DSRC Research Paper (Working Draft)

Dynamic sustainable resource composability

Business simulation of short-term network capacity purchases

TM Forum Catalyst | C26.5.1006

Project: Dynamic sustainable resource composability	Document: Business simulation working paper
Status: Working draft	Evidence: Synthetic simulation
Date: 11 November 2026	

TM Forum project listing

tm forum **Catalyst project team**

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TAUSPACE

Purpose

When one operator runs short of capacity, can it buy a few hours of radio access or backhaul from a neighbour for less than it would cost to serve the same demand itself? We built a simulator to test where this works, what the buyer can afford and whether the supplier has a reason to sell.

Our starting point is the best existing arrangement. In the Souillac network example, scheduled sharing captures about 96% of the saving available from sharing. In a separate purchasing experiment, where the cheaper supplier changes, buying at the current price cuts combined cost by 14.5% against the schedule. One supplier still earns less. That is the commercial question for an operator trial: can the parties agree prices that leave each better off?

Three questions with different answers

Question	What the model measures
Can the network carry the traffic?	Usable radio and transport paths, capacity in each window and continuity when resources switch.
Is buying better than the alternative?	The buyer's spending, each seller's margin and the combined cost of serving the same demand.
Who is owed what?	The agreement, the resource each seller supplied and the evidence supporting its charge.

What the evidence supports

The network and purchasing results use synthetic operating data. The project also demonstrates a purchase and fulfilment workflow using mock APIs. We have not measured operator savings, provisioned a live network or tested whether an AI agent makes better decisions than the rules used here.

The practical next step is an offline replay with two competing operators in one service area. Before asking either to integrate systems, establish how often a usable offer exists, what cost it avoids and whether both parties would accept its terms.

1 The network and demand model

The model follows three operator groups, A, B and C, for 48 hours in 24 two-hour windows. Each group has demand, one radio access network (RAN) host and a local transport route. A customer group can use another operator's host or route only where the input data permits the connection.

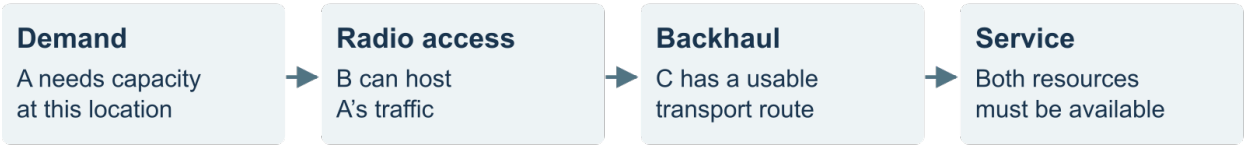


Figure 1. A feasible path can have two suppliers. Radio headroom alone does not make a usable offer.

Why we started with Souillac

The 2022 census records 4,941 residents in Souillac Village Council Area, Mauritius [1]. A national mobile traffic benchmark gives 17.18 GB per resident per average month for 2024 [2]. We use those figures to set the scale of demand. Neither tells us which sites serve Souillac, when they are busy or what any operator pays.

Input	Default for Souillac	Evidence status
Demand over 48 hours	5,580 GB after rounding	Derived from population and national usage. Local hourly shape and operator split are assumed.
Supply per operator	300 Mbps RAN; 600 Mbps transport	Illustrative inventory. The model holds 20% in reserve and requires two active radio groups.
Conditions at a site	Power, backup, maintenance, demand peaks and link failures	User-defined events. A failed uplink or route removes a path; it cannot create a new one.

What can transfer to another place

The approach also has profiles for Kenya, Sri Lanka, South Africa, the UK, Germany, Saudi Arabia and the UAE. Those comparison profiles use an assumed 10,000 residents and the same illustrative inventory. They are useful for testing assumptions, not for ranking networks. An operator study needs measured demand, verified sites and working interconnections for its chosen area.

