

Techno-Economic Modelling of Mobile Access Network Alternatives

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Overview

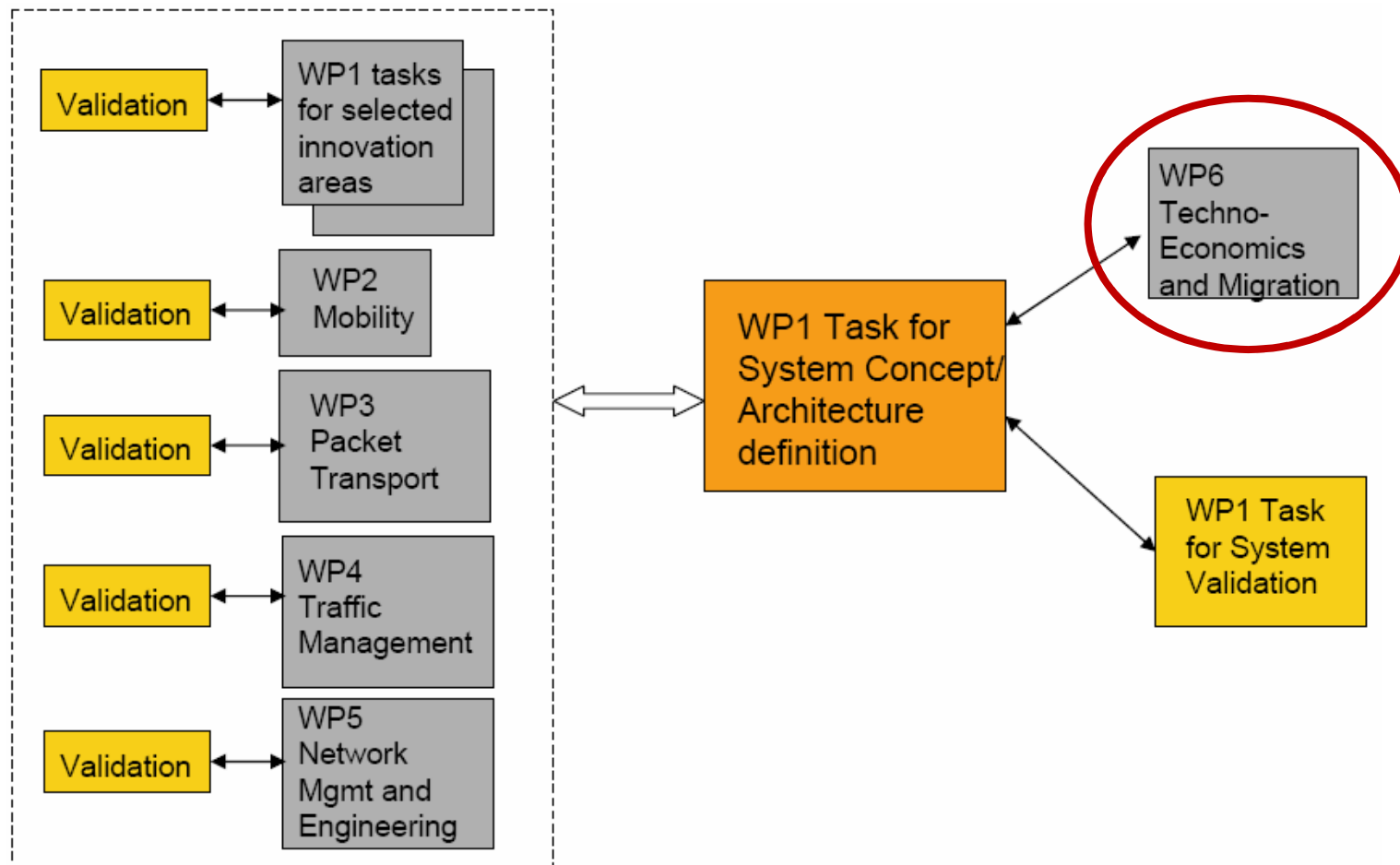
- MEVICO project
- Techno-economic modelling (with STEM)
- Techno-economic example
- Access network modelling
- Backhaul alternatives
- Summary

MEVICO project

“Mobile Networks Evolution for Individual User Experience”

- EU Celtic Call 7 project
- European consortium of about 25 partners in 10 countries
- Project Co-ordination: Nokia Siemens Networks, Finland
- Ends by End of 2012 / Later in 2013
- Focusses on LTE EPC and Backhaul network

MEVICO tasks → WP 6



Techno-economic modelling

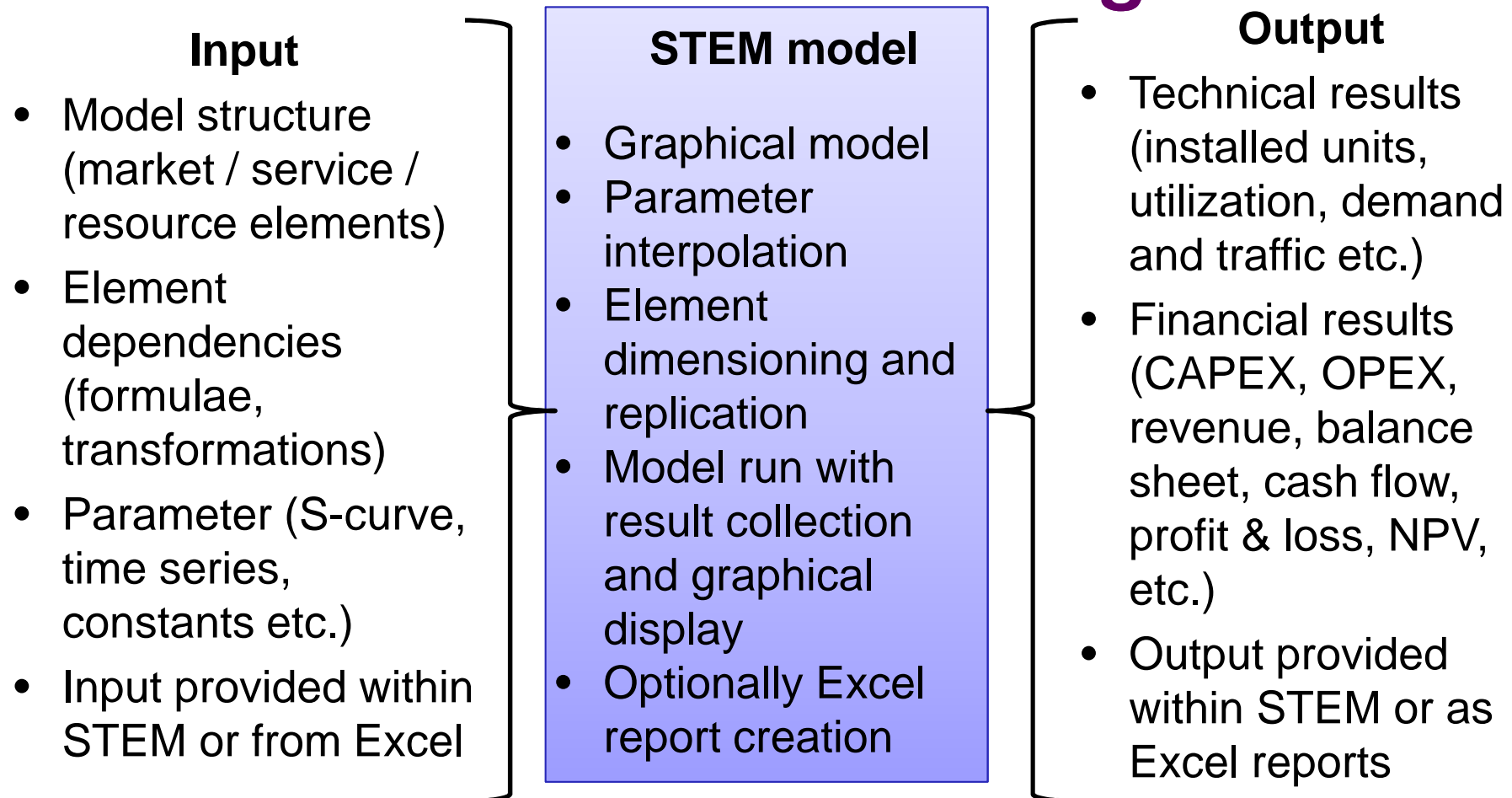
What is it?

- Business case modelling taking into account the technical dependencies and constraints during the process of cost and revenue calculations
- Long term business planning supporting strategic decisions and medium term operations and management decisions
- Periodic model runs with adopted input for result consolidation, operations controlling and decision valuation
- Sensitivity analysis reveals focus areas/elements for optimization

What is it not?

