecom Spend Matrix is a proprietary Altman Solon dataset available in the tool at no extra cost to Arrow subscribers.

Competition Manager defines how factors such as available technology, service speed and brand recognition translate into fair share for the planned network

Area Based Competition Library – Identifies which library contains competitive information stored for individual geographical areas – Census Blocks by default – to use when calculating individual locations' fair share.

Location Based Competition Library – *Only for use in conjunction with the CostQuest locations data* – Identifies which Arrow library contains location-level competition data that can be matched to target endpoints purchased from CostQuest, to evaluate fair share for each location individually.

Please reach out to Arrow Customer Success team for help with setting up custom, or location-level competition systems.

Retail – Tower - Wholesale – Settings defining competitive profile of the network planned by Arrow

  BAU Speed (Mbps) – Implied service speed of the legacy network / the network that Arrow is going to overbuild. This value is only relevant when running an overbuild scenario *(configured in ROIC Manager)*.

  Plan Speed (Mbps) – Maximum service speed of the planned networks.

  Brand Strength – Go-to-market strength factor for own brand (default = 1.00 = 100%) , i.e., technology and speed being equal, how well is the provider planning the network recognized, regarded and positioned to win new customers relative to its competitors.

Retail = Residential and Small Business endpoints

Wholesale = Medium and Large Businesses

Tower = Tower endpoints

Competition
1. **Tabs** – The manager is divided into three sections/tabs
   - *Configuration* – Competitive profile of the <u>own network</u>, i.e., the one planned by Arrow
   - *Brand Strength* – Competitive profile of <u>other providers</u> i.e., their brand strength
   - *Speed Matrix* – Retail – Matrix defining relative competitiveness of individual technologies and their speeds, used in fair share calculation

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Brand Strength tab of the Competition Manager defines competitive go-to-market strength of providers that the planned network is competing against

1 **View By Regions** – Users can filter provider list by the state(s) in this they operate

2 **Coverage Threshold** – Coverage threshold slider can be used to display only the providers that report sufficient presence in the preselected states

3 **Above/Below Threshold** – Prioritized list of providers to define their individual brand strengths. Providers with coverage below the target threshold are reported on the separate tab

Carrier – Provider name

Coverage – Fraction of census blocks in the selected region(s) in which the carrier reports service

Wholesale – Brand Strength inputs for Medium and Large Businesses

Tower – Brand Strength inputs for Tower endpoints

Retail – Brand Strength inputs for Residential and Small Business endpoints

Strength of 1 implies regular competition level from the given provider, while 0 means that they do not compete at all.

Network operators should set their own competitive weight to 0 here to avoid simulating competing with themselves.

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Retail Speed Matrix tab of Competition Manager defines relative competitiveness of individual technologies and speeds used in fair share calculations

Fields define relative strength of the product

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Residential opportunity fair share is estimated by combining the Competition Manager inputs and the competitive intelligence data available for each location

Identify providers serving given Census Block	Translate the available speed, technology and go-to-market strength into offer strength	Aggregate across all providers and calculate implied fair share

List all providers serving target census block using FCC's BDC fabric data *(for US-based implementations)*

Look up their reported technology and maximum download speed

Look up estimated area coverage for the reported technology

Look up Technology Strength for each provider's technology and speed

Look up Brand / Go-to-Market Strength of each provider

Multiply strengths to derive Offer Strength of each provider

Sum offer strengths of all providers

Incorporate Arrow's offer strength into the total

Determine the implied resulting fair share

EXAMPLE

Provider	Technology	Max Speed (Mbps)	Area Coverage	Technology Strength		Brand Strength		Offer Strength		Implied Fair Share
		From FCC (or other applicable source)	*Calculated by Altman Solon*	*Lookup from Competition Matrix tab*		*Lookup from Brand Strengths tab*		*Calculated*		*Calculated*
Provider A	Cable	75	25%	0.50	x	1.00	=	0.125	->	4.82%
Provider A	Fiber	150	75%	1.00	x	1.00	=	0.750	->	28.92%
Provider B	Fiber	500	50%	1.00	x	0.75	=	0.375	->	14.46%
Provider B	Copper	25	50%	0.25	x	0.75	=	0.094	->	3.61%
Provider C	Satellite	30	100%	0.00	x	1.00	=	0.000	->	0.00%
Provider D	Fixed Wireless	125	100%	0.25	x	1.00	=	0.250	->	9.64%
Arrow	**Fiber**	**1,000**	**100%**	**1.00**	x	**1.00**	=	**1.000**	->	**38.55%**
		Implied	*Lookup from Configuration tab*	*Implied*		*Lookup from Competition Matrix tab*		*Lookup from Configuration tab*		

1 / 2.594 = 0.3855

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ROIC Manager defines the YoY financial profile of each plan analyzed in Arrow

ROIC

1. **Tabs** – The manager is divided into three sections/tabs
   - *Configuration* – Global financial model inputs
   - *Models* – Granular inputs set separately for each endpoint type and BAU and Planned network scenarios
   - *Subsidies* – Dedicated controls for managing plans that include subsidies
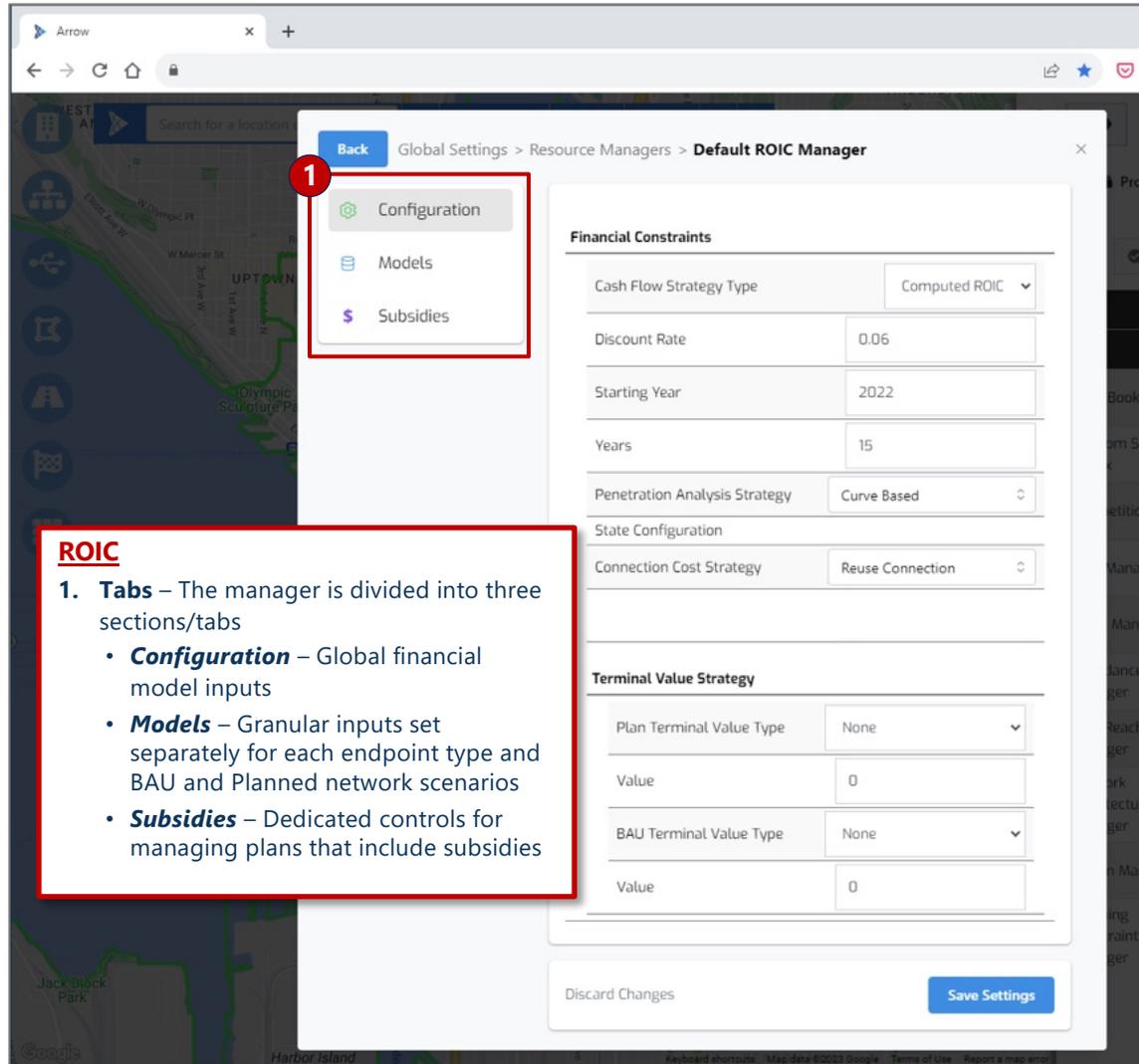
Financial Constraints – Global business case inputs