2 What changes when a site loses power

In the Souillac case, grid power fails at A at noon on day one. The cut lasts eight hours and the assumed backup lasts eight hours. Diesel raises the cost of keeping A active; the base case does not exhaust its fuel. Every policy faces the same demand and outage.

Operating policy	Default cost	Demand +25%	What the stress test shows
Independent operation	130.70	Incomplete	Two windows cannot serve all demand.
Fixed sharing with hindsight	127.65	129.83	One fixed resource set passes both checks.
Scheduled sharing	114.51	119.75	The cheapest policy that passes under stress.
Dynamic sharing	113.79	117.31	Allocates all traffic but fails two switching checks under stress.
Dynamic with switching limits	121.67	123.84	Fails one switching check under stress.

Table 1. Combined operating cost for 48 hours in model USD. A lower price counts only if the service checks pass. All five policies pass both checks in the default run.

The right baseline

The default dynamic plan costs 16.91 less than independent operation, but only 0.72 less than scheduled sharing (0.6%). For an operator that can already share on a schedule, 0.72 is the relevant saving. At 25% higher demand, the lower dynamic subtotal no longer qualifies.

At noon on day one the three groups need 350 Mbps. In the selected dynamic window B and C supply radio access and A still carries backhaul on backup power. The mock verifies 350 Mbps. Moving the radio traffic did not remove the need to keep A’s site powered.

What the cost includes

Of the dynamic total of 113.79, energy and generator idle cost account for 64.56; transport for 43.20; switching and overlap for 2.03; and coordination for 4.00. Moving traffic saves diesel only if fuel use falls. Putting a route to sleep does not remove a fixed lease payment.

The allocator checks capacity after reserve. During a switch it checks whether the previous active resources could carry the incoming load using raw capacity. Passing that check does not prove seamless handover. A full allocation is a plan; the mock separately records whether each selected path was delivered.

3 The business case for a purchase

This experiment has its own workload and prices. A requests 20 Mbps for two hours, twice per window: 48 purchases in 48 hours. One block-hour is 10 Mbps for one hour. Of 192 block-hours requested, A supplies eight during activation and buys 184. Both policies below meet all demand.

Supply pattern	Purchase rule	A pays[1]	B margin	C margin	Combined
Changing offers	Scheduled	212.16	67.20	0.00	144.96
Changing offers	Current offers	169.92	23.00	23.00	123.92
Predictable	Scheduled	212.16	105.60	0.00	106.56
Predictable	Current offers	169.92	46.00	0.00	123.92

Table 2. Model USD over 48 hours. [1]A's total cost includes own supply, reserve and transaction costs as well as payments to sellers. Margins exclude integration and other fixed costs.

Who would agree to these prices

When B and C take turns as the cheaper supplier, A saves 42.24 and combined cost falls by 21.04 (14.5%). B's margin falls by 44.20; C gains 23.00. The deal creates value across the group, but B could prefer the schedule. When B stays cheaper throughout, A still saves 42.24 while combined cost rises by 17.36 (16.3%). The buyer's bill alone gives the wrong answer.

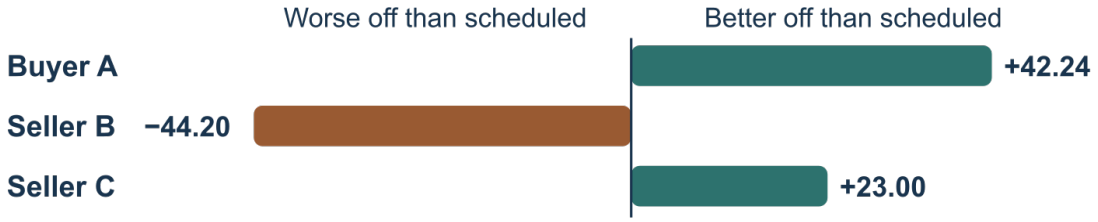


Figure 2. Gains against the schedule in the changing-offer case. The three positions add to a combined saving of 21.04 model USD.