- No replacement for network planning
- Normally not inventory based
- No real-time or short term monitoring or controlling

Techno-economic modelling in STEM



(STEM ... Strategic Telecoms Evaluation Model)

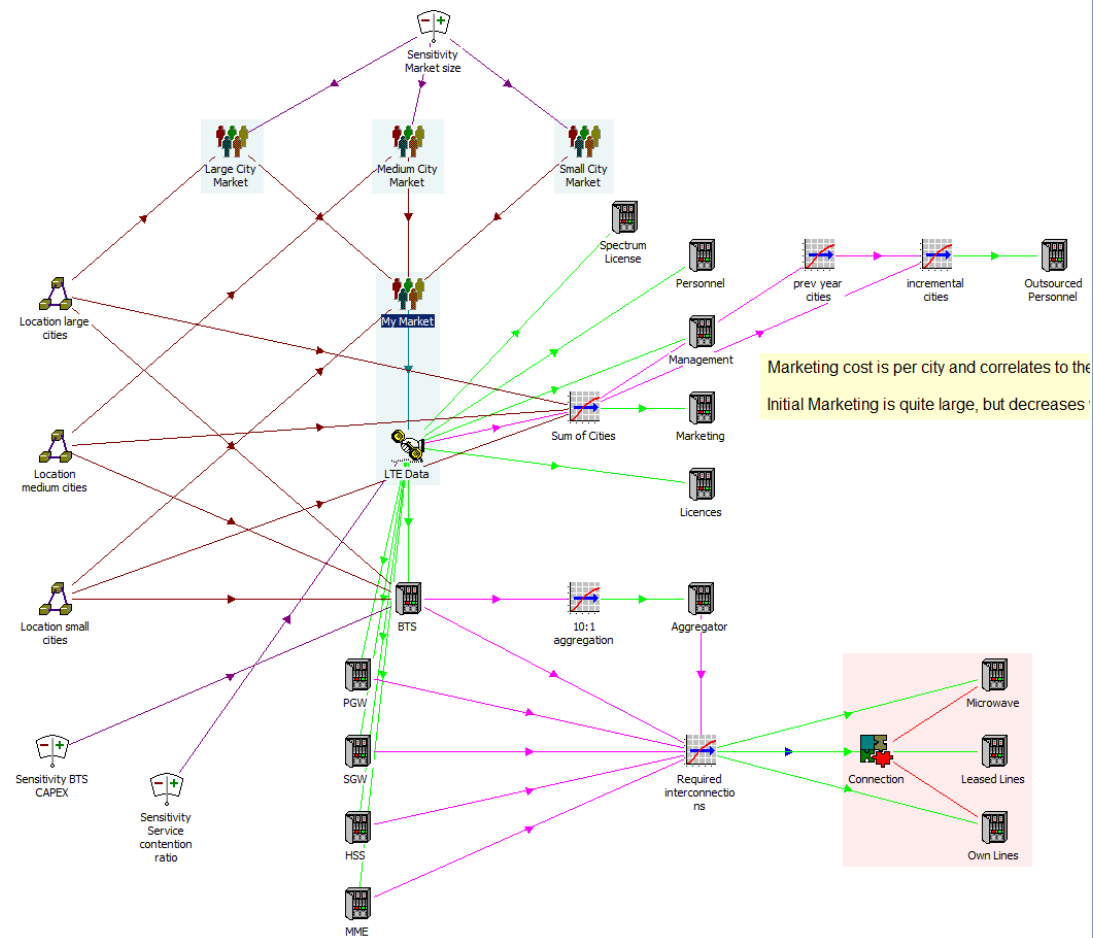
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Techno-economic example

LTE business case model

- LTE roll-out over several years in 3 types of cities
- Single flat-rate data service with setup fee and monthly tariff
- Aggregation tree in access and backhaul network
- Using different transport technologies and
- Considering extra cost (marketing, personnel, licences etc.)



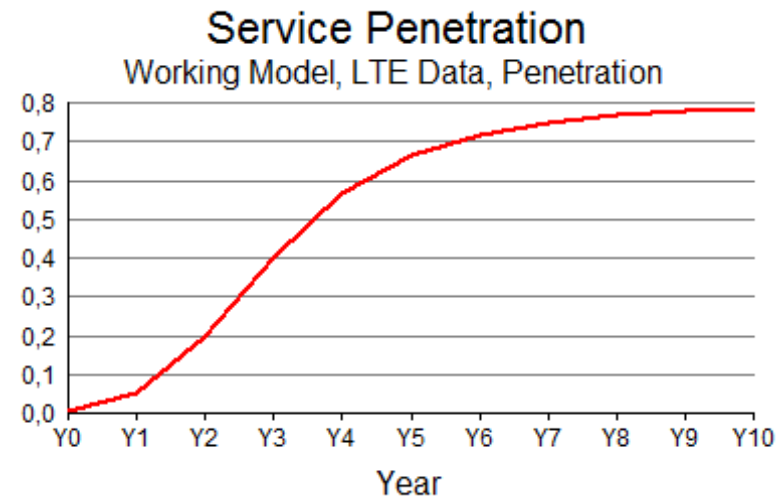
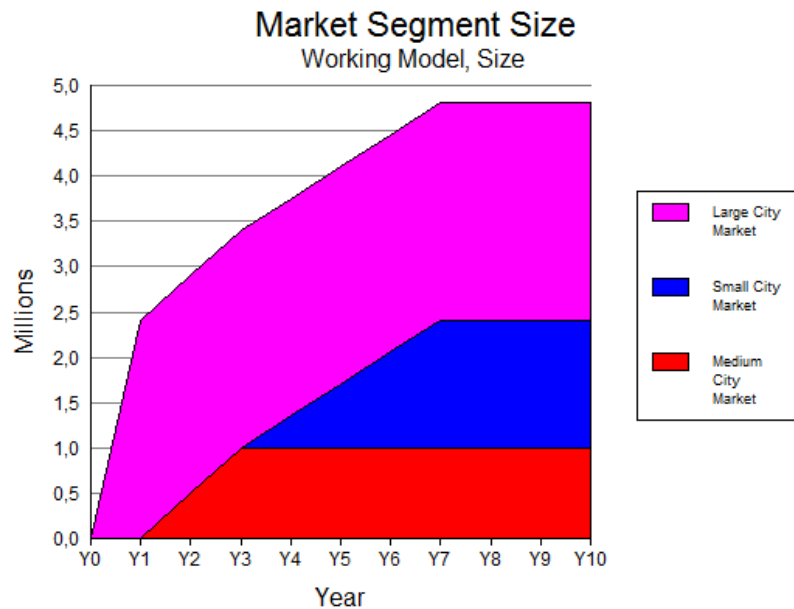
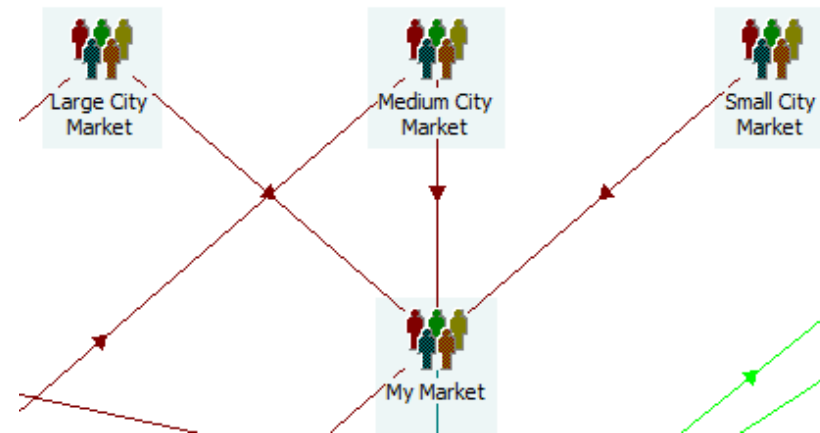
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Techno-economic example