Cash Flow Strategy Type – use Computed ROIC for all plans

Discount Rate – Cost of capital / WACC to use for NPV calculation

Starting Year – Which year the plan starts *(only relevant when TSM ARPU strategy is used)*

Years – How many years to project the cash flows for and use in NPV/IRR calculations

Penetration Analysis Strategy – Specifies the method to determine customer penetration over time
- **Curve Based** – Penetration follows a predefined adoption curve *(defined by the penetrationRate parameter on the Models tab)*
- **Flow Share** – Uses granular flow-share modeling to determine each period's subscribers *(using churn and locations growth settings from the Models tab)*

Connection Cost Strategy – Specifies how to handle individual location's re-connect costs
- **New Connection** – Charges full new connection cost every time location (re)subscribes *(cost set by ConnectCost field in the Models tab)*
- **Reuse Connection** – Probabilistically model what fraction on new subscribers had connected in the prior periods and only charge for the net new locations

Terminal Value Strategy – Set separately for Planned and BAU scenarios

Terminal Value Type – Defines what method of TV calculation to use
- **None** – No terminal value applied
- **Net Cash Flow Multiple** – Last year's net cash flow multiplied by the value and added to the last period
- **EBITDA Multiple** – Similar to Net Cash Flow, but maintenance and new build costs are excluded
- **Perpetual Growth** – Assumes that a business will generate cash flows at a constant rate (from the last period) forever

Value – Multiplier to use for the given strategy type (fraction for Perpetual Growth)

ROIC Manager defines the YoY financial profile of each plan analyzed in Arrow

1 **Inputs are set independently for each endpoint type** – Residential (households), Towers and Small, Medium and Large Businesses

2 **For each endpoint type, users can set BAU (cat3) and Planned (cat7) network inputs** – This allows Arrow to account for revenue cannibalization in network overbuild scenarios
- **Legacy / BAU** – Sets up the cash flow profile of locations served by the legacy network / the network that Arrow is going to overbuild. These values need only be adjusted when running an overbuild scenario.
- **Planned** – Cash flow inputs for locations that will be connecting to the planned network

penetrationStart – starting penetration of passed locations (at year 0)

penetrationRate – when Curve-Based penetration strategy is used (set on the Configuration tab), it determines the pace of subscriber ramp to the fair share value

entityGrowth – annual growth percent of passed locations

churnRate – own <u>annual</u> churn rate *(used to calculate new connects in each period)*

marketChurnRate – market <u>annual</u> churn rate *(only used with Flow Share penetration strategy)*

opexPercent – fraction of the total revenue spent on operating expenses

maintenanceExpense – fraction of the total revenue spent on maintenance expenses

connectionCost – one-time success-based CapEx, incurred when given location subscribes to the new network

broadBandPenetration – broadband adoption ratio, effectively adjusting total number of premises passed in the plan (and correspondingly scaling down revenues and cash flows)

customerConnectCost – The cost to connect a new customer, <u>regardless of connection strategy</u>. It is applied per-customer, not per-connection.

penetrationWindow – The number of periods over which to average the penetration (best to leave set to 1)

Dedicated tab in the ROIC Manager is used to define how subsidies are used in a plan
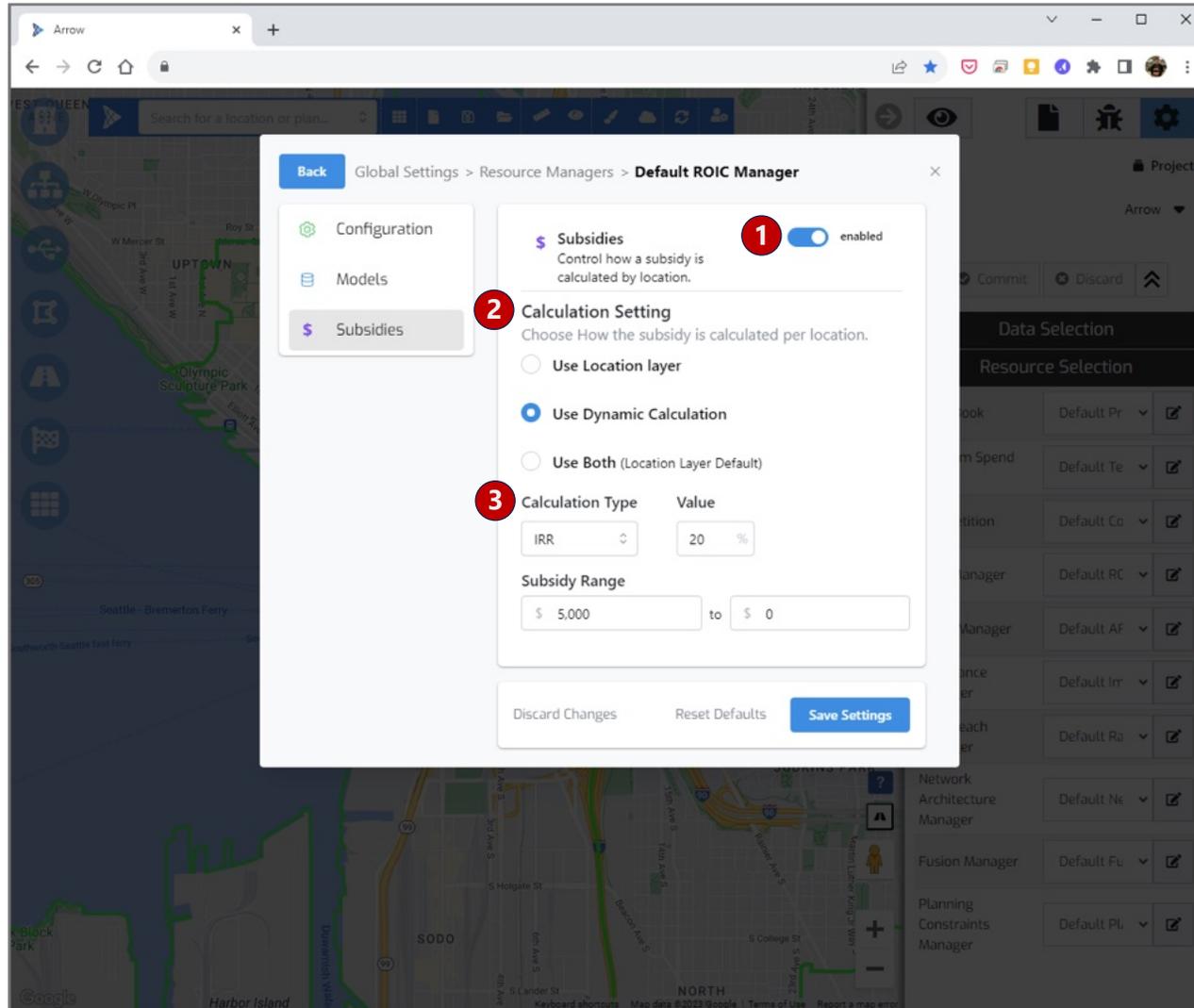
1 **Enable subsidy calculation** – Toggles location-level subsidy calculations. Subsidy amounts are then used to offset the cost of the new network build. The subsidy can be predefined or calculated by Arrow (configured below)

Note that **individual locations must be flagged as subsidy-eligible** to be included in subsidy calculations via "grant_eligible" attribute. Please refer to the Data Preparation guide for information how to prepare these inputs.