How the changing offer result adds up

Each seller supplies 92 block-hours at 0.70 per block-hour against a supply cost of 0.45. Each earns 92 × 0.25 = 23.00. A pays 128.80 for external capacity, 20.00 for own supply, 15.36 for reserve and 5.76 to transact: 169.92 in total. Across the operators, the payment becomes seller revenue. Count the 82.80 cost of supplying those blocks instead, and the combined total is 123.92.

The same changing-offer run costs 160.72 under fixed-price purchasing. The 22.9% difference against that rule answers a different question from the 14.5% against scheduled sharing. Neither percentage is a forecast of an operator's annual savings.

4 From an offer to a settlement record

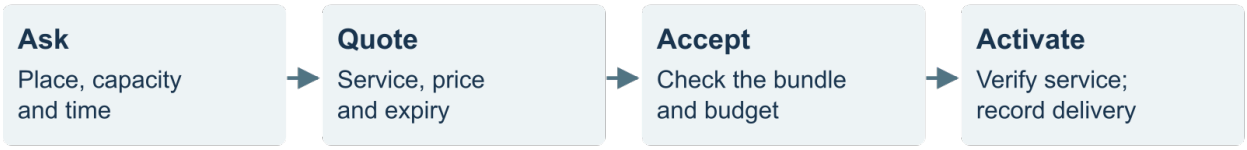


Figure 3. Each operator keeps control of its commitments. Pricing and ordering can be automated under a standing agreement.

The network simulator sends the selected paths to a shared mock server. It uses catalogue and agreement records (TMF620, TMF651), a quote (TMF648), product and service orders (TMF622, TMF641), and service inventory (TMF638). Only a verified external path counts as delivered. An unresolved activation retains its reservations. The partner's OSS fulfilment demonstration is separate. No live BSS, network or payment system is connected.

Who pays for the missing hour

In a separate settlement replay, A books 100 Mbps from 18:00 to 22:00. B reserves radio at $8 per hour. C supplies backhaul at $12 per verified service hour. Backhaul starts one hour late.

	18–19	19–20	20–21	21–22
B Radio	Reserved	Reserved	Reserved	Reserved
C Backhaul	Not delivered	Delivered	Delivered	Delivered

Figure 4. The evidence is the same under both tariffs. The contract determines whether the first radio hour earns a charge.

Under a reservation tariff A owes B $32 and C $36: $68. Under a delivery-only tariff A owes B $24 and C $36: $60. That $8 shifts liability; it does not change the resources used. If evidence for C's last hour is missing at close, $12 stays on hold until it is confirmed or released.

We propose the Inter-Operator Dynamic Settlement Protocol (IODSP), evolved from the OmniBOSS Phase III disaster settlement work, to link each charge to the agreement, order, supplier, interval and delivery record. It establishes what is owed. Service fulfilment and payment remain separate.

5 A trial two operators could run

Start in one service area where competing operators can reach the same demand. Pick a recurring need, such as planned maintenance. Agree the service target, permitted uses and evidence both sides will accept. Replay the period offline before spending money on integration.

Record	One row represents	Fields needed
Supply and rights	A resource or permitted connection	Owner, site or route ID, endpoints, capacity (Mbps), reserve, sharing permission and validity dates.
Demand and availability	A resource or group in one interval	Timestamp with zone, interval length, offered Mbps, usable capacity, outages, maintenance and backup remaining.
Offers and decisions	A quote or attempted purchase	Request ID, seller, quantity, start, expiry, price unit, reservation or delivery tariff, acceptance or refusal and reason.
Delivery and money	An order interval for one supplier	Order ID, resource, activation, verified quantity, evidence status, charges, credits and any dispute.
Operator costs	A resource interval or trial task	Avoidable energy and transport cost, seller's next best use, staff time, failed attempts, setup and recurring support.