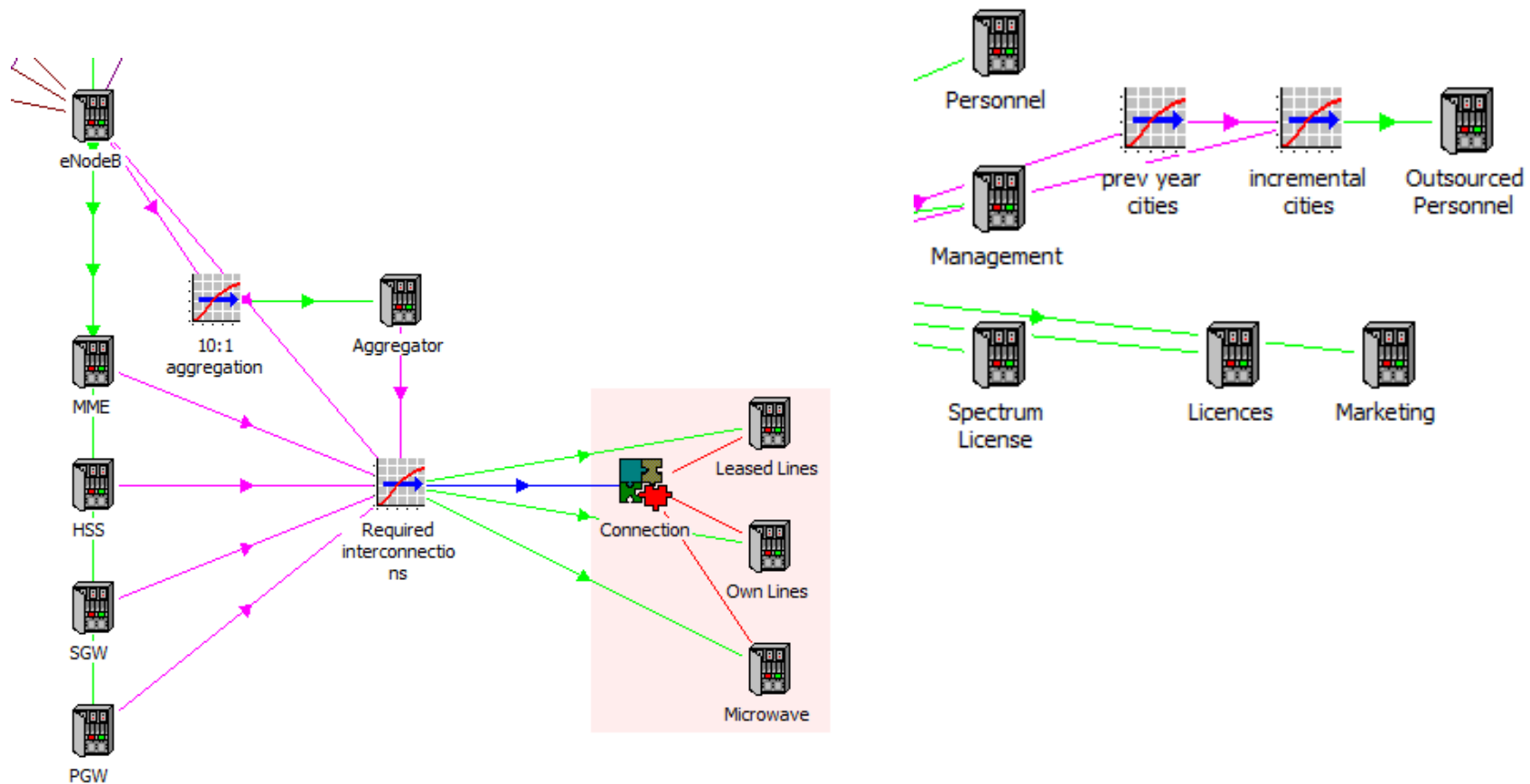
Cumulative market structure

- Potential customer bases rises with the LTE roll-out progress
- Market penetration determines the resulting service demand