2 **Calculation Setting** – Determines how the subsidy is used / determined
- **Use Location Layer** – Uses the predefined subsidy amount assigned to each location i.e., the user defines the amount of subsidy each location is receiving. *("ROIC.PLAN.SUBSIDY" location attribute is used to define the subsidy amount)*
- **Use Dynamic Calculation** – Determine the amount of subsidy required to meet the target threshold (as defined by Calculation Type setting below)
- **Use Both** – First look for predefined subsidy amount stored with the location layer. If no values are present, the Dynamic Calculation is used for locations marked as grant eligible

3 **Calculation Type** – Defines how to calculate the required subsidy amount
- **IRR** – determines the necessary amount to achieve target IRR value for locations marked as grant eligible (leach location on a proportional cost basis)
- **Fixed** – applies a fixed $ amount to all locations marked as grant eligible
- **Percentage** – applies a percentage value of the proportional cost required to reach locations marked as grant eligible

Value – Target value for Dynamic Calculation Type *(percentage or $ amount)*

Subsidy Range – Apply upper and lower bound on acceptable subsidy amounts to avoid extreme results. Minimum and Maximum values are used when calculated about is outside of the range.

ARPU Manager is used to define monthly revenue assumptions for target endpoints

Segmentation strategy view
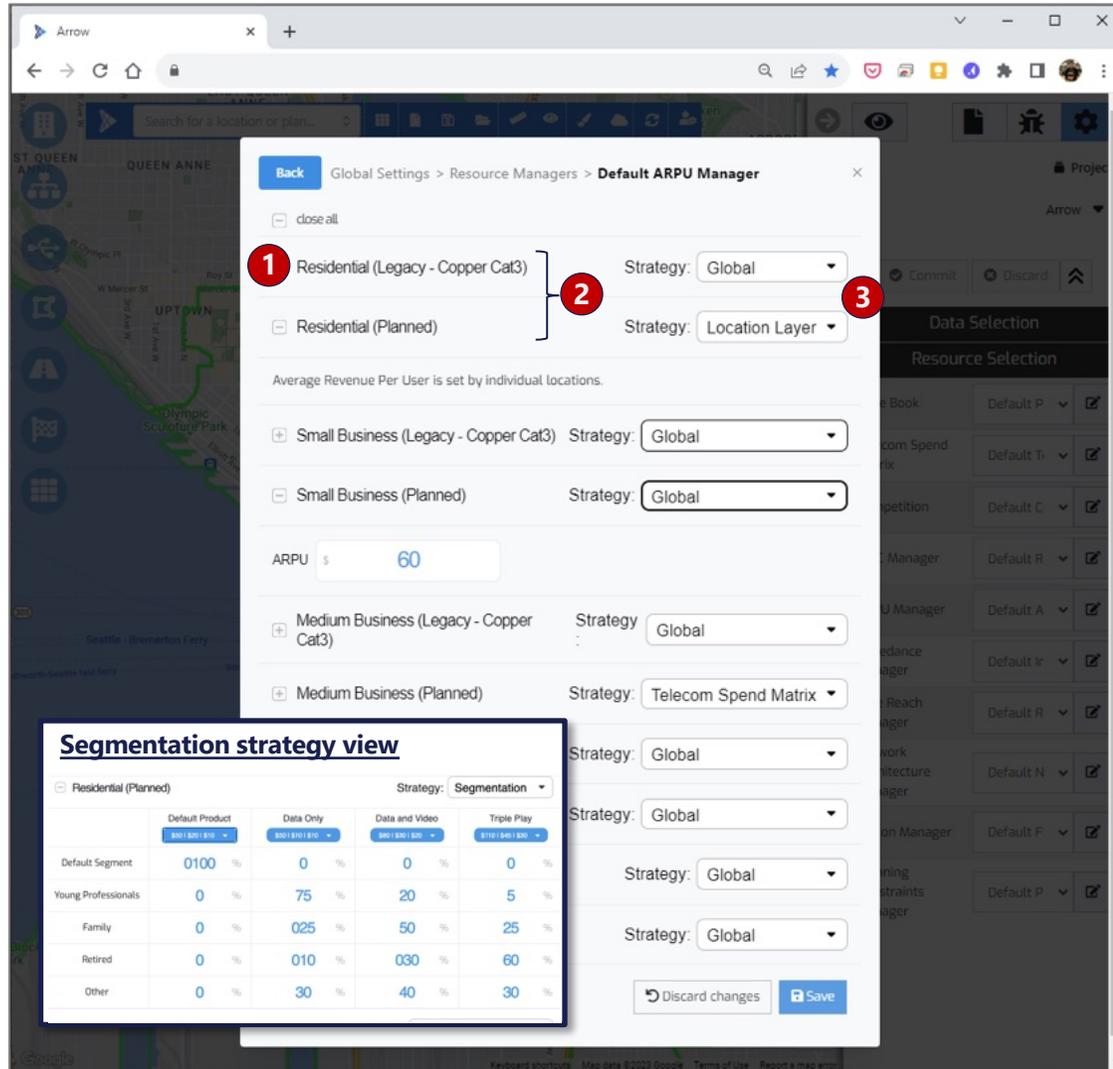
1 ARPU strategy is set independently for each endpoint type – Residential, Towers and Small, Medium and Large Businesses

2 For each endpoint type, users can set BAU and Planned ARPU inputs – This allows Arrow to account for revenue cannibalization in network overbuild scenarios
- **Legacy / BAU** – ARPU of current subscribers served by the legacy network / the network that Arrow is going to overbuild. These values need only be adjusted when the financial model (in the ROIC Manger) is being set up to account for existing network's current cash flows.
- **Planned** – Expected revenue of locations that will be connecting to the planned network

3 Users can select from the following strategies:
- **Global** – The specified value is used for all locations of the given type
- **Location Layer** – Each location uses the ARPU value that is assigned to it in the data layer. Note that this strategy only works in conjunction with locations layers that explicitly assign ARPU to each record via attributes ("ROIC.PLAN.MONTHLY_ARPU" / "ROIC.BAU.MONTHLY_ARPU" [case sensitive]). Please refer to Arrow Data Preparation Guide to learn how to assign ARPU to each location.
- **Telecom Spend Matrix** – *For Business endpoints only*, each location is computed its own revenue based on the combination of the business' size, industry, market, and addressable products defined in Telecom Spend Matrix resource manager. For most accurate results, each business should have a 4-digit industry SIC code assigned to it, as outlined in the Data Preparation guide.
- **Segmentation** – *For Residential endpoints only*, the Segmentation strategy uses the values based on the product mix specified in the UI across pre-defined segments. It also allows you to adjust OpEx and Acquisition cost at the individual product level.
  Note that segmentation strategy only works in conjunction with locations layers that explicitly assign segments to each location. Please contact Arrow Customer Success team to discuss setting it up in your instance of Arrow.

Impedance Manager controls wireless signal loss characteristics as a function of distance and topography in fixed wireless plans

Impedance manager

The input values represent wireless signal strength deterioration over a set distance.

Each value is calibrated to match the signal degradation (speed loss) characteristics for the type of impedance tile (clutter/foliage type) and wireless spectrum.

Please reach out to Arrow Customer Success team for help with calibrating your inputs.