The decision to proceed

Use the same demand and service target for own supply, scheduled sharing and current offers. For each operator, compare its net cost or margin with its best feasible alternative. Include unsuccessful attempts. If the average gain per attempt is positive, divide its monthly fixed cost by that gain and round up: that is the number of attempts it needs to break even. Compare this with observed activity. A zero or negative gain has no break-even volume at those terms.

Use anonymised IDs and a common clock to join records. Label indicative quotes where no trading history exists. Measure unserved demand and activation delay alongside cost. The first candidate areas are Souillac or Moneragala; neither is a confirmed deployment.

What an agent would need to prove

A rule can already ask for a quote and buy within a limit. Test an agent against that rule with identical offers, budgets and failure events. Give it a clear objective: minimise cost while meeting the service and reserve targets. Measure any gain alongside invalid orders, decision time and recovery when a supplier is unavailable.

Reading the simulator

The network view follows traffic through a service window. The purchasing view follows an order. They answer different questions and use different inputs.

Souillac at noon during the power cut

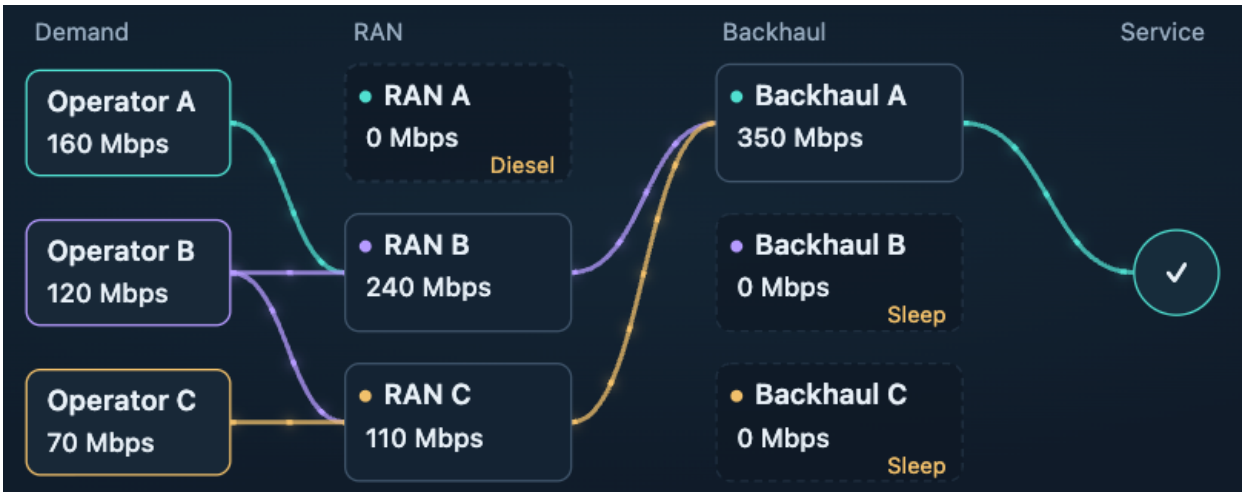


Figure 5. The network simulator shows 160 Mbps from A, 120 from B and 70 from C. B and C carry the radio load; all 350 Mbps leave on A's backhaul.

Read the map from left to right. A's radio carries no traffic, but its site still needs backup power for backhaul. Counting the whole site as a diesel saving would overstate the benefit. The checkmark means the mock verified service in this window.