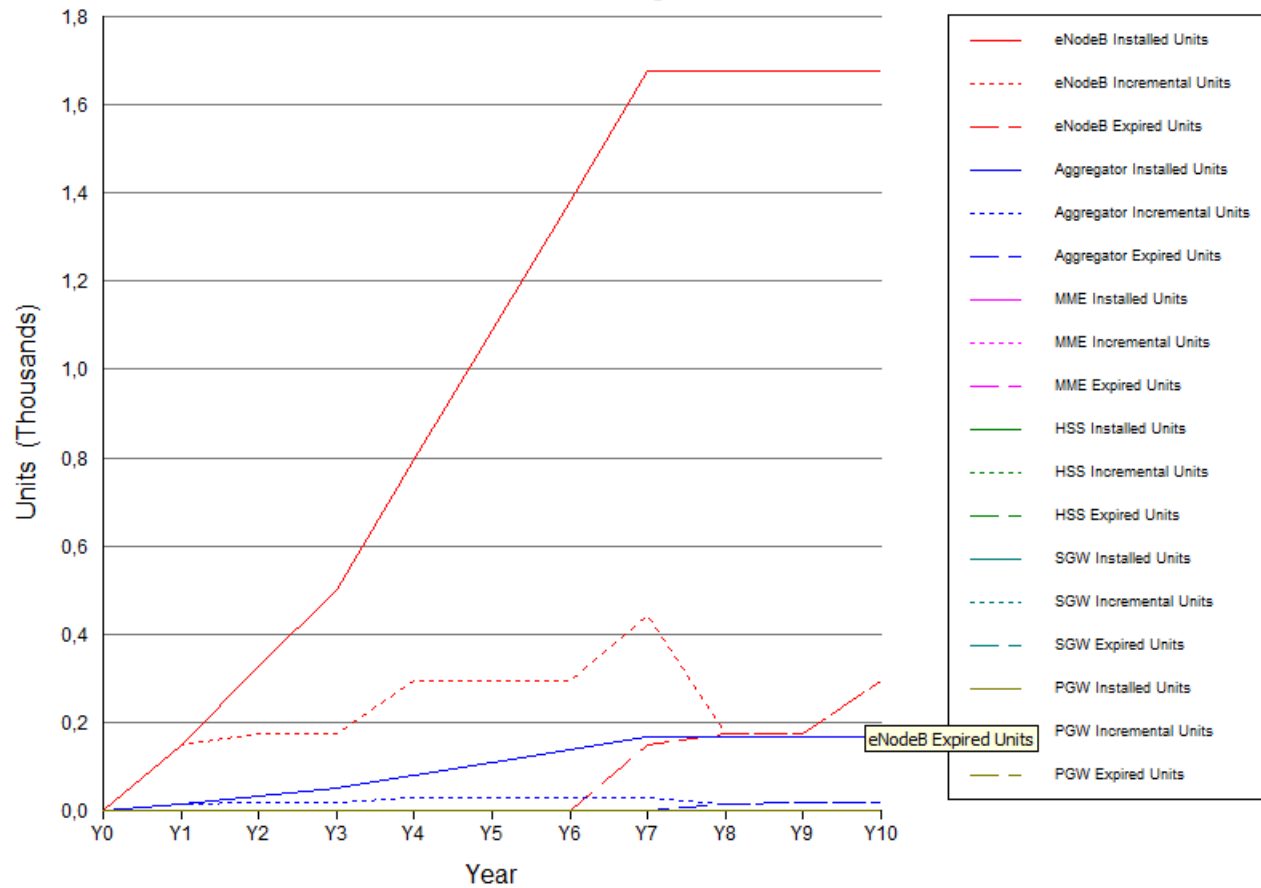
Techno-economic example

LTE elements, transport resources and general expenses



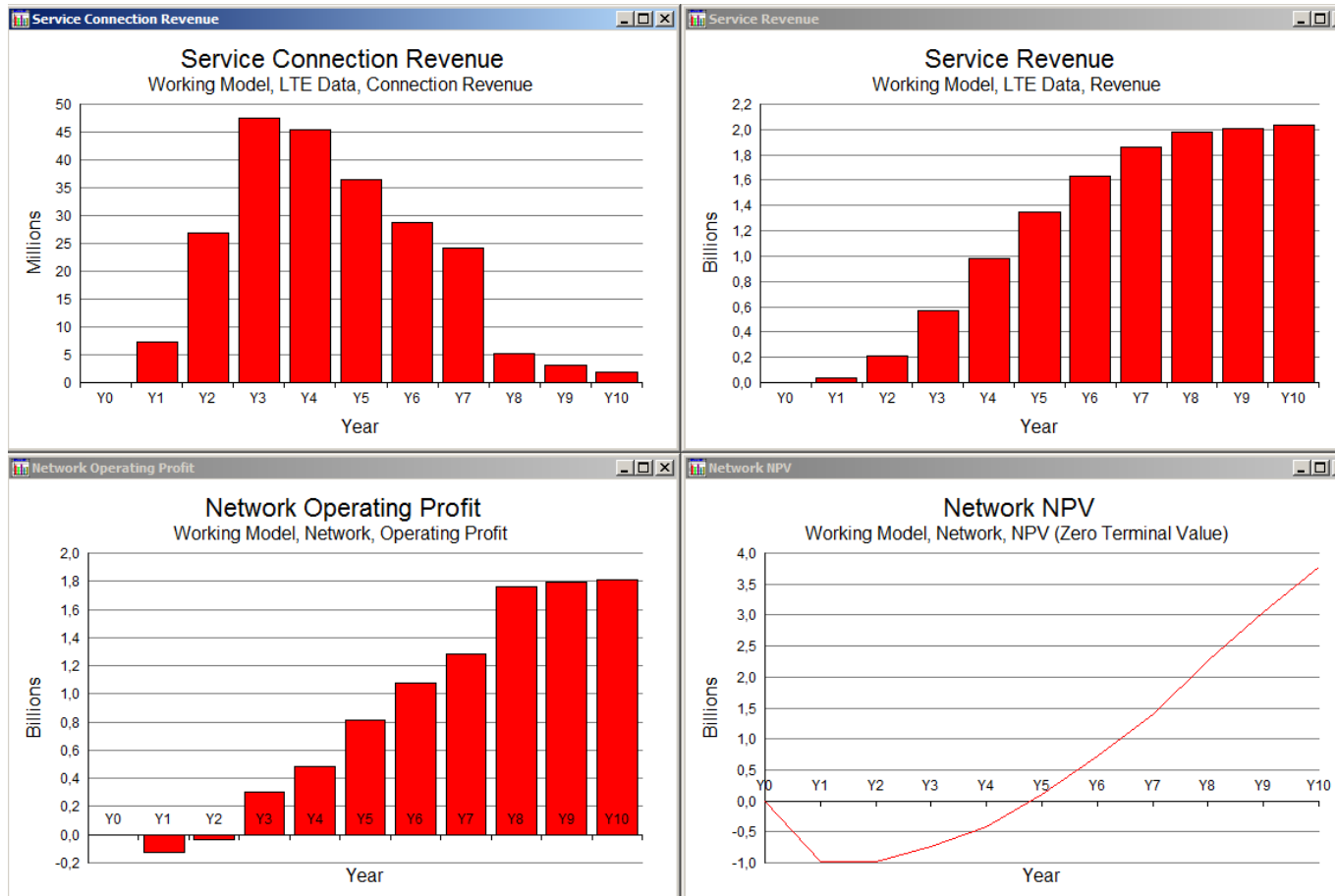
Techno-economic example

Resource Installed and Incremental Units
Working Model



Techno-economic example

Revenue and Profit



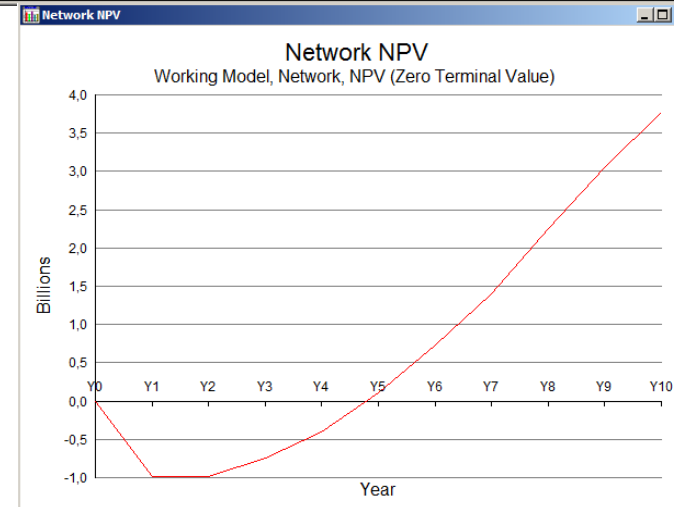
Techno-economic example

Financial statements

Millions	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Cash	0	1	2	3	5	6	8	9	9	9	9
Cash Deposits	0	0	0	0	346	1.175	2.276	3.584	5.411	7.281	9.163
Debtors	0	3	18	47	81	110	134	153	162	165	167
Current Assets	0	4	19	50	431	1.291	2.418	3.746	5.583	7.456	9.339
Net Tangible Assets	0	21	43	61	92	117	136	162	148	133	128
Net Intangible Assets	0	933	867	800	733	667	600	533	467	400	333
Investments	0	0	0	0	0	0	0	0	0	0	0
Long-Term Assets	0	954	909	861	825	784	736	695	615	533	461
Total Assets	0	958	929	911	1.256	2.075	3.154	4.441	6.198	7.989	9.800
Overdraft	0	0	0	0	0	0	0	0	0	0	0
Long-Term Borrowing Payable	0	96	93	28	0	0	0	0	0	0	0
Creditors	0	1	2	3	5	6	8	9	9	9	9
Tax Payable	0	0	0	0	0	0	0	0	0	0	0
Dividends Payable	0	0	0	0	0	0	0	0	0	0	0
Current Liabilities	0	97	95	31	5	6	8	9	9	9	9
Borrowing Payable after One Yr.	0	383	371	112	0	0	0	0	0	0	0
Total Liabilities	0	480	466	143	5	6	8	9	9	9	9
Share Capital	0	608	624	624	624	624	624	624	624	624	624
Retained Earnings	-0	-130	-162	144	627	1.444	2.522	3.807	5.565	7.355	9.166
Equity	0	478	463	768	1.252	2.069	3.146	4.432	6.189	7.980	9.791
Total Liabilities plus Equity	0	958	929	911	1.256	2.075	3.154	4.441	6.198	7.989	9.800

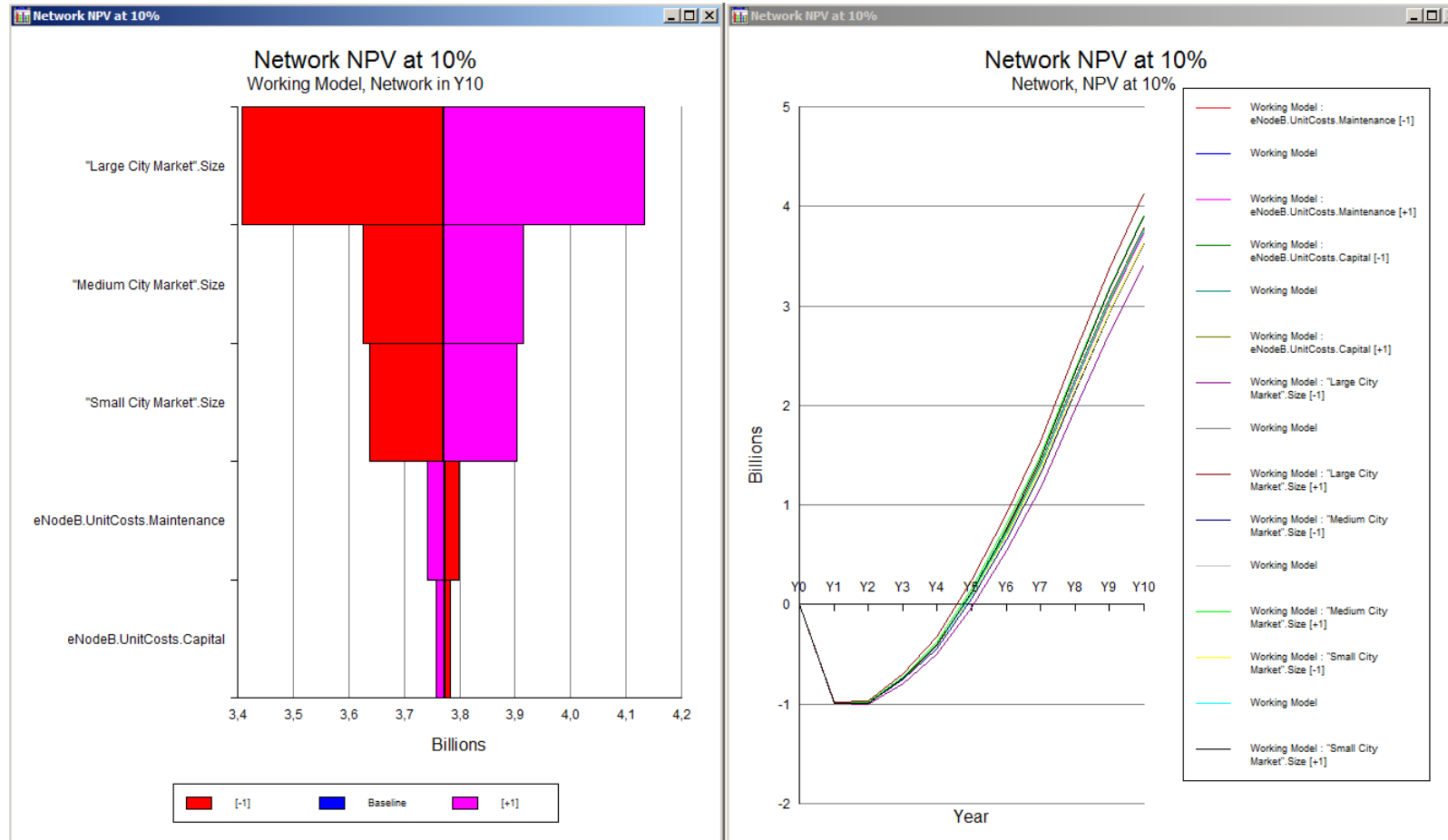
Millions	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Revenue	0	40	213	568	984	1.344	1.630	1.864	1.976	2.011	2.032
Depreciation	0	93	157	162	378	385	392	399	40	41	42
Amortisation	0	67	67	67	67	67	67	67	67	67	67
Operating Costs	0	9	21	35	55	75	94	112	112	112	113
Operating Profit	-0	-129	-32	305	484	817	1.078	1.286	1.757	1.791	1.811
Profit on Sale of Assets	0	0	0	0	0	0	0	0	0	0	0
Interest Income	0	0	0	0	0	0	0	0	0	0	0
Interest Expense	0	0	0	0	0	0	0	0	0	0	0
Debt Fees	0	0	0	0	0	0	0	0	0	0	0
Pre-Tax Profit	-0	-129	-32	305	484	817	1.078	1.286	1.757	1.791	1.811
Tax Charge	0	0	0	0	0	0	0	0	0	0	0
Net Profit	-0	-129	-32	305	484	817	1.078	1.286	1.757	1.791	1.811
Dividends Declared	0	0	0	0	0	0	0	0	0	0	0
Retained Profit	-0	-129	-32	305	484	817	1.078	1.286	1.757	1.791	1.811

Millions	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Pre-Tax Profit	-0	-129	-32	305	484	817	1.078	1.286	1.757	1.791	1.811
Depreciation	0	93	157	162	378	385	392	399	40	41	42
Amortisation	0	67	67	67	67	67	67	67	67	67	67
Profit on Sale of Assets	0	0	0	0	0	0	0	0	0	0	0
Ch. in Debtors less Creditors	0	3	13	28	32	28	22	18	9	3	2
Tax Paid	0	0	0	0	0	0	0	0	0	0	0
Cashflow from Operations	-0	28	179	505	896	1.241	1.514	1.734	1.855	1.896	1.918
Cap. Ex. - Tangible	0	114	179	180	409	411	411	425	27	26	36
Cap. Ex. - Intangible	0	1.000	0	0	0	0	0	0	0	0	0
Proceeds from Sale of Assets	0	0	0	0	0	0	0	0	0	0	0
Change in Investments	0	0	0	0	0	0	0	0	0	0	0
Cashflow before Financing	-0	-1.086	-1	325	488	830	1.103	1.309	1.828	1.870	1.881
Change in Total Borrowing	0	479	-15	-324	-140	0	0	0	0	0	0
Change in Share Capital	0	608	16	0	0	0	0	0	0	0	0
Dividends Paid	0	0	0	0	0	0	0	0	0	0	0
Cashflow after Financing	0	1	1	1	347	830	1.103	1.309	1.828	1.870	1.881
Ch. in Cash plus Cash Deposits	0	1	1	1	347	830	1.103	1.309	1.828	1.870	1.881