Rate Reach Manager is used to define distance thresholds for placing FTTN/DSL equipment to serve target locations

Fields define maximum distance (in feet) over which a given speed can be sustained

Network Architecture Manager is used to define key equipment properties for each of the available network architecture types
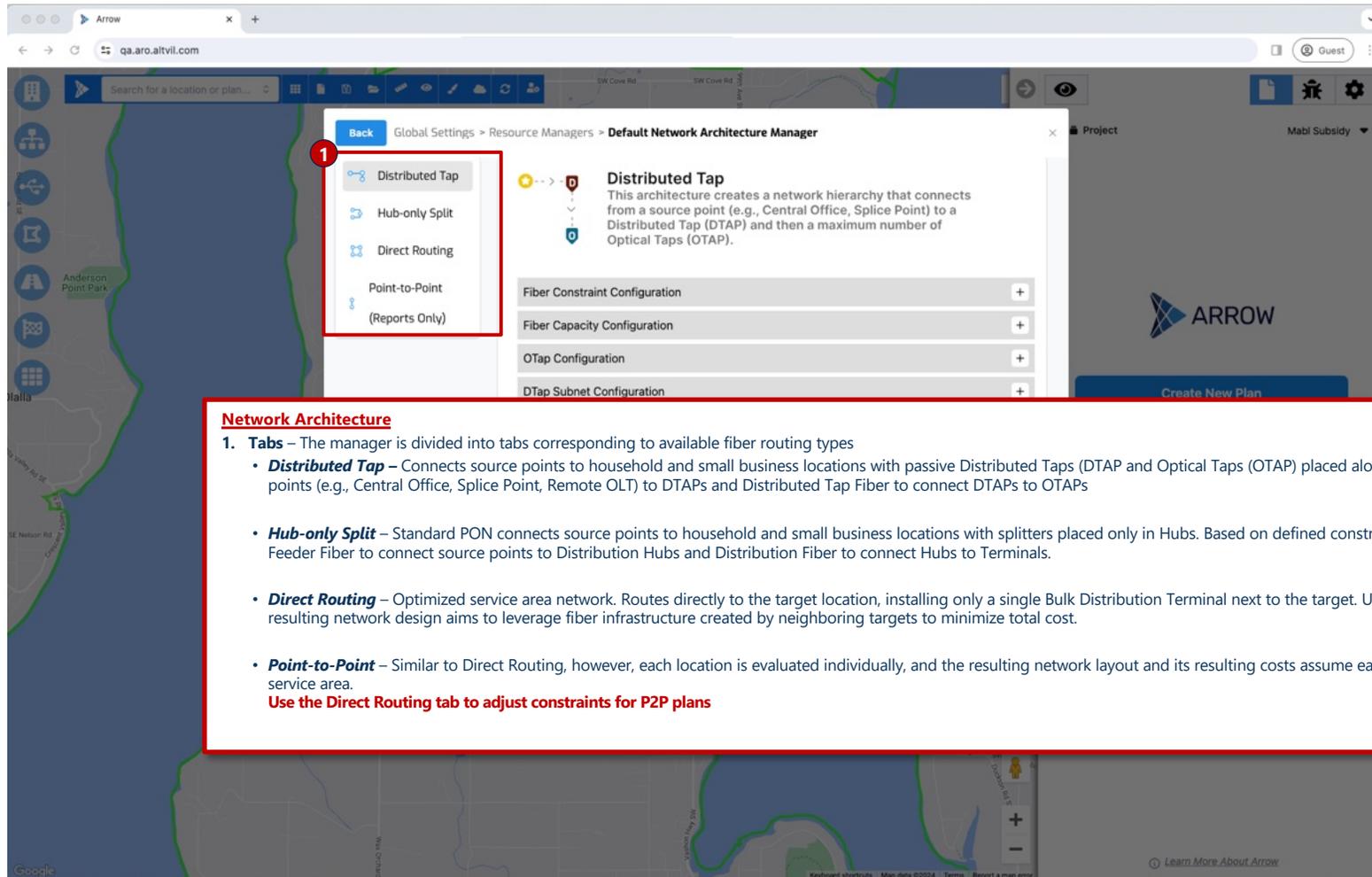
Network Architecture

1. **Tabs** – The manager is divided into tabs corresponding to available fiber routing types
   - **Distributed Tap –** Connects source points to household and small business locations with passive Distributed Taps (DTAP and Optical Taps (OTAP) placed along the route based on defined constraints. Uses Feeder Fiber to connect source points (e.g., Central Office, Splice Point, Remote OLT) to DTAPs and Distributed Tap Fiber to connect DTAPs to OTAPs

   - **Hub-only Split** – Standard PON connects source points to household and small business locations with splitters placed only in Hubs. Based on defined constraints, it places passive Fiber Distribution Hubs and Terminals along the route. Uses Feeder Fiber to connect source points to Distribution Hubs and Distribution Fiber to connect Hubs to Terminals.

   - **Direct Routing** – Optimized service area network. Routes directly to the target location, installing only a single Bulk Distribution Terminal next to the target. Uses Feeder Fiber to connect source points to Bulk Distribution Terminals. The resulting network design aims to leverage fiber infrastructure created by neighboring targets to minimize total cost.

   - **Point-to-Point** – Similar to Direct Routing, however, each location is evaluated individually, and the resulting network layout and its resulting costs assume each location <u>does not</u> leverage fiber infrastructure created by other locations in the service area.
     Use the Direct Routing tab to adjust constraints for P2P plans

Distributed Tap settings are in effect for plans ran using Distributed Tap network construction option
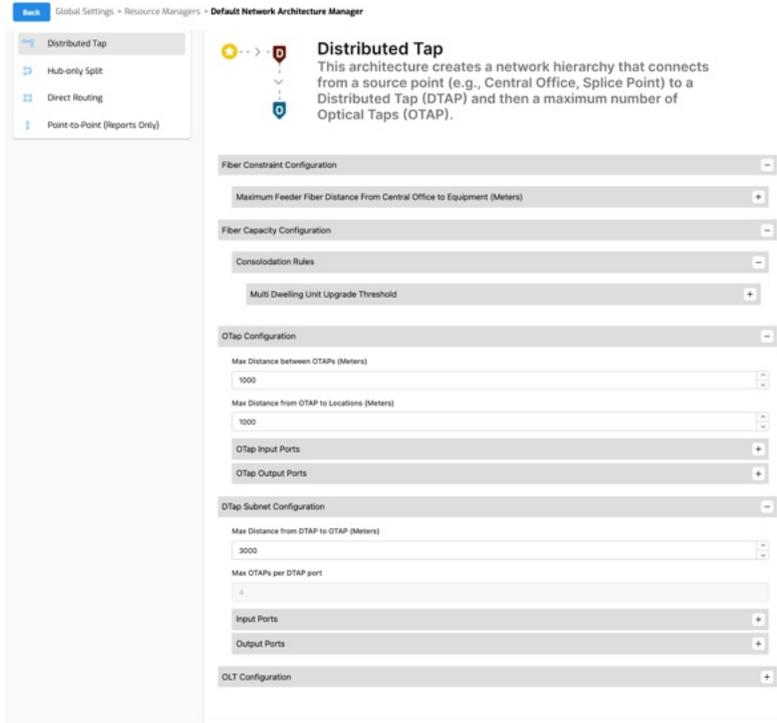
Fiber Constraint Configuration – Feeder fiber length maximums

Maximum Feeder Fiber Distance to Equipment (Meters) – Thresholds for the maximum length of buildable feeder fiber per service area, set separately for each target equipment type used in a plan (e.g., DTAP Subnet, Remote OLT)

Fiber Capacity Configuration – Defines how individual locations types connect to the planned network and their bandwidth requirements.