The first purchase under changing offers

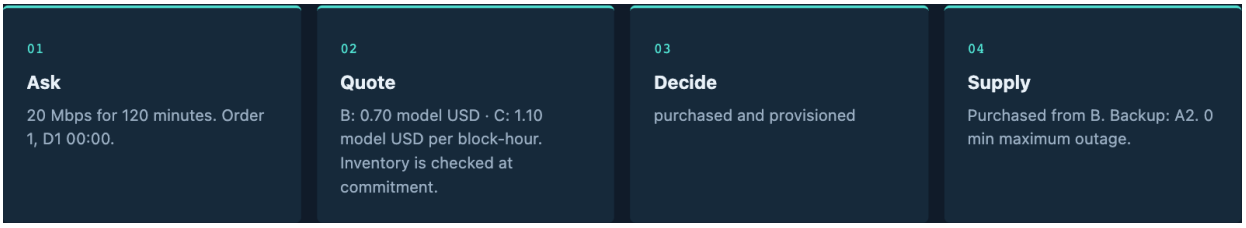


Figure 6. In the pricing experiment A asks for 20 Mbps for two hours. B quotes 0.70 and C quotes 1.10 model USD per 10 Mbps-hour. The rule buys from B and retains backup.

This trace explains how the model chose a supplier. It is not an HTTP log. The network simulation below sends actual requests to a mock server.

APIs used in the network simulation

The browser selects a candidate path. The mock server decides whether the resources can be committed and records what was delivered. A quote by itself reserves nothing. The sequence below follows a path that buys capacity from another operator.

1 Read the offer and the terms

TMF620 Product Catalog Management supplies the network-path and resource offers. TMF651 Agreement Management supplies the standing agreement. The browser reads both at the start of a run.

2 Quote and admit the order

TMF648 Quote Management prices the path for a window. The buyer accepts the quote. TMF622 Product Ordering Management then checks current capacity, permissions, the buyer's budget and each seller's credit limit before reserving the bundle. An accepted quote can still fail that check.

3 Activate and verify the service

TMF641 Service Ordering Management opens the service order. A simulator-only control produces the fulfilment outcome; TMF638 Service Inventory Management exposes the resulting service state. Both radio and backhaul must be verified before the path counts as delivered. An unknown outcome holds capacity and funds, with no earned charge.

4 Record what each supplier is owed

The proposed IODSP interface accepts a commitmentRecord against the transaction ID and delivery evidence, then creates a bilateralStatement for each external supplier. Owned resources earn no inter-operator charge. A failed bundle earns zero under the network mock's tariff; a statement is not a payment.

These are selected TM Forum API operations and a proposed DSRC settlement interface, exercised against synthetic records. One shared server represents the operators. This demonstrates the exchange, not TM Forum conformance or a live fulfilment integration.

Method and sources

Allocation and demand

For each two-hour window the allocator enumerates active radio and transport combinations and uses minimum-cost flow to route 10 Mbps blocks. Each group's traffic must reach a permitted radio host, then a reachable route. Total flow cannot exceed either resource's available capacity after reserve. The model does not predict radio propagation or separately size the access link.

Mean Mbps = population × GB per resident per month × 8,000 ÷ seconds in an average calendar month × local demand factor. The average month is 365.25/12 days. A normalised daily profile and operator shares distribute the volume. The second day repeats the first before event effects are applied.

Policy and scope

The fixed benchmark can use hindsight to choose one active resource set for all 48 hours. The schedule knows baseline demand and planned maintenance, and can use a feasible fallback. Dynamic sharing chooses the cheapest feasible plan in the current window, including switching cost. The switching-limits variant also tests a minimum saving and a minimum time between changes.

Power and transport affect operating costs; RAN and transport capacity determine feasible routes. Shared field visits, ducts, sites and points of presence are candidates for future experiments. The current results assign them no saving. Spectrum, core costs, tax and full network capital costs are outside the operating subtotal.

Sources and reproducibility

[1] Statistics Mauritius, 2022 Housing and Population Census, Volume III. Table G1, printed page 5: Souillac Village Council Area population.

[2] ITU, ICT Development Index 2026 dataset. Mauritius, 2024 inputs, Data!O96 and I96. Traffic per subscription and subscriptions per 100 residents yield the national demand benchmark.

[3] DSRC Business Impact Assessment. Slides 6–10 cover the network baseline, block-hour costs and operator incentives.

[4] DSRC Settlement Management. Standing-agreement replay and the relationship between delivery evidence and bilateral statements.