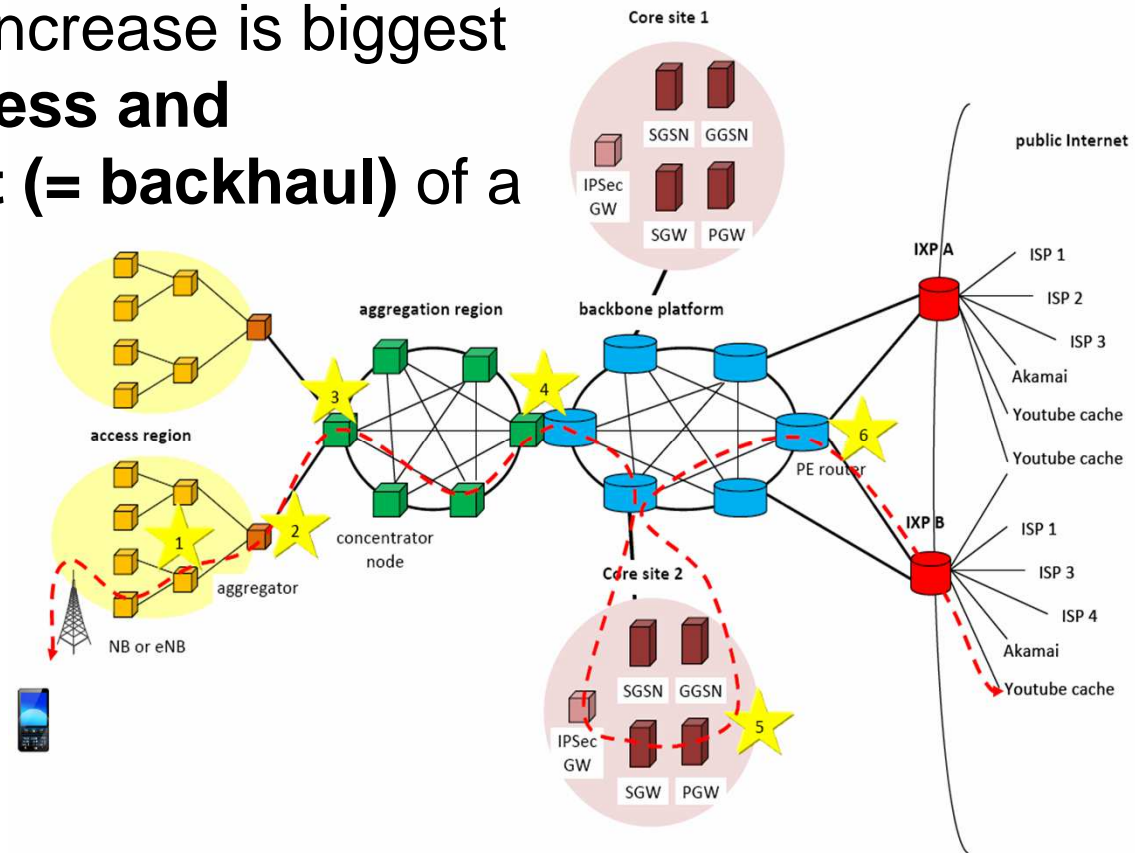
Techno-economic example

Sensitivity analysis / Tornado graph



Access network modelling

Traffic demand increase is biggest challenge for **access and aggregation part (= backhaul)** of a mobile network.



Access network modelling

Typical network structure of backhaul network:

- Tree like traffic aggregation up to Concentrator Nodes (CNs)
- Ring like interconnection of CNs with 5..10 CNs per ring
- Head end CN redundantly connects to the fibre backbone platform of the operator
- Mobile core equipment (e.g. EPC) is also connected to the backbone platform

Backhaul alternatives

Layer 2 alternatives

- Ethernet variants
 - Rapid Spanning Tree (RSTP)
 - Multiple Spanning Tree (MSTP)
 - Shortest Path Bridging (SPB)
 - Transparent Interconnect of Lots of Links (TRILL)
 - Provider Backbone Bridging – Traffic Engineering (PBB-TE)
 - 802.1ad support (“Double VLAN tagging”)
- Generic Framing Procedure (GFP)
 - Single link aggregation over p2p connection

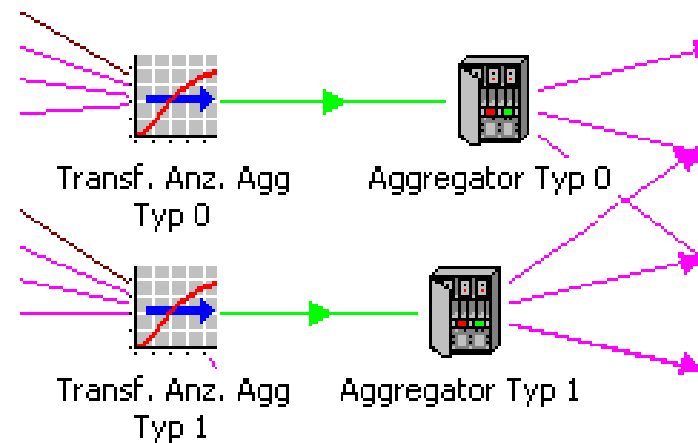
Backhaul alternatives

Layer 2,5 alternatives

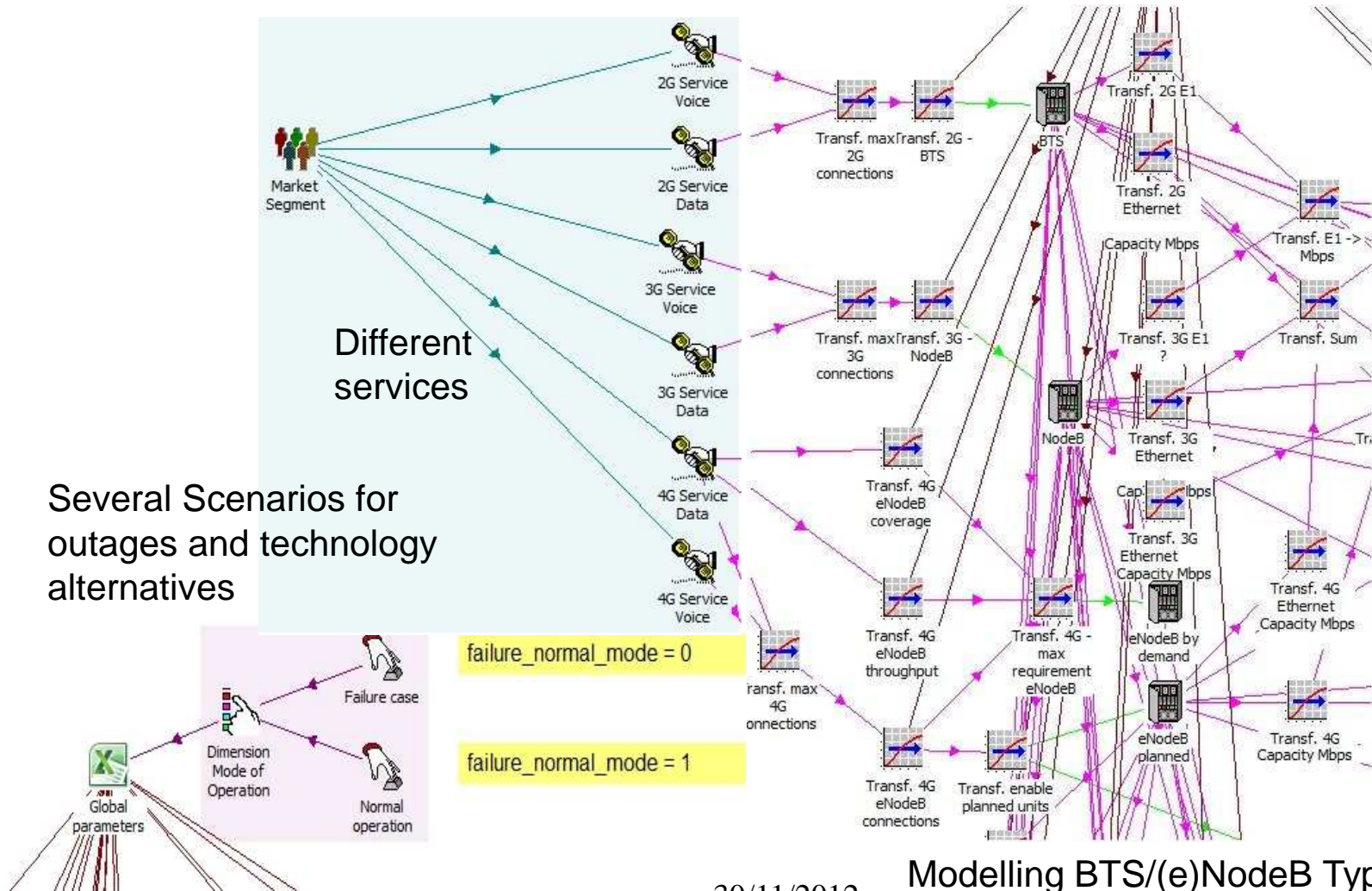
- Multi-Protocol Label Switching (MPLS)
 - Widely used in core, new to access / aggregation
 - Statistical packet aggregates with “engineered” paths
- MPLS Traffic Profile (MPLS-TP)
 - Pseudo-wires over end-to-end LSPs
 - Similar to PWE3
- Seamless MPLS
 - Consistent IP/MPLS deployment
 - Ideally between eNodeB and gateways