Consolidation Rules

- **Multi Dwelling Unit Upgrade Threshold** – The threshold determining how many locations on the exact latitude and longitude should be treated as an MDU location. For example, setting this to 5 means that any location with more than 5 units is treated as an MDU (connects with MDU terminal) rather than five households connecting through one or more OTAPs. **Note, ensure that this setting is above the maximum connections in OTap Configurations.**

OTap Configuration – OTap-specific equipment settings

Max Distance between OTaps (Meters) – Maximum distance between OTaps connected to the same DTap port

Max Distance between OTaps to Locations (Meters) – The maximum length of the drop cable connecting individual locations. Note that locations further than this distance from the conduit available for routing (e.g., distance from road layer) will not be connected.

OTaps Input and Output ports are currently not configurable through the UI.

DTap Subnet Configuration – Terminal-specific equipment settings

Max Distance from DTap to OTap (Meters) – Maximum length of buildable Distributed Tap fiber between a DTap and OTap

Output Ports – Target and maximum number of Ports available on each DTap for Distributed Tap fiber. Note that multiplying this number by the fiber size (e.g. , FS_1X32) provides you with the location capacity the DTap can support.

OLT Configuration – Defines capacity constraints for Remote OLTs

Output Ports – Sets minimum, target, and maximum number of Ports available for Feeder Fiber connectivity in each Remote OLT. **Note, this functionality for Distributed Tap is currently in Early Access as we continue to refine it.**

Hub-only Split settings are in effect for plans ran using Hub-only Split network construction option
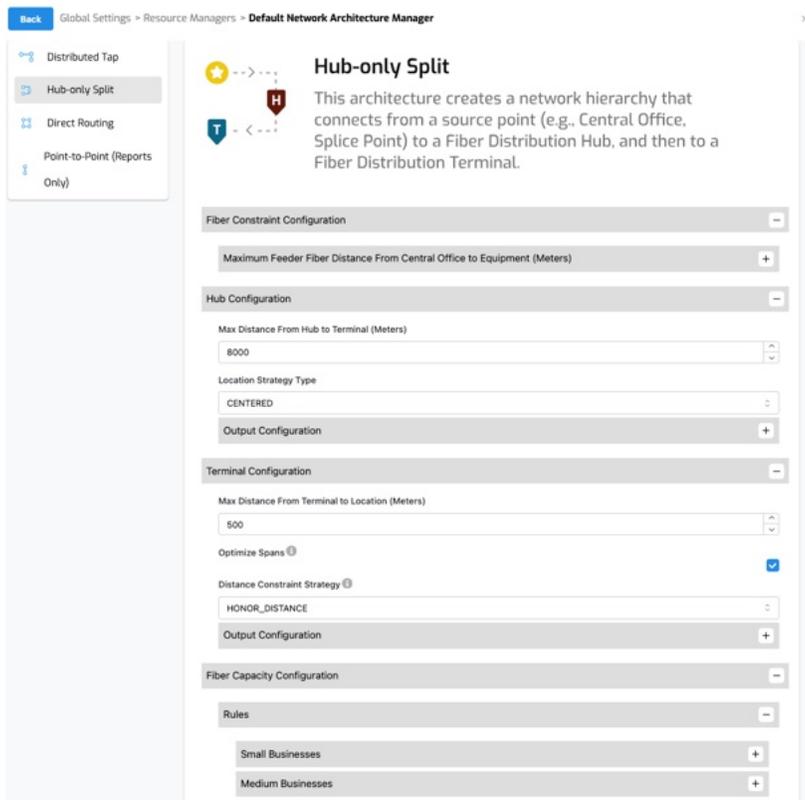
Fiber Constraint Configuration – Feeder fiber length maximums

Maximum Feeder Fiber Distance to Equipment (Meters) – Thresholds for the maximum length of buildable feeder fiber per service area, set separately for each target equipment type used in a plan (e.g., Fiber Distribution Hub, Remote OLT)

Hub Configuration – Hub-specific equipment settings

Max Distance from Hub to Terminal (Meters) – Maximum length of buildable distribution fiber between Hubs and Terminals

Location Strategy Type – Determines how the Hub is placed in the context of its serving cluster
- **Centered** – Hub is placed in the center of the location cluster
- **Optimized** – Hub is optimally placed, closer to the boundary of its serving area, towards the CO, to reduce Feeder fiber length
- **Fiber Optimized** – Extension of "optimized" strategy, where the hub is placed on top of other planned feeder fiber, closer to center of target locations, minimizing distribution fiber requirement

Output Configuration – used with K-Means hub clustering (Planning Constraints Manager setting)
- **Target Connections** –- Target number of connections per Hub
- **Maximum Connections** – Upper bound of how many connections each hub can support

Terminal Configuration – Terminal-specific equipment settings

Max Distance from Terminal to Location (Meters) – The maximum length of the drop cable connecting individual locations

Optimize Spans – Control if Terminals can traverse road intersections to serve locations. With Optimized Spans unchecked, the Terminal will not cross intersections and reduce the likelihood of path overlap

Distance Constraint Strategy – Defines how to treat locations that are beyond the drop cable distance threshold
- **Honor Distance** – Location is dropped. Only locations that are within the maximum distance are connected.
- **Always Connect** – Location is connected. The Terminal is placed as close to the location as possible (a longer drop cable is required)

Output Configuration
- **Maximum Connections** – the maximum number of connections each Terminal can support.

Hub-only Split settings are in effect for plans ran using Hub-only Split network construction option

Fiber Capacity Configuration – Defines how individual locations types connect to the planned network and their bandwidth requirements

Rules

- **Fiber Capacity Type** – Defines what equipment is used to connect each target endpoint type ("SingleConnection" = FDTs/MDUs, "DropCoil" = Drop Coil / BDT)
- **Atomic Units** – The number of distribution strands that are required to enable each location category, e.g., at 32 strands connection has sufficient feeder fiber to enable a tower, medium or large business

Consolidation Rules

- **Multi Dwelling Unit Upgrade Threshold** – The threshold determining how many locations on the exact latitude and longitude should be treated as an MDU location. For example, setting this to 5 means that any location with <u>more than</u> 5 units is treated as an MDU (connects with MDU terminal) rather than five households connecting through one or more terminals. **Note, ensure that this setting is above the maximum connections in Terminal Configurations.**

Slack Subnet Configuration – Defines slack loop cluster constraints. Relevant only when Slack Clustering is enabled in the Planning Constraints Manager

Boundary Generator Strategy – Defines how the slack loop boundary polygon is created

- **Spatial Buffer** – Generates a spatial buffer around the centroid of the target locations
- **Spatial Concave** – Generates concave buffer around target the target locations
- **Centroid Distance** – Snaps centroid of target locations to the nearest road edge, and then builds a polygon based on the maximum roads distance from that point
- **Optimized Polygon** – Generates a polygon based on road distance for every target location and then takes the spatial intersection of all the polygons. The resulting polygon defines the area that guarantees that all targets are at most N meters from the subnet parent

Max Distance (Meters) – Defines the maximum radius of a slack loop cluster

Location Strategy Type – Determines how the slack loop is placed in context of a cluster

- **Centered** – Slack loop is placed in the center of the location cluster
- **Optimized** – Slack loop is optimally placed to reduce Feeder fiber length
- **Fiber Optimized** – Extension of the "optimized" strategy, where the loop is placed on top of other planned fiber, if it exists, closer to the target locations, minimizing future lateral fiber requirement

OLT Configuration – Defines capacity constraints for Remote OLTs

Output Ports – Sets minimum, target, and maximum Ports available for Feeder Fiber connectivity in each Remote OLT. **Note that the minimum number of ports multiplied by Fiber cable size should be equal to or greater than the maximum Hub connections set under the Hub Output Configuration.**