Backhaul alternatives model

- Definition of key network elements
- Definition of main transport path alternatives
- Using traffic forecasts
- Using technology roadmaps
- Consideration of migration scenarios

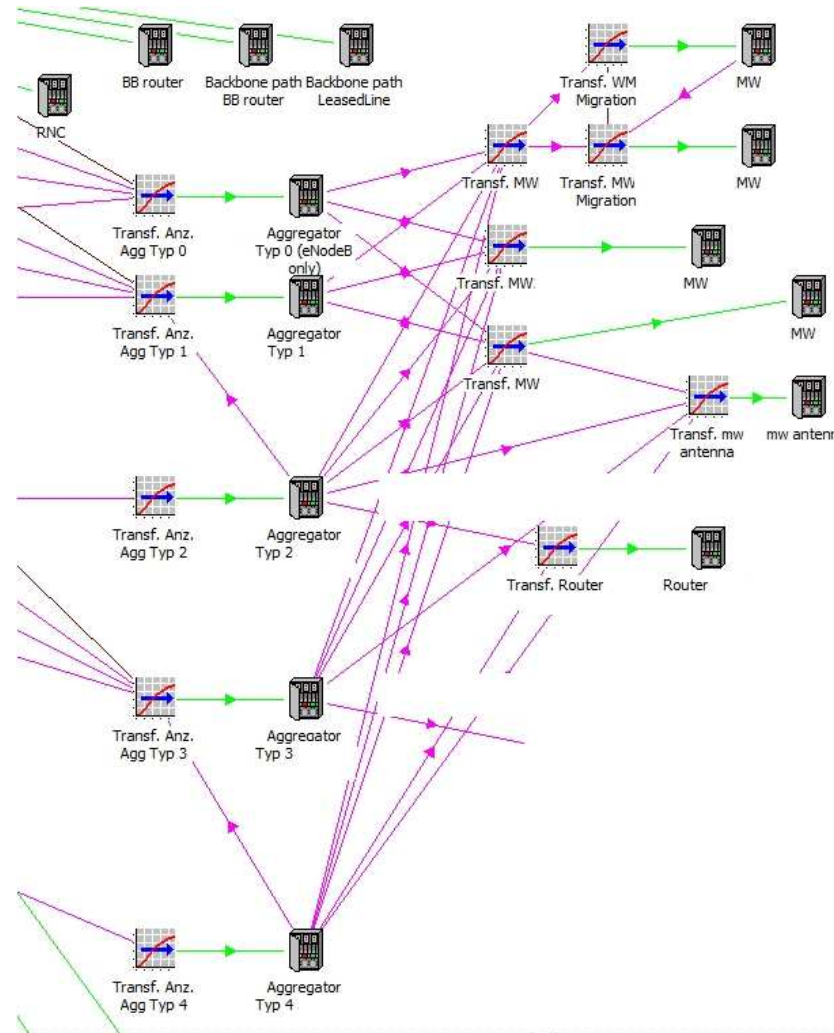


Backhaul alternatives model



Backhaul alternatives model

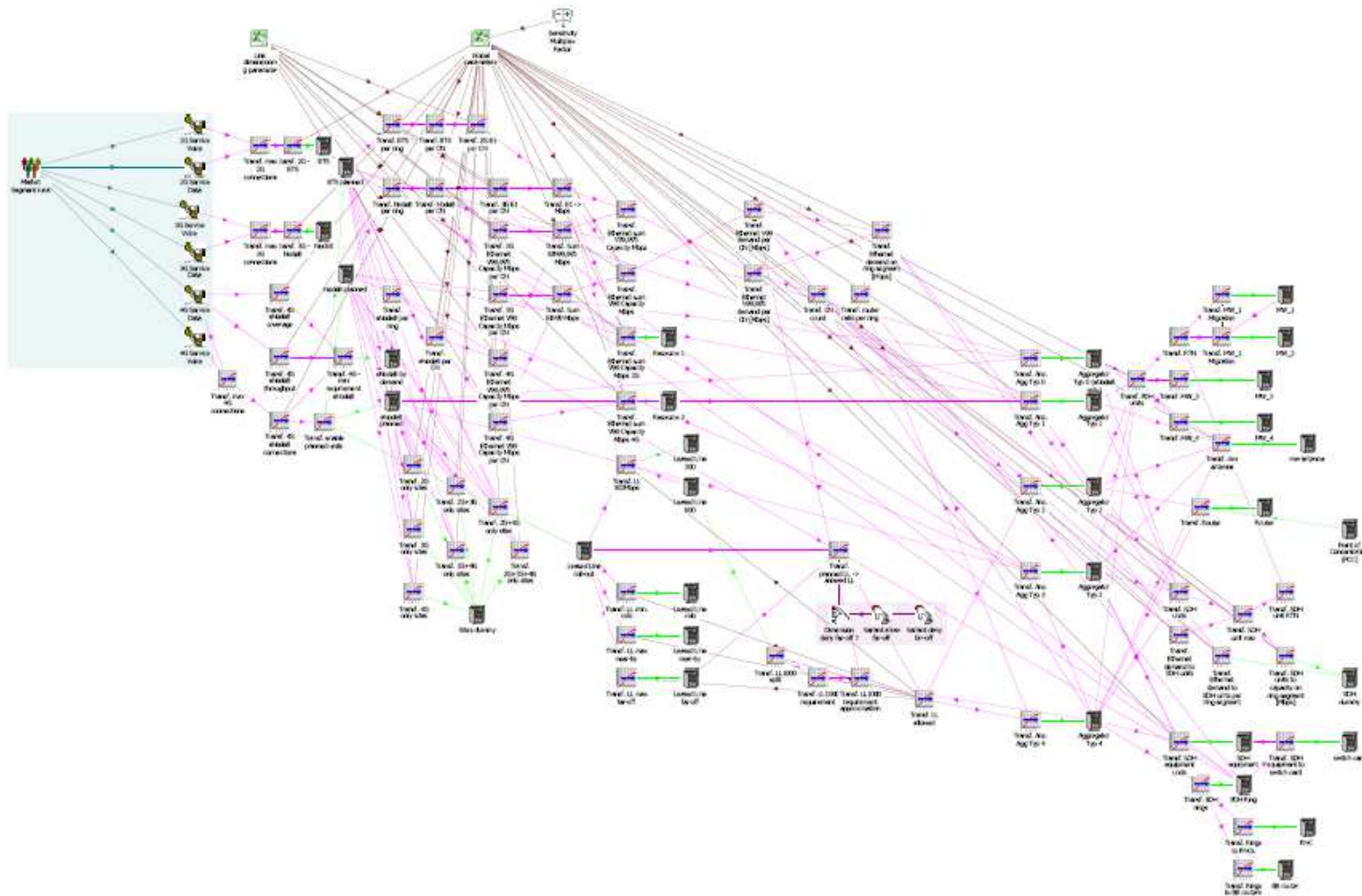
Modelling access and aggregation locations and network equipment by means of Aggregator Types 0 .. 4 with L1 and L2 equipment for scenarios with different alternative solutions



Backhaul alternatives model

- Results on expected concentrator load + outlook how long SDH microwave can cope with it
- Modelling of fibre leased line interconnections to drain traffic and achieve SDH ring life span extension
- CAPEX / OPEX trade-off for near-by vs. far-off leased line interconnects among several LL providers
- Evaluate partially meshed access networks for better demand distribution
- L2 vs. L2.5 migration decision

Backhaul alternatives model

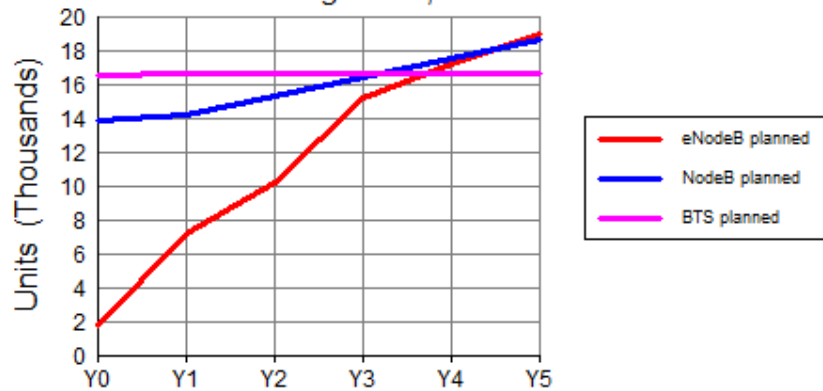


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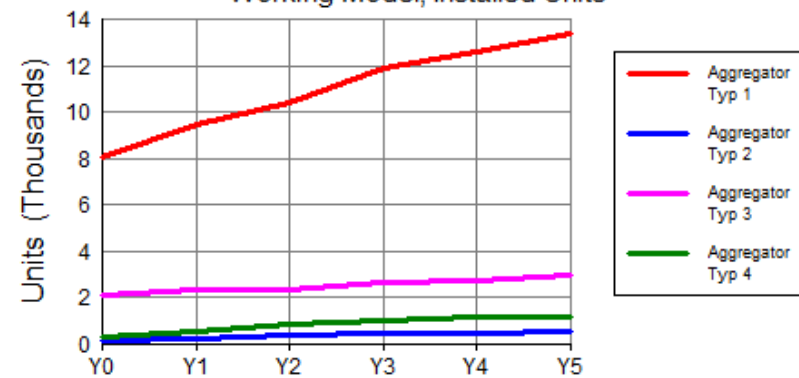
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Backhaul – Installed Resources