Direct Routing settings are in effect for plans ran using Direct Routing and Point-to-Point network construction option
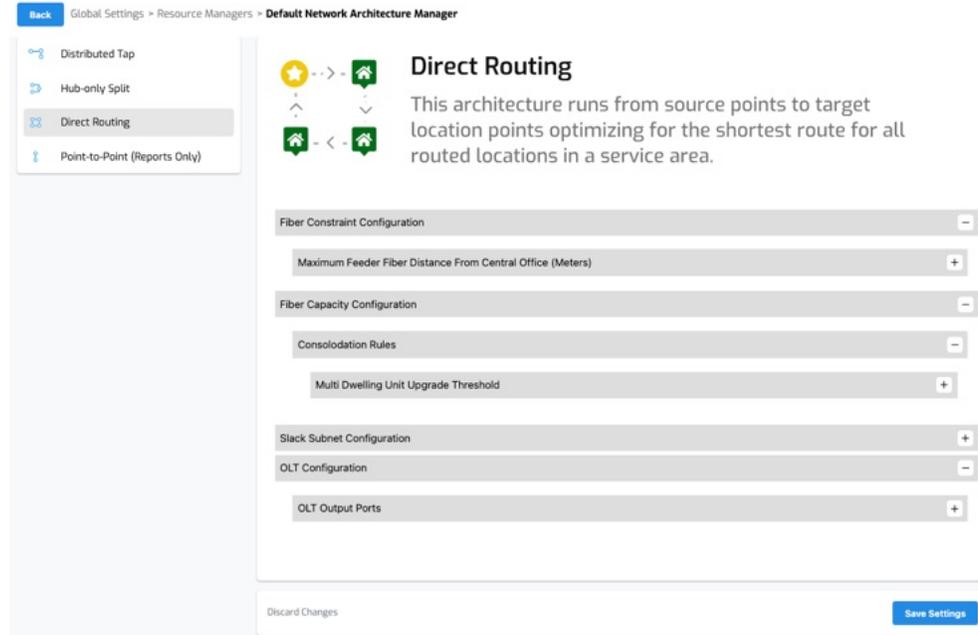
Fiber Constraint Configuration – Feeder fiber length maximums

Maximum Feeder Fiber Distance from Central Office (Meters) – Thresholds for the maximum length of buildable feeder fiber per service area, set separately for each target location type (e.g., Large Business, Cell Tower, Remote OLT)

Fiber Capacity Configuration – Defines how individual locations types connect to the planned network

Multi Dwelling Unit Upgrade Threshold – Threshold that determines how many locations on the same latitude and longitude should be treated as an MDU location.
For example, setting this to 5 means that any location with <u>more than</u> 5 units is treated as an MDU (connects with MDU terminal) rather than five individual households that connect through a BDT

Slack Subnet Configuration – Defines slack loop cluster constraints. Relevant only when Slack Clustering is enabled in the Planning Constraints Manager

Boundary Generator Strategy – Defines how the slack loop boundary polygon is created
- **Spatial Buffer** – Generates a spatial buffer around the centroid of the target locations
- **Spatial Concave** – Generates concave buffer around target the target locations
- **Centroid Distance** – Snaps centroid of target locations to the nearest road edge, and then builds a polygon based on the maximum roads distance from that point
- **Optimized Polygon** – Generates a polygon based on road distance for every target location and then takes the spatial intersection of all the polygons. The resulting polygon defines the area that guarantees that all targets are at most N meters from the subnet parent

Max Distance (Meters) – Defines the maximum radius of a slack loop cluster

Location Strategy Type – Determines how the slack loop is placed in context of a cluster
- **Centered** – Slack loop is placed in the center of the location cluster
- **Optimized** – Slack loop is optimally placed to reduce Feeder fiber length
- **Fiber Optimized** – Extension of the "optimized" strategy, where the loop is placed on top of other planned fiber, if it exists, closer to the target locations, minimizing future lateral fiber requirement

OLT Configuration – Defines capacity constraints for Remote OLTs

Output Ports – Sets minimum, target, and maximum number of Ports available for Feeder Fiber connectivity in each Remote OLT. **Note, this functionality for Direct Routing is currently in Early Access as we continue to refine it.**

Point-to-Point settings are currently only used for reporting purposes, and do not need to be changed

Point-to-Point architecture is the same as Direct Routing *(it only differs in how network costs are calculated).*

You should **adjust the Point-to-Point architecture constraints in the Direct Routing section.**

Fusion Manager enables users to define precise interaction rules between conduit networks for plans that leverage multiple conduit types
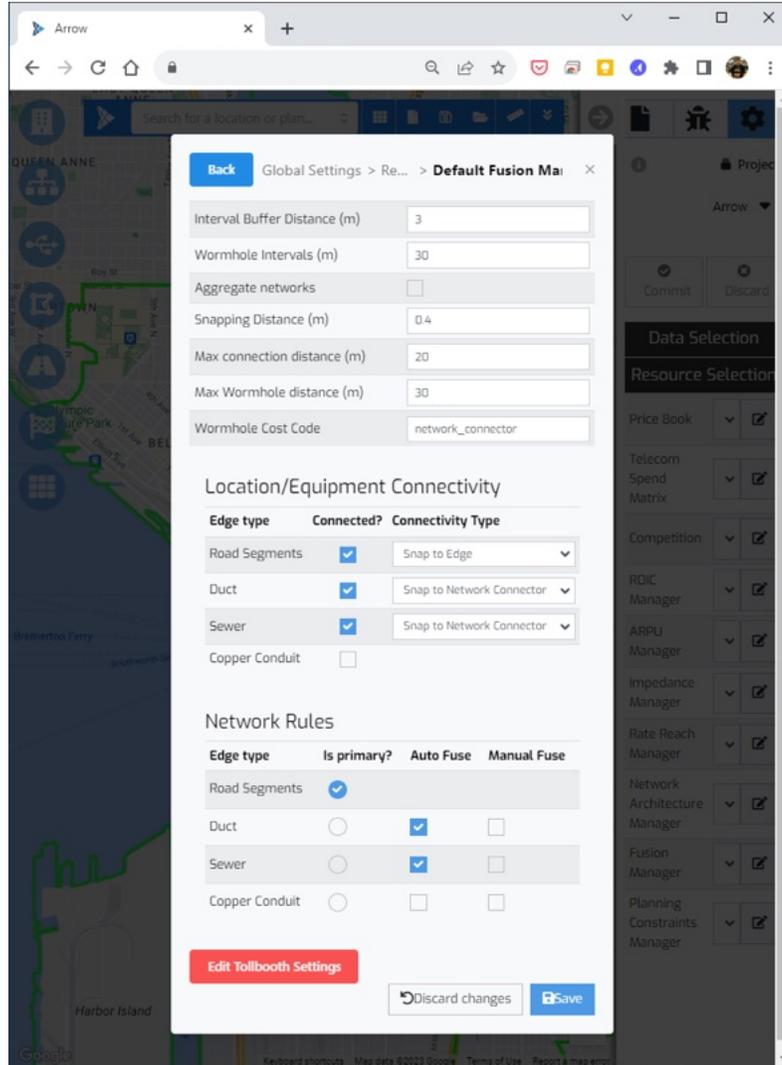
Interval Buffer Distance – Interval for putting synthetic splice points on the primary conduit edge (i.e., how frequently to consider a new splice point locations when routing from existing fiber)

Wormhole Intervals – Distance between auto-generated potential connection points (wormholes) along each network

Aggregate networks – If selected, networks of the same type and different size can be treated as equal (e.g., treat small and large ducts as equivalent)

Snapping Distance - the distance over which networks of the <u>same type and size</u> can be snapped together i.e., the proximity between two conduit segments to be considered intersecting with one another (e.g., small sewer to a nearby small sewer line)

Max connection distance – the distance over which networks of the <u>same type but different size</u> can be snapped together (e.g., small sewer to a large sewer)

Max Wormhole distance – the distance over which networks of <u>different types</u> can be snapped together (i.e., the distance between sewer/manhole and sewer/road)

Wormhole cost code – specifies which price book item represents wormhole cost (connections between conduit types)

- -

Location/Equipment Connectivity – Determines how target locations connect to the planned network

- **Connected?** – toggle to select which conduit types target locations can connect to
- **Connectivity Type** – defines how the connection occurs (directly [Snap to Edge], or via a dedicated Network Connector)

- -

Network Rules – Defines rules around jumps between conduit types

- **Is primary** – Tells Arrow which layer should be treated as the primary/default conduit layer (generally, Road Segments as they are most complete)
- **Auto Fuse** – when enabled, allows Arrow to autogenerate connection points between different conduit types, i.e., it allows the planned routes to switch between conduits in any place (e.g., places manholes to connect roads with sewers),
- **Manual Fuse** – tells Arrow to only use the predefined network connection points, which must be uploaded ahead of time and selected from the equipment data layer to include in a plan

- -

Tollbooth Settings – Defines exact rules use of tollbooths in a plan (one-time costs associated with switching between which conduit the planned route goes through). Please contact Arrow Customer Success team if think tollbooths might be needed in your plans.