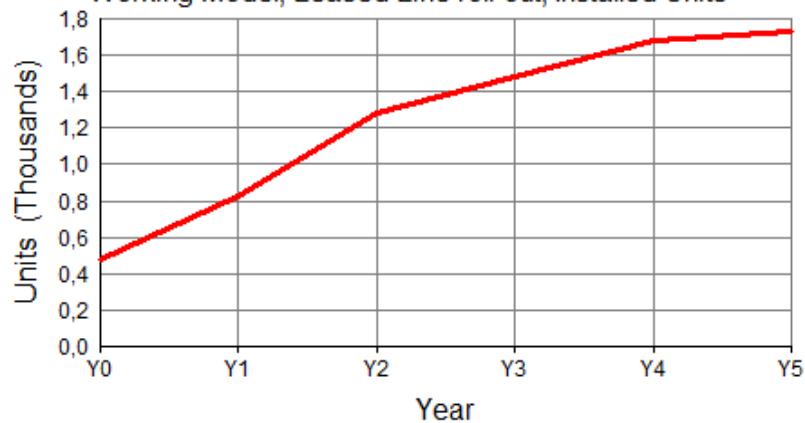
Resource Installed Units
Working Model, Installed Units



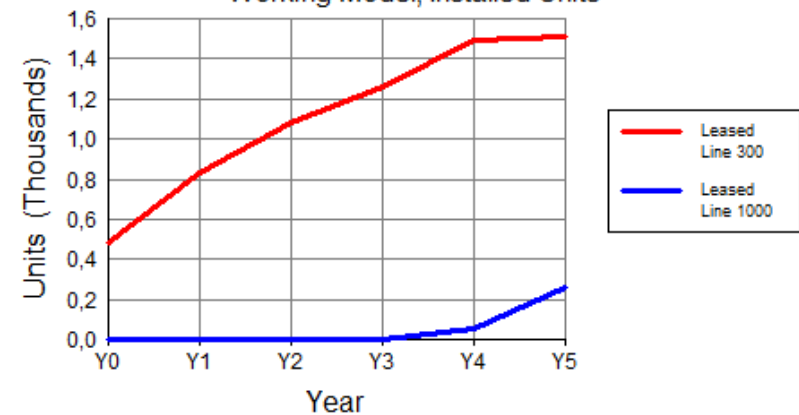
Resource Installed Units
Working Model, Installed Units



Resource Installed Units
Working Model, Leased Line roll-out, Installed Units

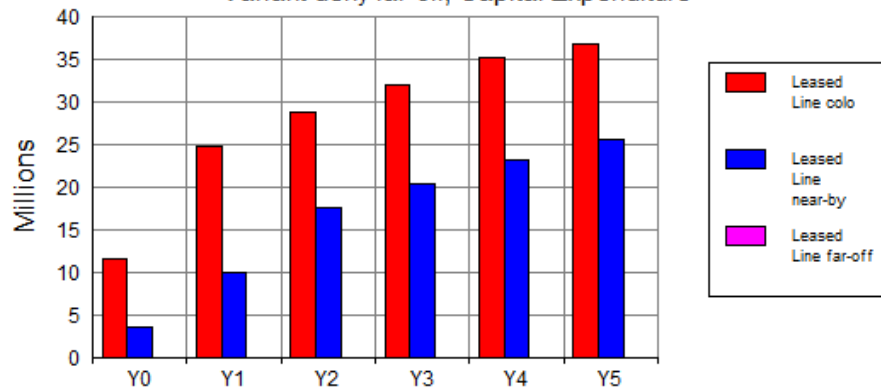


Resource Installed Units
Working Model, Installed Units

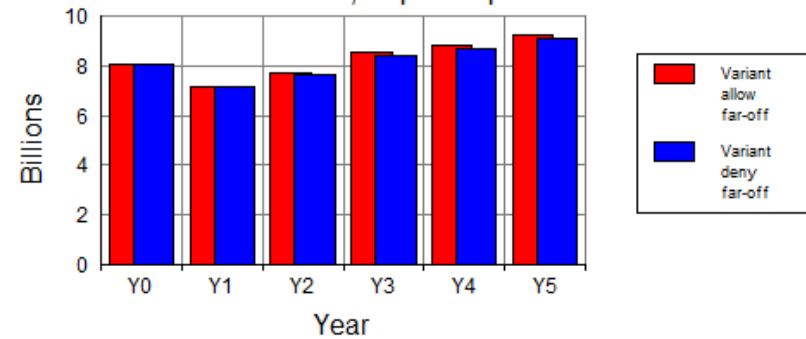


Backhaul – Leased Line far-off

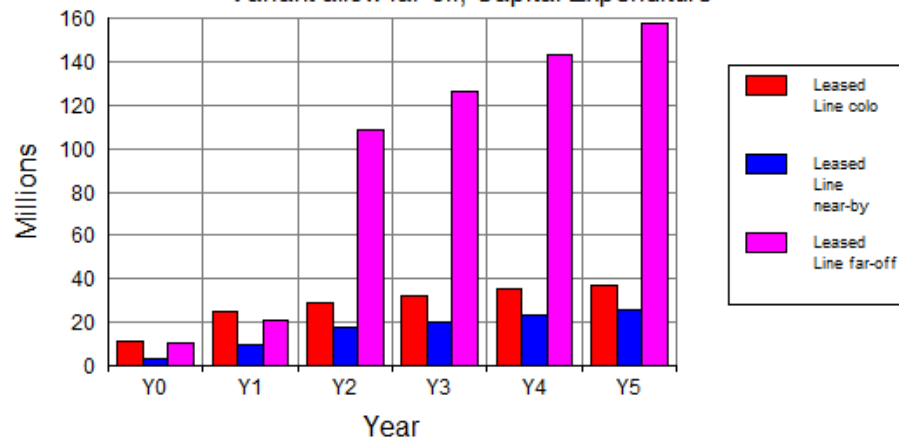
Resource Capital Expenditure
 Variant deny far-off, Capital Expenditure



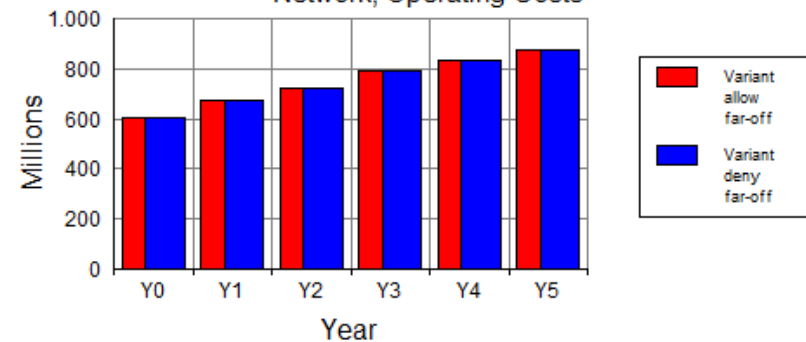
Network Capital Expenditure
 Network, Capital Expenditure