Settings at the top of the Planning Constraints Manager define placement behavior of fixed wireless and FTTN/DSL nodes

Cell Node Constraints – Fixed Wireless Cell Node / equipment behavior settings

Placement Strategy – Defines how to chose initial placement of network nodes
- **Existing Locations** – Places initial set of coverage nodes using user specified latitude and longitude data
- **Random** – In areas with no specified node data or areas with coverage gaps due to limited existing data, random strategy enables Arrow to place additional nodes to meet coverage or IRR targets
- **Existing and Random** – Combination of the two above

Polygon Strategy – Defines how the coverage area of the cell node is defined
- **Fixed Radius** – Circular coverage areas with set radii *(e.g., 500 meters)*
- **Average Radius** – Circular coverage areas with set radii based on assumed average coverage distance
- **Ray Tracing** – Variable octagonal coverage areas determined by impedance clutter data between polygon centroid and shape points. Requires Clutter data (Conic tile system) is selected in plan's data selection, and the Impedance Manager defines wireless signal propagation characteristics

Cell Radius (Meters) – Constant coverage radius assumption for Fixed and Average radius polygon strategies above

Cell Granularity Ratio – The interval along conduit edge segments that cell towers are placed when searching for optimal placement

Minimum Ray Length (Meters) – *Used only when Ray Tracing is selected* - Minimum ray length used when computing diagonal rays

Snapping Distance (Meters) – Determines the cell radii overlap with each other during the initial cell node placement.

DSLAM Node Constraints – FTTN/DSL equipment behavior settings

Placement Strategy – *Same functionality and options as for Cell Node Placement Strategy*

Cell Radius (Meters) – Currently not used

Cell Granularity Ratio – The interval along conduit edge segments that the terminals are placed when searching for optimal placement

Snapping Distance (Meters) – Determines the radii overlap with each other during the initial node placement

Optimization Speed (Mbps) – The minimum service speed that each connected location is required to achieve. The setting is used in conjunction with Rate Reach Manager to calculate the maximum distance between a location and its serving DSLAM/FTTN node to deliver the minimum speed.

Planning Constraints Manager defines various optimization constraints, reporting settings, and technology-specific parameters

Equipment Constraints – Fiber route starting point(s) settings

Fiber Routing Mode – Determines where to originate/splice from when designing the new fiber paths.

- **Route From Fiber** – Routes start at splice points that are automatically placed on top of existing fiber. Interval Buffer Distance setting in Fusion Manager defines how densely those synthetic splice points can be placed
- **Route From Nodes** – Routes originate from Central Office or <u>existing</u> splice points (i.e., layer containing splice points data that is selected in the Equipment data selection dropdown)

Minimum Fiber Splice Capacity – Defines the minimum splice point capacity required to be usable in the plan, i.e., only splice points with spare capacity set above this threshold are used in a plan. Note that splice point capacity must be defined on the equipment layer for this setting to take effect.

Missing CO Strategy – Defines what to do when a Central Office is not present in the selected service area(s), i.e., how to go about placing a new CO required for a network in the area:

- **Do Nothing** – Do not place a new Central Office. As a result, there will be no planned fiber in areas with no existing COs
- **Use Existing Splice Points Only** – Place a new CO on top of <u>existing</u> Splice Points *(when splice point data layer is selected)*
- **Use Synthetic Splice Point Only** – Place a new CO on top of auto-generated splice points from a selected existing fiber layer, i.e., place CO on top of existing fiber
- **Use All Splice Points** – Use a combination of existing and synthetic splice points for optimal CO placement
- **Use Primary Edges** – *Preferred* - Place a new CO anywhere along the primary Conduit layer (typically roads)

Competition Fiber – Wholesale & Tower competition threshold

Fiber Buffer Size (Meters) – Defines the radius used to determine the competitive presence of other service providers from the target location, used in its fair share calculation

Edge Snapping Settings – Defines maximum distances from conduit to location-supporting equipment

Max Distance – Location to Edge (Meters) – Maximum distance from the conduit edge for the target to be considered routable

Max Distance – Equipment to Edge (Meters) – Maximum distance from the conduit edge for the equipment to snap to a fiber network

Equipment Constraints

Fiber routing mode	Route from fiber
Minimum fiber splice capacity	0
Missing CO strategy	○ Do Nothing
	○ Use Existing Splice Points Only
	○ Use Synthetic Splice Points Only
	○ Use All Splice Points
	● Use Primary Edges

Competition Fiber

Fiber buffer size (m)	152.4

Edge Snapping Settings

Max distance - location to edge (m)	500
Max distance - equipment to edge (m)	300

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Planning Constraints Manager defines various optimization constraints, reporting settings, and technology-specific parameters

Service Area Buffering – Service Area conduits inclusion settings

Edge Buffer Distance (Meters) – Maximum buffer distance outside of the selected service area(s) to allow the planned fiber to go through. This allows the planned fiber to temporarily leave the service area to reach locations inside of it that would otherwise be unreachable though the conduit networks restricted to the service area boundary, e.g., reach the other side of the lake, or take more direct / cheaper path in service areas that are oddly shaped.

Location Clustering – Automatic location clustering/merging settings

Business Cluster Distance (Meters) – Defines the maximum cluster width for business endpoints. Inside each cluster, the business are aggregated together into a single latitude and longitude, and the planned fiber and equipment reach only this single point rather than each location individually. Revenues and financial potential of each locations are not impacted preserving the integrity of the business case.

Household Cluster Distance (Meters) – Defines the maximum cluster width for residential endpoints. Inside each cluster, the households are aggregated together into a single latitude and longitude, and the planned fiber and equipment reach only this single point rather than each location individually. Revenues and financial potential of each locations are not impacted, preserving the integrity of the business case.

Service Area Buffering	
Edge buffer distance (m)	400
Location Clustering	
Business cluster distance (m)	0
Household cluster distance (m)	0
Cluster Discounting	
Discount Strategy	Linear

Cluster Discounting – *Used for Integrated Build planning only* – defines how to discount future revenues of location clusters. *It is only applicable when Slack Cluster Rule Type is set to Cluster, i.e., when Integrated Build module is engaged.*

Discount Strategy – Defines the discounting strategy for location clusters

- **None** – Do not discount revenues
- **Linear** – Turns on the discount strategy for Integrated Builds. Linear option helps when a slack cluster has a small number of locations with a significant variance in potential revenue. When selected, the expected revenue is discounted based on a factor that is derived from a ratio of the Expected Revenue and the Median Revenue from a distribution of the locations in the cluster.

Planning Constraints Manager defines various optimization constraints, reporting settings, and technology-specific parameters

Hub Clustering – Settings defining how to generate hub-service areas and where to place the network equipment

Hub Cluster Strategy – Specifies an approaches for deciding on where to place Fiber Distribution Hubs
- **DAG (Directed Acyclic Graph)** – *Legacy* – The algorithm places hubs "downstream" from the CO, prioritizing filling the hub with as many locations as possible (within the maximum locations per hub constraint).
It is a very fast algorithm but may result in oddly shaped hub serving areas.
It should only be used to reproduce legacy Arrow results *(pre-2021)*
- **Minimum Spanning Tree** – Similar to DAG, however, prior to doing the hub placement, the algorithm uses a minimum spanning tree to eliminate redundant conduits from the route, e.g., if there are multiple road edges connecting the same point it removes the longer ones. This is also a fast algorithm, that produces slightly more realistic hub serving areas.
- **K-Means Clustering** – *Default* – The algorithm uses a clustering approach to first cluster locations based on the road distance, and then places hubs in relation to these clusters, while ensuring the maximum locations per hub (or cluster) and the maximum distance from locations to the hub settings are honored.
This approach results in the most realistic output, i.e., like what a network engineer would plan by hand, but is slightly slower than the other two. Nevertheless, any analysis (short of high-level *relative* comparison of attractiveness of different markets) should be using this approach.

Polygonizer Road Edge Types – *Used only with K-means clustering strategy* – Defines which road edge types to use when dividing the whole service area into smaller polygons, that are then used in K-means analysis to determine final hub serving areas. Using the Polygonizer results in hub boundaries that are closer to what a network engineer would design. It also improves overall plan runtime.

Polygonizer Hub Cutting Threshold – *Used only with K-means clustering strategy* – Threshold at which additional road edge types are considered. For example, with Primary and Secondary entered and Hub Cutting Threshold set to 5, if any of the polygons created using Primary roads have 5 or more Hubs Secondary roads will also be used to further divide the polygons.
Note that this value may need to be carefully calibrated to match your exact preferences and current planning practices.

Resolve Hub Overlap – *Used only with K-means clustering strategy* – In areas with sparse road network, it is possible to encounter two hubs leveraging the same road segments to connect their respective locations. When this occurs, hub boundaries may overlap. This setting detects such scenarios and places a third hub to ensure all three polygon boundaries do not overlap with each other. The approach effectively reduces the size of the two original hubs and forces the third one to be placed.

Near Net – Near-Net module settings

Near Net Strategy – Enables leveraging the Slack Loop clusters along routes targeting specific locations. The Slack Cluster Rule Type needs to be enabled, and the Business Cluster distance should be set to 0. For example, Slack Loops will be placed along the path when a plan is run for selected Cell Tower locations and Slack Cluster Rule Type is enabled for Medium Businesses. In addition, routed lateral fiber distances are calculated for each Medium Business included in a cluster.

Splice Separation – Determines the distance interval along the Fiber route evaluated for placing Slack Loops.

Planning Constraints Manager defines various optimization constraints, reporting settings, and technology-specific parameters

Location Data – Location-level reporting settings

Location Cost Persistence Types – Defines the level of detail to preserve when saving location-level attribution of plan's costs. Note that this writes significant amount of data into the database, and should only be used when necessary

- **Summary Cost** – Total attributed cost (fiber + equipment) as a single entry
- **Detail Cost** – Detailed cost attribution by equipment and fiber type
- **Total Cost** – *only for RFP plans* – Minimum cost needed to connect the location. (This ignores fiber route sharing benefits with other targets included in the plan)
- **Cash Flows** – Year-over-year financial model components, as selected in the settings below

Cash Flows: Component Analysis – When locations-level cash flows are enabled in Location Cost Persistence above, it defines which components of the business model to save for each location:

- **BAU** – BAU for all locations in the service area – *generally redundant*
- **BAU Plan** – BAU for all locations passed by the planned network
- **BAU Remaining** – BAU for locations not passed by the planned network – *generally redundant*
- **BAU Intersects** – All passed locations that are still subscribers of the legacy technology
- **New Network** – All passed locations that already migrated to the new technology
- **Planned Network** – All passed locations (New Network + BAU Intersects)
- **Incremental** – Incremental impact of the new network, i.e., Planned Network – BAU Plan

Cash Flows: Selected Curves – When locations-level cash flows are enabled in Location Cost Persistence above, it defines which line items of the business model to save for each location

Cable Codes – Defines available cable sizes, by fiber cable type. Cables are rounded up from their exact strand count (based on the downstream locations demand) to the next available size. Cable surcharges for each size can are defined in the Price Book and are added on top of fiber install costs.

Feeder Fiber Cable Codes – List of eligible Feeder fiber sizes

Distribution Fiber Cable Codes – List of eligible Distribution fiber sizes

Lateral Fiber Cable Codes – List of eligible Lateral fiber sizes – *only used in Integrated Build plans*

Planning Constraints Manager defines various optimization constraints, reporting settings, and technology-specific parameters

Fiber Planning – Defines how to treat/cost instances of feeder and distribution fiber overlapping with one another

Pricebook Defined Overlap Cost – When selected, all instances of overlapping fiber will be separately itemized in the bill of materials, and a separate Price Book cost code is used when costing the overlapping distance. You can set the "Planned Overlap" fiber cost in Price Book to $0/m to completely eliminate double counting of the overlap portion of the network, or to any number lower than actual fiber cost to represent the reduced cost of such double routes. Total route mileage is unaffected by this setting

Slack Cluster – *Used to engage the Integrated Build planning functionality* – Defines the behavior of slack loop location clusters

Slack Cluster Rule – Turns the slack loop location clustering on/off
- **None** – No clustering, *i.e., the Integrated Build functionality is off*
- **Cluster** – Turns the slack loop clustering on for the Integrated Builds

Slack Cluster Types – Defines which location types are aggregated into slack loop clusters. Note that running plans with slack clustering enabled but no eligible endpoint types selected is equivalent to running the plan without the Integrated Build functionality enabled.

Subnet Output – Sub-service area financial reporting settings

Generate Financials – Directs the tool to saves financial details at a subnet level, e.g., by hub, enabling more granular cost reporting

Data Generation Settings – Settings defining how much detailed data to saved with each plan

Summarize Service Mods – Summarizes all equipment, fiber, and coverage for a plan as it is modified

Generate Plan Location Links – *Required to retrieve routed locations reports* – Directs the tool to save the linking between each target endpoint and the equipment it connects to, enabling detailed reporting of each connected locations in a plan – *Keep selected*

Generate Subnet Linking – *Required for Plan Editing* – Directs the tool to establishes tracing between equipment, fiber, and endpoints which enables generation of network topologies – *Keep selected*

Persist Junction Nodes – When selected, the includes Junction Nodes in its detailed equipment output and cost breakdown

Aggregated BOM – When selected, the tool produces breakdown of equipment and fiber costs, vs. just the total cost – *Keep selected*

Fiber Planning	
Pricebook Defined Overlap Cost	☐
Slack Cluster	
Slack Cluster Rule Type	None
Slack Cluster Types	celltower ✕ large ✕
Subnet Output	
Generate Financials	☑
Data Generation Settings	
Summarize Service Mods	☐
Generate Plan Location Links	☑
Generate Subnet Linking	☑
Persist Junction Nodes	☐
Aggregated BOM	☑

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Planning Constraints Manager defines various optimization constraints, reporting settings, and technology-specific parameters

Edit Plan Setting – Defines UI behavior in Plan Edit mode

Use Only Selected Locations – When selected, only the originally selected target locations will be displayed in the Edit Mode. This makes it easy to, e.g., inspect that all targets have been connected (or view the ones that were not), but eliminates the possibility of expanding the list of plan targets from inside the Edit Mode, e.g., by manually adding a new hub

Debug Setting– Debugging settings

Log Request Event – *Do not enable unless directed by the Customer Success team* – Saves detailed debugging data in the database

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