Resource Capital Expenditure
 Variant allow far-off, Capital Expenditure

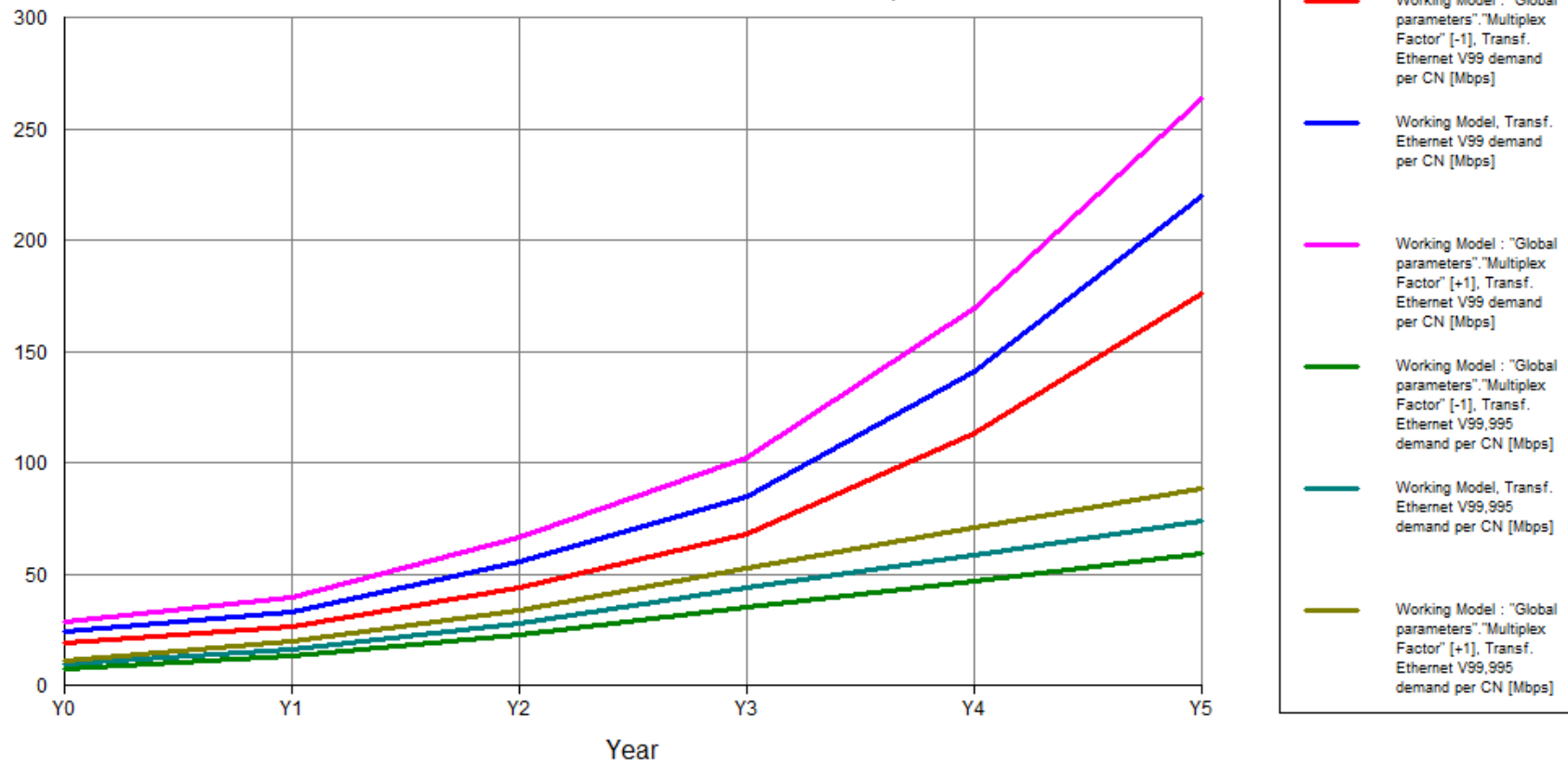


Network Operating Costs
 Network, Operating Costs

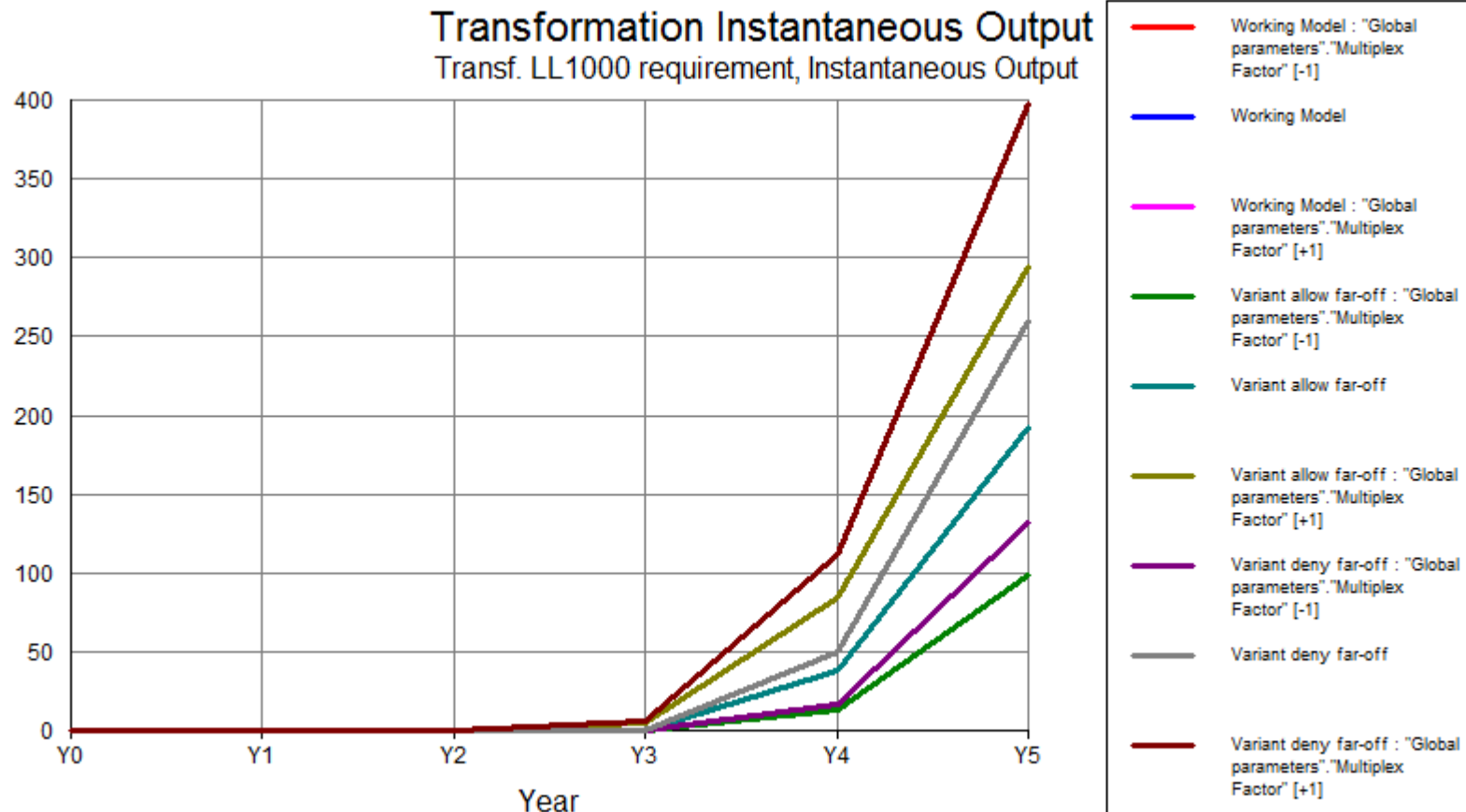


Backhaul – Multiplex Factor

Sensitivity of Multiplex Factor vs. V99 & V99,995 capacity demand
Instantaneous Output

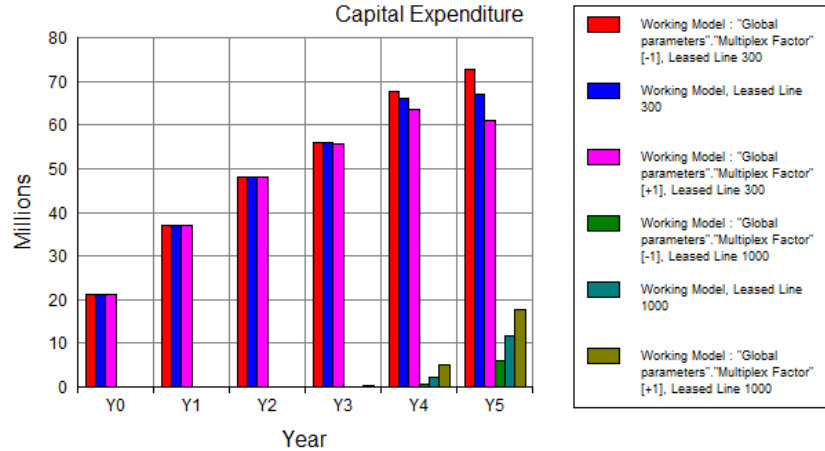


Backhaul – Multiplex Factor

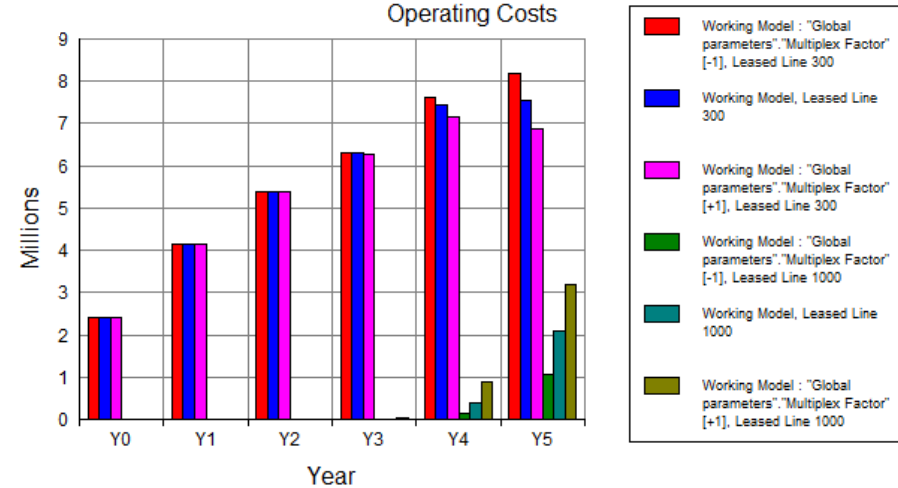


Backhaul – Multiplex Factor

Resource Capital Expenditure
Capital Expenditure



Resource Operating Costs
Operating Costs



Summary

- Operators face many design choices
- Current access network topologies need to be extended
- Detailed techno-economic modelling required
- Complete OPEX modelling also covering Energy cost for network operation
- Modelling reveals dependencies
- Sensitivity analysis reveals cost drivers
- Scenario calculations for strategic decisions

Thank You

<http://www.life-cycle-costing.de/STEM/>